Racetrack Management

A Manual for Racecourse Managers

A report for the Rural Industries Research and Development Corporation

by A.K. Stubbs & J.J. Neylan

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Foreword

A survey of grass racecourses in Australia in 1995 (RIRDC Project TGT-1A), and subsequent Racecourse Managers’ Conferences, has revealed a wide variation in the level of racetrack management expertise and technical knowledge, but a keen desire by racecourse staff to learn more about their craft.

This comprehensive Manual of Racetrack Management includes material from Conference Proceedings, but with more detail and objective information about some topics, plus other sections covering matters not adequately dealt with at conferences.

It will provide a standard reference on latest, best practice options for the fundamentals of racetrack management to increase knowledge and benefits from improvements in track performance, appearance and life, plus associated economic and environmental advantages for racing clubs and the community.

The project was funded from RIRDC Core Funds which are provided by the Federal Government.

The report, a new addition to RIRDC’s diverse range of over 700 research publications, forms part of our Horses R&D program, which aims to assist in developing the Australian horse industry and enhancing its export potential.

Most of our publications are available for viewing, downloading or purchasing online through our website:

downloads at www.rirdc.gov.au/reports/Index.htm
purchases at www.rirdc.gov.au/eshop

Peter Core
Managing Director
Rural Industries Research and Development Corporation
Acknowledgements

Compilation of this Manual of Racetrack Management would not have been possible without the excellent contributions from a large number of authors of papers on the various topics, most of which were presented at Racecourse Managers’ Conferences. The people concerned are given credit at the head of each paper.

In addition, financial support for production of the Manual was generously donated by several companies supplying products and services to the racing industry. They included:

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Bill Heraghty Machinery  Stabilizer Solutions
Heritage Seeds  Steriline Racing
Hunter Irrigation  Strathayr Turf Systems

About the Editors

Arthur Stubbs, Managing Director of Primary Tasks Pty Ltd, has conducted numerous successful projects for RIRDC in recent years, on a range of topics connected with various plant and animal industries.

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They have jointly been responsible for the organisation and running of most of the Australian Racecourse Managers’ Conferences.
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Executive Summary

Introduction

A survey of grass racecourses in Australia in 1995 (RIRDC Project TGT-1A) found a wide variation in the level of racecourse management expertise and technical knowledge, and an expressed need by racecourse managers for more information relevant to their jobs.

This led to Racecourse Managers’ Conferences being held in the following five years, at Rosehill, Moonee Valley, Doomben, Morphetville and Melbourne, each attended by 70 or more racecourse managers from most States, together with suppliers, consultants, turf specialists and researchers associated with the racing industry.

The conferences addressed a wide range of issues connected with racecourse and racetrack management and performance. Conference Proceedings were published including many papers on aspects of racetrack management. The conference papers published to date have not completely covered all aspects of racetrack management, or in complete detail, and are not in a readily accessible reference format.

A comprehensive manual, concentrating on racetrack management, was proposed, to include material from Conference Proceedings, but with more detail and objective information about some topics, plus other sections covering matters not adequately dealt with at conferences.

Objective

Production of a reference manual for racecourse staff on all aspects of racetrack development, maintenance and modification, to extend knowledge of best practices for improved racecourse management.

Methodology

A review and editing of published Conference Proceedings was undertaken as a first step towards compiling manual content. This included consultation with several racecourse managers to guide the scope of the manual. Additional sections were prepared on topics insufficiently covered by conference papers, and contributions sought from persons with particular expertise on some topics.

A manuscript was produced, with illustrations, graphics and diagrams where needed, for printing and distribution by RIRDC.

Results

The outcome is the production of a reference manual for racecourse staff on all aspects of racetrack development, maintenance and modification, to extend knowledge of best practices for improved racecourse management.

Implications

This publication will provide a standard reference on latest, best practice options for the fundamentals of racetrack management to increase knowledge and benefits from improvements in track performance, appearance and life, plus associated economic and environmental advantages for racing clubs and the community.
1. Introduction

A survey of grass racecourses in Australia in 1995 (RIRDC Project TGT-1A) found a wide variation in the level of racecourse management expertise and technical knowledge, and an expressed need by racecourse managers for more information relevant to their jobs.

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2. Racetrack Design and Construction

Introduction

Very few new racetracks are being developed nowadays. However, many current racetracks are under review by club committees and management with the aim of improving both the design and the soil and drainage conditions. Most of these tracks have been laid down decades ago, based on expedient design criteria, usually dictated by the amount and shape of the land allotment available, using the natural topography and soil type with little alteration, and creating a simple turfgrass surface.

As racecourses become fewer in number due to rationalisation of meeting venues, modern racetracks are required to cope with a greater number of racedays (even night racing), increased field sizes, more consistent and safer “going” in all weathers for this increasingly professional industry. In addition, due to the ever rising number of racehorses, and trainers seeking the best possible racetrack-like facilities, the required standard and load capacity of training tracks continues to grow in importance.

A range of reasons, rather than just one, are usually behind the decision to spend money and time on reconstruction of race and training tracks. The normal reasons, many of which are interrelated, include:

- Track surface – drainage, hardness, variability.
- Track shape/design – width, length, angle of curves, chutes, crossings.
- Track topography – evenness, crossfall.
- Turf type – durability, softness, traction.
- Water inflow/outflow – irrigation efficiency, recycling, disposal.

Not surprisingly, at any given time, major re-design and reconstruction of racetracks is taking place, or being planned, on a number of courses throughout Australia. The latest developments in sportsturf technology are being applied to produce uniform, resilient and long lasting turf based racing surfaces to handle the pressures of modern racing. The following papers outline the important factors to consider in racetrack design and construction, and detail experiences from two actual, recent reconstructions.
Track Surveys

by Frank Henville, Rygate & Co. Rosehill, 1996.

Racecourse Shape

There are basically three shapes defining Australian racecourses -
1. Four rectangular straights connected by four curves.
2. Three straights in a triangular pattern connected by three curves.
3. Two parallel straights connected by two symmetrical curves at each end of the straights.

The majority of tracks consist of the rectangular shape, including Randwick and Rosehill. Triangular shaped tracks include Flemington and Warwick Farm. The third pattern is represented by modern tracks such as Sandown, and is based on the American design of race tracks which traditionally all conform to this symmetrical shape.

The alignment of all tracks however, consists of straights and circular arcs, which make up the turns, as well as chutes aligned tangentially to the circuit, to better accommodate race starts. It is the survey measurement of these various geometric alignments which is today important in providing track information for the accurate positioning of running rails.

Standards

Under the provisions of the Gaming and Betting ACT of 1912 a track for horse racing must have a circumference of not less than 6 furlongs when measured 1 yard outside the running rail. With the introduction of the metric standard of weights and measures in 1973 this requirement has become 1200 metres when measured 1 metre from the running rail.

For the purpose of track measurements in determining distances from the finish line to position sectional markers and starts, Clubs have adopted a nominal line along the track which is 610 mm (2 feet) from the running rail. The length of any line parallel to the straights of a track will be unaltered irrespective of its distance from the running rail, however on turns track lengths will obviously increase in proportion to the measurement line's distance from the running rail. To ensure an acceptable standard it was then necessary for the Racing Industry to have established this nominal line for track measurements as the closest a horse is able to run against the rail.

Having established the geometrical configuration of a race track it is then necessary to mark the inner line on the ground so that the running rail will conform with this alignment to ensure that markers and race starts represent correct distances. In sprint races horses travel at speeds approaching 64 km/hour or almost 18 metres per second. When it is considered that races are now timed to 1/100 of a second, a time interval which is equivalent to 20 centimetres (or 8 inches), it can be appreciated that an accurate standard for the measurement of tracks is important for the comparative analysis of race records.

Surveying

The survey of any track should include marking the tangent points of each turn and points on the turn at intervals of 9 metres, to enable the accurate positioning of each third rail post. On straights, rail installation is relatively simpler, and markings to ensure straight lines within these parts of a track may only need to be placed every 50 metres. Completion of the field survey of a track then enables calculation to determine the relative chainages (sequential distances from zero at the Winning Post) of the tracks tangent points. Having determined the distance measurements of each of these prominent points on the track, start points are able to be marked to represent the conventional distances of races run at each particular track. (Fig. 1)
Because of the practice of moving running rails, to better manage tracks to cope with today's increased amount of racing, it is necessary to determine track distances for these alternate rail positions. The longer arc lengths of turns must be calculated using the greater radius lengths of the arcs within turns, which will result when the running rail is erected outside its true or normal position. The increased chainage distances of tangent points for these varying rail positions indicates the respective changes to start distances of races, which are run around each of the turns.

For example, the circumference of the Randwick Course Proper increases from 2227 metres to 2284 metres, a distance of 57 metres, when the running rail is moved from its true to 9 metre position. (Fig. 2) Likewise the circumference of the Rosehill Course Proper increases from 2055 metres to 2092 metres, a distance of 37 metres, when the running rail is moved to its 6 metre position. These differences to race distances can be appreciated when it is seen that the Randwick 3200 metre race varies 70 metres between the extreme rail positions and the Rosehill 2400 metre race varies 38 metres for its rail differences. Distances such as these are a significant factor in the marking of race starts. For this reason a correctly
surveyed track is essential if Race Club’s are to conduct racing in a professional manner befitting such a high profile industry.

Fig. 2  Schedule of Start Adjustments for Alternative Running Rail Positions – Randwick Racecourse

<table>
<thead>
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<th>STARTS</th>
<th>3 Metres</th>
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<tr>
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Track Width

A final matter which should be considered in a discussion on track surveys is the course width. With the exception of starting and perhaps finishing a race, horses bunch to generally race within a 3 or 4 metre wide corridor adjacent to the running rail. However to accommodate the discussed rail shifts it is considered that course proper tracks should ideally be 25 metres wide. A rail shift of 9 metres on a track of this size would reduce its usable width to 16 metres, which could restrict field numbers due to the limitation on barrier movements within this narrower area.

There is a perception on the part of trainers and riders that racing is somewhat disadvantaged when the running rail is placed outside its true innermost alignment. Obviously in such situations there is a narrowing of the track width, which may account for some reservation as to the track’s overall suitability. However from a mathematical viewpoint an outward movement of the running rail creates an improvement to the track’s geometry. The radii of curves is increased which therefore generates larger turns, such being universally accepted as providing better racing conditions than the smaller radii curves which inevitably earn a course the reputation of a “tight turning” track.
Engineering Assessment of Race Tracks

by Alex Taylor, Douglas Partners. Rosehill, 1996

Introduction

This paper discusses the soil property criteria which govern the performance of turf race tracks and provides guidance on the use of modern techniques to monitor the engineering properties of the track soils and to evaluate track surface variability.

Most race tracks in Australia have been constructed in areas of relatively flat ground on soils comprised of either sands or clays. Whilst very occasionally, shallow rock is present just below track surface level, soil cover generally is quite substantial and hence, the properties of the soils play an important role in determining the speed rating of the track under various climatic conditions.

Engineering testing of soils has developed significantly in the past forty years, with greater emphasis now placed on testing soil in-situ, rather than in the laboratory. Methods have been developed over the last ten years whereby the soil profile, strength and deformation properties can be accurately determined in-situ, allowing immediate comparison of soil profile and properties at various test locations. Such methods have particular application to race track performance evaluation insofar as each layer of soil within the track can be identified and evaluated and subtle variations - not readily detectable in laboratory testing, can easily be identified and taken into account in the evaluation process. In-situ methods test the whole soil profile whereas laboratory testing only tests selected samples taken from the track.

The first part of the paper is devoted to a discussion of the various soil parameters which largely influence track strength and performance, and is followed by a description of the apparatus and methods by which the parameters are measured. Finally, the application of the test techniques is detailed, with examples of recent testing undertaken on two Sydney racecourses.

Track Construction Strategy

To satisfy the demands imposed upon modern day racing, race tracks have to be able to provide an aesthetically pleasing, safe, uniform surface under a wide variety of weather conditions. To meet these requirements it is necessary to build a track having the following attributes:

- Hard wearing surface
- Good surface drainage
- Adequate water infiltration rate
- Gradients which assist cornering
- Good shock absorbent properties
- Uniform performance across and along track

Track design devoted to achieving one or a number of the above attributes may inevitably have a negative impact with respect to other attributes. Hence, a compromise solution often has to be found because of potential conflicts between good surface drainage and adequate water infiltration necessary to sustain grass growth and to provide a surface which is not unduly hard on horses hooves. Similarly, a track which is heavily cambered will invariably have preferential drainage which will adversely affect the inside running for a period following heavy rain or after track watering.
To develop the above attributes it is usually necessary to build into the track a number of distinct layers which are designed to serve a specific purpose. Starting from the top, the layers would comprise:

1. Turf and grass root zone including topsoil,
2. Sand base with drainage capability,
3. Gravel blanket for base drainage, and
4. Subgrade - natural soil layer or filling

The depth of construction of the track down to the level of the subgrade would normally be in the range 0.5 - 1.0 m and consequently, each component layer can be considered to have an influence on the strength of the track and hence its performance. It is not intended here to comment further on the merits or otherwise of various materials used to form the layers, as design is normally carried out by horticultural experts, except to note that it is normally necessary to set relatively narrow limits on soil particle sizes for the upper three layers in order to achieve the design intent.

**Track Rating**

Track rating clearly is a function of the strength of the various soil layers used to form the track down to the critical depths which are stressed by horses galloping on the track, i.e., to around 0.6 m depth. When evaluating a track, therefore, it is necessary to critically appraise the strength of the differing soils to this depth under varying moisture conditions, ranging from moderately dry to saturated. Typically, clay soils have high strength when dry and low strength when wet. Sands on the other hand have low strength when dry and even lower strength when saturated or waterlogged.

The strength of clay soil is directly related to its cohesion which in general, is governed by its moisture content; although a relatively complex relationship arises when the clay soil is only partially saturated. The strength of sand is directly related to its angle of friction and density which, when waterlogged and buoyant, reduces to around one half its dry density.

The turf and topsoil layer typically has properties intermediate between clay and sand and hence, its strength is critically dependent on both moisture content and density. Given that the thickness of this layer is normally less than 150 mm, the strength of the layer is less important to the overall track strength, as the layer is largely serving as a shock absorber when transferring dynamic loading to the sand base or underlying clay subgrade.

Topsoil layers having thickness greater than is necessary to sustain vigorous grass growth are undesirable, as both strength and permeability will be greatly impaired under surface water influence.

**Measurement of Soil Strength**

Traditional methods of measuring soil strength have largely been based on obtaining undisturbed samples of soil from carefully drilled bore holes, extruding the soil in the laboratory and then testing specimens in a triaxial cell under artificial stress conditions intended to simulate field conditions. Inherent problems associated with these methods include:

- Accurately positioning the samples within relatively thin layers
- Obtaining truly "undisturbed" samples
- Further disturbance of samples during extrusion
- Inability to identify precisely the material enclosed within the steel sample tube
- Artificiality of test method and the unreliability of strength measurement due to partial saturation particularly at the low stress levels appropriate to race track performance
- Changes in soil density due to drilling and sampling processes
- The large number of samples needed to gain statistical confidence
At best, the traditional methods only provide an approximate guide to track strength. Any pattern of variability suggested by the results can as readily be explained by lack of precision in the sampling and testing methods as by natural variation in the materials tested.

The advent of more accurate in-situ penetration testing techniques, such as cone and dilatometer test methods, has permitted much more comprehensive measurement and assessment of patterns of variation in track strength. Testing of a kilometre length of track can be completed in a single day, so that the influence of track drying or other changes during the period of testing can be minimised. When results are combined with other closely spaced test results, a reliable guide can be obtained as to track variation both along and across the whole of track being studied.

**Cone Penetration Test**

This test uses a 35 mm diameter cone with a 600 face and a following 150 mm friction sleeve which are pushed vertically into the soil using a surface mounted ballasted system. Essential components of the cone are shown in Fig. 1. Electronic strain sensors are attached to load cells mounted in the cone tip and on the sleeve which monitor pressure at 20 mm intervals as the cone is pushed into the soil at a penetration rate of 20 mm per second. Strain gauge output is monitored using computerised equipment which displays continuously cone resistance and friction resistance as well as friction ratio (friction resistance divided by cone resistance).

Fig. 1  Friction Cone Penetrometer

Whilst being robust enough to be able to penetrate weak rock if required, the cone is also very sensitive and can record pressures in the range 10 kPa to 50 MPa.

Both the cone resistance and the sleeve friction can be used to estimate soil strength, the former being related to the pressure required to initiate punching shear failure of the soil.

Whilst absolute values of imputed soil strength are useful, a distinct advantage of the cone test is its ability to record subtle variations in soil strength at each location, as well as variations between locations, thereby highlighting the presence of seams, layers or zones of potential weakness.

The friction ratio measured by the cone provides a means by which the soil can be identified. A relationship between friction ratio and soil type has been found to generally apply to local soils. Low friction ratios in the range 0.5% - 2.0% are normally associated with sand and gravel, whilst clay commonly has a friction ratio between 3% and 6%. Where any doubt exists - as sometimes can be the case with organic soil and peat, supplementary sampling can be carried out with a view to specifically targeting suspect layers.
A typical cone test taken at Rosehill Gardens, over a penetration depth of 1.0 m, differentiated five distinct strata, viz:

- (a) the sandy loam topsoil,
- (b) sand base, grading from loose to medium dense,
- (c) the gravel drainage layer, and
- (d) the clay subgrade

Note two scales are used to plot cone resistance, with the 0 - 5 MPa values shown dotted and providing ten times the sensitivity of the 0 - 50 MPa values shown as a solid line.

The cone test has now been in use in this country for over twenty years and has been accepted as a most versatile exploratory tool proving to be equally adaptable for both shallow conditions such as race track evaluation, as well as for deep conditions such as proving for foundations for grandstands and multi-storey buildings. Adaptations of the cone include modified circuitry for conductivity testing in conjunction with groundwater contamination studies and the fitting of a pore pressure transducer to improve the definition required for intermediate type soils below the water table including sandy clays and clayey sands, as well as silts.

**Marchetti Dilatometer**

This is another rapid in-situ test method used for measuring soil strength, modulus and in-situ stress and at the same time, providing a means of identifying the type of soil being tested. As with the cone, the instrument is pushed into the soil, but using a flat spade shaped adaptor housing a 60 mm diameter membrane which is inflated in a horizontal direction against the soil being tested. Inflation pressure necessary to initiate movement and the pressure required to cause 1 mm expansion of the membrane are the critical pressure values recorded and then subsequently used to compute the various soil properties.

Under certain conditions the dilatometer is more reliable than the cone - particularly for measurement of modulus or compressibility, but it is not always as effective in delineating thin layers, as testing normally is conducted at 200 mm vertical intervals and the results are not readily available in graphic form at the test site.

**Measurement of Permeability**

Apart from strength, the most important property of soils used to construct race tracks is permeability. This property largely governs the amount of water which infiltrates the surface and by inference, the amount of water which remains on the surface and has to be relieved by surface drains during heavy rain.

Infiltration rate is a function of the permeability of the soil and the thickness of the permeating layer, i.e. the greater the thickness of the permeable layer, the less water that will be infiltrated.

Relatively simple methods are available for infiltrometer testing of racecourse track surface materials and a typical arrangement is shown in Fig. 2. The important precaution to take with most methods is to continue testing until steady state flow conditions are recorded, in order to avoid errors caused by initial partial saturation of the soils.
Fig. 2 Double Ring Infiltrometer

Benefits derived from Track Testing

Investigation and testing of race track soils provide an invaluable insight into the composition and strength of the near surface soil layers, such that when testing is undertaken at sufficiently close centres, a very good guide to the variability of the profile and strength of the entire track can be obtained.

In planning a track maintenance program testing beforehand will readily identify potential problem areas, soil and layer variability, lack of strength under various conditions or variable strength due to poor drainage as well as loss of profile due to variable compaction.

When carried out in conjunction with track maintenance or reconstruction works, testing will help to ensure:
1. Compliance with engineers' specification for the work,
2. Identification of unsuitable material, and
3. Uniform layer thickness and strength

Examples of Track Testing

Randwick Racecourse

Some two years ago Sydney experienced an unusually dry spell which necessitated regular irrigation of the track at Randwick. The heavy demands on the bore water resources at the course inevitably resulted in a severe drawdown of the water table. Coincident with the heavy watering of the track, course maintenance staff and jockeys were reporting unusual undulations in the track surface, with local variation in surface level of some 50 mm or more. Through Rygate & Company, surveyors monitoring the track at the time, Douglas Partners were requested to investigate the causes of the irregular surface depressions and to advise on appropriate remediation.

The racecourse at Randwick is situated within the Botany Basin sand belt area and consequently, is underlain by deep sand soils. Not infrequently these deposits contain layers of peat which can give rise to subsidence under conditions associated with a drop in the water table.

The cone penetration test was selected as an appropriate exploration tool and a pattern of testing was conducted over two sections of track concentrating on a 100 m section before the 150 m mark in the main straight and another 100 m section at the back of the course beside the 1750 m mark. Test positions were selected so as to represent adjacent low and high areas.

It was concluded from the testing in the main straight that an irregular pattern of loose and medium dense sand existed such that preferential channelling of water infiltrating the track was concentrating flow through the deeper loose zones, causing gradual densification and repacking of the sand grains, but at the same time creating local subsidence of the surface.
The temporary drop in water table from around 2 m to 4 m at the time due to excessive drawdown from pumping and irrigation had greatly increased the flow path of infiltrating water and had exacerbated the problem which probably had been occurring over a considerable period of time, although not being clearly identified until the onset of the recent drought.

Testing at the back of the course also showed irregular patterns and depths of loose sand which could have given rise to localised subsidence, although here shallow refusal in one of the tests suggested a limited depth of sand underlain by sandstone.

The problems being experienced at the time were diagnosed as being primarily caused by excessive irrigation during the period of unusual drought and were considered likely to diminish once the water table had been restored by natural rainfall processes.

To prevent future recurrence of the problem it was recommended that a special-type of roller be used on the track having a capability of compacting the sand subgrade soils to depths of 2.5 - 3.0 m. Infilling of local undulations by topdressing was also suggested as a short term remedy; however continued build up of topsoils eventually could be undesirable, as eventually surface drainage and infiltration could be severely impaired, giving rise to further maintenance problems.

**Rosehill Gardens Racecourse**

During the second half of 1994 the STC were anxious to demonstrate that the track surface at Rosehill Gardens was not subject to any unusual bias, as the Club had recently undertaken a major upgrade of the track which was intended to give the course a "premier status" rating.

A program of testing of the track was devised, designed to reveal any variation - or irregularity in track strength, both across and around the track. Testing was also to be conducted to simulate two differing course conditions, viz:

- Normal dry weather condition with typical course surface watering, and
- After heavy rainfall when the course would typically be rated as "dead" or "heavy"

Testing was undertaken at a total of seventy seven locations coinciding with some twenty marks around the course and at three or four positions across the track at each mark. A suite of tests was conducted at each location including:

- Cone penetration testing to 1.0 depth,
- Infiltration testing,
- Core sampling of sand base material, and
- Dynamic penetrometer testing including Perth penetrometer and course penetrometer

Core samples of sand removed from the track were further tested in the laboratory for moisture content, density and particle size distribution.

An initial program of testing was carried out in September, 1994, when the course rating was "good" to "fast" and repeat cone testing was undertaken in May, 1995, after a week of heavy rainfall.

Track strength is probably best represented by the cone resistance readings. These were found to increase more or less linearly with depth through the sand base layer, reaching a maximum before declining as the clay subgrade was approached. For comparative purposes, cone values at 0.1 m penetration and maximum values were used to assess the strength of the sand base layer.

Comparison of average values allowed easy identification of any irregularities in track strength between various locations both across and around the course. The comprehensive program of testing, though, revealed no significant irregularities, with very uniform results up to the 1000 m mark - the section recently upgraded. Beyond this mark, the maximum cone values declined, reflecting a lower level of
track strength, as might have been expected. This variation was quite evident in the cone penetration testing, but was not obvious from the dynamic penetrometer tests. All tests, though, gave lower results on a heavy track than on a fast track, demonstrating a significantly lower track strength when wet.

The field and laboratory results gave good correlation between infiltration rates and silt fraction, demonstrating the need to limit silt content in the sand to around 10%.

From the study it was possible to conclude that the track strength was uniform under fast conditions and uniform also under heavy conditions. Inevitably, though, some variation would occur under drying conditions, reflecting differing rates of drying for various sections of the course.

Conclusions

Because of the need to evaluate relatively large areas of comparatively shallow soils, simple, cost effective, but very accurate methods are necessary in order to properly evaluate the engineering properties of race track soils.

The use of in-situ test methods is essential, as laboratory test methods are not suited to the shallow conditions generally applying to race tracks.

The use of cone penetration tests has been most successful in delineating soil types, strength, profile and uniformity in two applications at Randwick and Rosehill Gardens and the application of this test method is advocated for all racecourses utilising natural soils as track formation materials.
Moonee Valley Track Reconstruction

by Ian Trevethan, Moonee Valley Racing Club. Moonee Valley, 1997

Introduction

The Moonee Valley Racing Club was confronted during 1989 with reconstructing both the course proper and chutes after experiencing lost meetings due to wet weather, also changes required to improve surface crossfall and reduce hardness.

Design

The decision to install the Moonee Valley Strathayr Allweather surface was decided in 1994 after several years of trials conducted along the back straight and around the turn out the back steeple straight. This allowed us to evaluate various duplicated combinations of profile, drainage and turf sections while conducting race meetings over the surfaces.

The Moonee Valley Strathayr profile consists of the following:

<table>
<thead>
<tr>
<th>Turf Surface</th>
<th>Washed bare rooted Kentucky Blue over sown with a combination of Javelin and Roper pasture rye grass (54,000 square metres total area) Kikuyu sprigs installed under washed turf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root Zone</td>
<td>150 mm depth A.C.I. Sports 40 sand Mixed with 10% peatmoss 6kg Netlon mesh elements per cubic metre</td>
</tr>
<tr>
<td>Intermediate Zone</td>
<td>113 mm depth A.C.I. Sports 40 sand No peatmoss mixed into this layer No Netlon “ “</td>
</tr>
<tr>
<td>Drainage Layer</td>
<td>100 mm depth (blanket layer) 5 mm blue metal 100 mm diameter half herringbone drainage pipe (4 kilometres in total) 150 mm collector drains around inside rail (2 kilometres in total)</td>
</tr>
</tbody>
</table>

Moonee Valley engaged the services of R A Young as project managers to complete the reconstruction with Akron Pty Ltd the successful main contractors. The project managers were confronted with many problems during the early stages due to Harness Racing being conducted on mid week and Saturday nights.

Irrigation

The irrigation system installed by Aquafield Pty Ltd enables us to have individual control of all sprinklers (95DRs) around both the inside and outside rails. The computer controller (Rainbird Master 3) allows for various combinations, eg, outside, inside, and turns only and can be operated in the following automatic, sequential and priority order.

Two turbo pumps draw the water supply from a dam located in the centre of the racecourse which is topped up by a pump situated along side the Moonee Ponds creek. Both the dam and creek supply is constantly monitored for salinity levels.

74 soil sensors have been installed to regularly monitor soil moisture, nutrient and temperature levels.
**Construction**

During the various stages of construction, every effort was carried out to ensure that Quality Control was adhered too. Material installed was constantly monitored to eliminate contamination within each profile layer.

Special machinery was engaged to apply and level each section completed. No wheel type vehicles or machinery were used during construction of the root zone, intermediate zone and drainage layer.

The mixing of the root zone material, which included the Netlon mesh elements and peatmoss, was conducted by A.C.I Pty Ltd at the old Rocla pipe depot next to the Sandown Park racecourse. Mixing of the material was completed using a pugmill and transported by covered trucks to the other side of the city.

**Track Performance**

Valuable information has been obtained during the last two years which will help us to further improve the profile as I firmly believe we have reduced the following concerns: poor drainage; surface hardness; surface wear (winning post); inconsistent material for repairs.

Material required for track repairs after each meeting has been reduced by two thirds. Previously we required approximately six cubic metres during winter, now only two are required. The general recovery has been excellent with no lost time due to bad weather when mowing and maintenance work is conducted.

Irrigation requirements during our recent period of extremely hot weather was much less than first expected.

**Cost of Works**

Approximately $6 million for track works. Total cost, including landscaping and the pedestrian tunnel of $7 million.

**Conclusion**

We will continue to further improve the Moonee Valley Strathayr system by developing better maintenance methods which will help reduce any areas of concern. We are very fortunate to have four excellent, different race tracks in the Melbourne metropolitan area which gives racegoers variation, even so, improvements must continue to strive for the ideal surface for the racing industry’s needs.
Facts on the Reconstruction and the new Moonee Valley Strathayr Track

**Earthworks:** 40,000 cubic metres

**Drainage:** More than 4 km of stormwater drainage and 2 km of collector drains

**Subsurface Drains:** More than 12 km

**Drainage Layer:** 10,000 tonnes laid and spread

**Growing Medium:** 55,000 square metres of sand, top layer includes peat moss

"Netlon" **Mesh:** 55,000 square metres

**Turf Grass:** 55,000 square metres of Kentucky Blue Grass & Rye
On sprigs of Kikuyu - over sown with pasture Rye

**Workmen:** At peak times 64 field personnel including Project Management and Sub-Contractors, plus M.V.R.C. Grounds and Maintenance staff assisting as required.

**Machinery:** 23 major items including excavators, graders etc.
Plus numerous other small items.

**Track Crossfalls:** Vary from 2.5 % (1 in 40) on the straights to 7.5 % (1 in 13.3) on the banked turns.

**Track Widths:** Over half the main course proper is a minimum of 23 metres wide (previously 16-19m) with the turn out of the straight increased from 19 to 26 metres wide.
**Turns:** The track geometry has been improved with banked turns for better viewing on the majority of the track. The radius of each turn has been increased as far as practicable in the space provided for improved safety.

**Circumference:** The course proper is 1805 metres with a rise of 5.05 metres from the 800 metre mark to the Winning Post. The Jumping course is 1750 metres. Straight is 178 metres.

**No Crossings:** The 1600 metre crossing has been eliminated and the course proper is crossing free.

**Flat Starts:** 1000m, 1200m, 1500m, 1600m, 2040m, 2500m and 3000m.

**Cost:** Course proper reconstruction - $6.2 million.
Natural turf racing surfaces

StrathAyr are the exclusive distributors and installers of the mesh element concept that was pioneered by the Hong Kong Jockey Club in the early 1980’s. Extensive University research, trial areas under racing conditions and long-term installations have proven the outstanding compaction resistance and growth enhancement benefits of ReFlex® mesh elements.

The mesh element concept has been installed at the course proper and grass training track at the Singapore Racecourse, the Royal Randwick Allweather Racetrack in Sydney, Sha Tin & Happy Valley Racetracks in Hong Kong and Moonee Valley Racecourse in Melbourne.

Mr John Meagher, leading Singapore Trainer (May 2001)

“I've always been a great fan of the StrathAyr at Moonee Valley but with the advances in technology the racecourse at Kranji is unbelievable,” he says.

“One morning we had 7 inches of rain at the track and I thought there would be no way that we would race.”

“Not only did they race the 1200m in under 1min 12sec, they bettered 1min 24sec in the 1400m without even marking the surface…… that’s how good the surface is.”

Dr Brian Stewart, Chief Veterinary Surgeon, Singapore Turf Club (May 2001)

“We have maintained statistics regarding our injury rate since moving to the Singapore Racecourse at Kranji in 1999. We have compared our results and statistics with other studies conducted in Japan, North America and elsewhere and there is no doubt that the Singapore figures are good.

“As a result we consider that the mesh element track at Kranji is a very surface, with a very low injury rate and we are happy with the racetrack. In fact, we regard it as an excellent racing surface”. Statistics available on request.

For further information please contact StrathAyr Turf Systems on:

Tel: (03) 5735 4122   Fax: (03) 5735 4133

www.strathayr.com
Doomben Track Reconstruction

by Warren Williams, Brisbane Turf Club. Moonee Valley, 1997

Introduction

There were many reasons for a reconstruction of the Doomben Racecourse. Issues which affected the existing course were:-

- Soil Type - very fine particle size
- Crossfalls - minimal if not negative cambers
- Water Table - very close to surface
- Drainage - no sub-surface drainage
- Punting Confidence
- Number of race meetings per season

To overcome the issues which have affected racing at Doomben for the past 20 years, the Committee decided in March 1995 to reconstruct the course proper. Extensive planning was required, investigations into recent track reconstruction's within Australia were studied for soils, cambers, turf species and drainage. All information was compiled and planning began.

Cambers were a main issue within the planning stages. What percentage should the crossfall be for corners and straights for successful equine racing is a question for every racecourse considering a track reconstruction. Discussions were held within the Racing Industry obtaining views, opinions and professional advice. The Brisbane Turf Club settled for 5% cambers for corners and 2% for straights.

Planning the construction process was vital. The closure for 13 weeks provided very limited time to undertake a job of this size. All items for construction had to be evaluated for duration, man power, equipment and start/finish dates. A total project program was designed ensuring the reconstruction could be undertaken within the 13 weeks.

Soils & Drainage

Soil type plays a major part in a track's performance. At the Brisbane Turf Club, the soil medium to be used had to meet a criteria of adequate infiltration, aeration porosity, particle size, compaction and stability. Using U.S.G.A. soil specifications as a bench mark, a blend of sand and soil was evaluated at different percentages until a blend met the criteria set by the Brisbane Turf Club. The final blend was 60% soil and 40% sand which was installed at a depth of 300 mm ± 10 mm. (Fig. 1)

Soil specifications were as follows:-

<table>
<thead>
<tr>
<th>Particle Size %</th>
<th>B.T.C. Soil /Sand Blend</th>
<th>Ideal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel (&gt;3.34 mm)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Fine Gravel (2.00 mm)</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>Very Coarse Sand (1.00 mm)</td>
<td>11</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Coarse Sand (0.50 mm)</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Medium Sand (0.25 mm)</td>
<td>29</td>
<td>69</td>
</tr>
<tr>
<td>Fine Sand (0.15 mm)</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Very Fine Sand (0.05 mm)</td>
<td>11</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Silt/Clay (&lt;0.05 mm)</td>
<td>4</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Total Porosity (%)</td>
<td>39.7</td>
<td>33-55</td>
</tr>
<tr>
<td>Aeration Porosity (%)</td>
<td>17.3</td>
<td>15-30</td>
</tr>
<tr>
<td>Hydraulic Conductivity (mm/hr)</td>
<td>82</td>
<td>&gt; 150</td>
</tr>
<tr>
<td>Gravimetric Water (%)</td>
<td>22.4</td>
<td>12-20</td>
</tr>
<tr>
<td>Volumetric Water (%)</td>
<td>22.4</td>
<td>15-25</td>
</tr>
<tr>
<td>pH</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Salts ppm</td>
<td>150</td>
<td>&lt; 600</td>
</tr>
</tbody>
</table>
Being a conventional type of reconstruction, drainage was installed in a half herringbone pattern at three metre intervals. (Fig. 1) The distance between each drain was based on "Houghoudts" theory (Maclntyre, Jacobsen, Turfcraft May, Sept 91).

A total of 17 km of drainage pipe was installed which comprised of 2 km of 150 mm slotted PVC main drainage pipe and 15 km of 80 mm corrugated drain coil for laterals.

A 7 mm washed pea gravel was installed around each pipe with 50 mm cover. The gravel was tested for bridging factor ensuring there was no migration of fine particles from soil profile into drainage material.

**Fig.1  Soil Profile & Drainage Pattern**

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**Turf**

The preferred turf species was *Kikuyu* (*Pennisetum sp*.), and like the soil blend the *Kikuyu* had to meet specific criteria:

i) **Quality** - healthy, disease & weed free, thick matted turf with extensive rhizome and stolons.

ii) **Quantity** - 62,000 square metres from one paddock only

iii) **Soil Medium** - compatible with new soil blend as turf will be layered with soil attached.

iv) **Rolls** - large rolls (20 m x 1.3 m)

v) **Supply** - turf to be supplied at a minimum of 4,000 square metres per day.

Due to the lack of demand for *Kikuyu* turf in Queensland, Brisbane Turf Club decided to engage a large *Kikuyu* grower from Sydney. Visiting various farms a supplier was found who met the set criteria. All turf was shipped overnight in refrigerated prime movers, maintaining a temperature of 5 degrees C. The turf was in excellent condition on arrival.

**Track Performance**

An eight week period for turf establishment was given before returning to racing. As the turf was still a little immature, the first meeting was conducted on 14th December, 1996. The meeting proceeded and was very successful. By April, 1997, there had been 18 meetings held over 126 days or one meeting per seven days.
Using the moveable rail has enabled the recovery of turf from each meeting. A period of four to five weeks was allowed for recovery before returning to racing on each particular rail position.

Turf establishment in the initial stages suffered due to leaching of nutrients and the heat from the summer months. Once nutrient leaves become adequate the turf performance increased and recovered very well after racing.

Soil and drainage performances have been shown to recover rapidly after 25 to 30 mm of rainfall, 36 hours before a meeting.

Reports from within the racing sector have been very positive and recent race times have shown the track is racing very evenly with fast times over a "Good" surface.

Cost

The total project cost of $2.6 million included the upgrading of one grass training track, irrigation system, mounting yard and the course proper.

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconstruction Course Proper</td>
<td>$1.8 million</td>
</tr>
<tr>
<td>Reconstruction Training Grass</td>
<td>$0.5 million</td>
</tr>
<tr>
<td>Associated Works</td>
<td>$0.3 million</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$2.6 million</strong></td>
</tr>
</tbody>
</table>

From the above figures the reconstruction of Doomben Racecourse was a cost effective project.

**Facts on the Brisbane Turf Club - Doomben Reconstruction**

<table>
<thead>
<tr>
<th>Cost</th>
<th>Course proper reconstruction - $1.8 million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference</td>
<td>1715 metres</td>
</tr>
<tr>
<td></td>
<td>2 m fall from 1200 m to 600 m</td>
</tr>
<tr>
<td></td>
<td>2 m climb from 600 m to winning post</td>
</tr>
<tr>
<td>Crossfalls</td>
<td>Vary from 2 % (1 in 50) in straights to 5 % (1 in 20) on turns</td>
</tr>
<tr>
<td>Track width</td>
<td>Average track width being 26.5 m with the narrowest point being 21.5 m</td>
</tr>
<tr>
<td>Turf species</td>
<td><em>Kikuyu species</em> (<em>pennisetum sp.</em>) 62,000 square metres</td>
</tr>
<tr>
<td>Drainage</td>
<td>15 km of 80 mm draincoil laid at 3 m c/c</td>
</tr>
<tr>
<td></td>
<td>2 km of 150 mm PVC slotted pipe</td>
</tr>
<tr>
<td>Growing medium</td>
<td>Loam/Sand blend - 34,000 tonnes</td>
</tr>
<tr>
<td>Irrigation</td>
<td>144 Hardi Turf Keeper 300 Impact Sprinkler 26.5 m head spacing. 13.5 litres/second delivery rate</td>
</tr>
<tr>
<td></td>
<td>40 Hardi Hydro Rain series 100, 80 mm electric solenoids</td>
</tr>
<tr>
<td>Water storage</td>
<td>20 megalitres (20,000,000 litres)</td>
</tr>
<tr>
<td>Length of home straight</td>
<td>340 metres</td>
</tr>
<tr>
<td>Starting positions</td>
<td>1000 m, 1100 m, 1200 m, 1350 m, 1615 m, 2020 m &amp; 2200 m</td>
</tr>
</tbody>
</table>
Racetrack Construction Panel Discussion

Panel discussion. Moonee Valley, 1997

The issue of track camber/crossfall was raised and how the slope was determined. There is no particular formulae or research to support the slope selected, however, it is related to the radius of the turn. In general crossfalls are related to horse balance and whether jockeys can move horses off the rail while going around the turn. The slope on the turns should also be such that it does not cause a change of stride in the horses action. More research is needed on best camber combinations with different track designs and effect of camber on horse injuries.

The sloping turns at Moonee Valley, Caulfield and Elwick have all proven to be successful and well accepted.

Kikuyu was incorporated into the Caulfield track both in the sod and under the sod. At this early stage its presence is evident but it is expected to take several years before it becomes a significant component of the sward.

The establishment of the new track at Doomben allowed for 8 weeks of growth during summer with applications of P & K to encourage good root structure - 10 weeks would have been better with 2 or so weeks between meetings rather than weekly.

Teething problems were discussed and included:
- slipping on turns
- racing too early on immature turf causing excessive damage
- low nutrient levels on the new profiles including low nitrogen and potassium

Methods for overcoming difficulties include:
- dethatching and sand topdressing to prevent slipping.
- country racing in Victoria is advised to dethach before the first race meeting and to prepare the track on the dead side of good so that the track has good purchase for the fiorse.
- essential to maintain high levels of fertiliser on young grass until it matures.

Other difficulties raised included:
- poor root growth during winter (i.e. low soil temperatures)
- thatch accumulation - difficulties in dethatching often enough due to racing schedule.
- control of Poa annua in cool season grasses.
- too much racing early on - should be gradually increased as the turf matures.

There was a general opinion that new technology (e.g. soil sensors) be used to monitor soil moisture and nutrient levels as well as monitor root growth, infiltration rates and surface hardness.

The moveable rail was discussed and the consensus was that it is the track managers’ best friend. It must be moved regularly so that the turf can cope with the heavy racing schedules. It is important to educate trainers, jockeys, punters and the press. On the reconstructed tracks, with uniform crossfalls the moving of the rail will have no influence on racing.
The panel was requested to comment on what factors were most important during construction and included:

- selection of contractors is critical and they must have good qualifications and experience.
- cost is a driving factor
- selection of the soil base required detailed investigation
- materials used in construction must be of consistent quality and a testing program during construction is required.
- drainage appears to be the single most important factor.
- in the case of Moonee Valley it was believed that extending the profile an additional 2-3 metres beyond the true position would have eliminated some of the concerns on the first metre inside the rail.
- initial survey of existing site conditions;
  - subgrade condition
  - existing pipe work, cables etc.
  - thoroughly examine all plans prior to letting the contract
- overall standards have improved greatly
- you get what you pay for.
Racetrack Design, Construction and Project Management

by Ray Young, Young Consulting Engineers. Melbourne, 2000

Introduction

Traditional approach
Historically tracks have been improved / repaired / upgraded on an ‘adhoc’ basis depending on the whim of the Committee

Changing needs
Need to consider owner expectation of a high standard track surface.
Legal position regarding horse value / injury to horses and jockeys has to be borne in mind.

Financial implications
Aim for ‘all weather racing’ – cancellations avoided
Night fixtures – increased turnover.

Falling attendance / remote viewing
Financial losses follow cancellations.
Track quality / drainage considerations exacerbated by introduction of ‘Internet betting’ which encourages meetings to be held when track conditions are poor.
(Tracks must be more predictable and of high quality to attract TV coverage.)

Design Considerations

Common Sense
“Rules of Racing” forms basis of design, which is further influenced by tradition, intuition and financial constraints.
Consult with but not be overly influenced by Jockeys, owners, trainers who store a ‘wealth of valuable knowledge’ regarding track preferences.

Some basic aims
Minimum radius and site available constrains layout
Longer straights offer wider variety of race lengths / starts.
Chute alignment / length – offer extra starts
Positioning time before turns – sacrifice large radius to allow longer run to first turn.

Blend of traditional with innovation
The traditionalists will hold onto ‘Good-Dead-Slow-Heavy’ concept.
New track surfaces may be more predictable with a move towards ‘Good / Dead’
Balance required, providing fair racing, but not always the same rating.

Design Guidelines
There is no standard to refer to when designing a racecourse
Need to seek common sense / proven advice, drawing information from wide range of the industry.
Geometry – basic objectives
Track width – available site, funds may restrict preferred width.
Bigger fields possible with greater width, and wear can be spaced by rail shifts.
Track length – available site, funds, obviously influence this, but each club or association may consider priorities lie for example, in shorter races.
(Chute configuration – depends on circuit length and preferred race starts.)
Banked turns – also related to radius

Existing Situation
In an upgrade, previous plan of track drainage, electrical cables, irrigation pipes etc. must be obtained.
Spend time carefully assessing existing infrastructure.

Existing plans, Master Plan proposals, concepts
Refer to previous proposals concepts considered by Committee or association. Is there a wish list?

Aerial photographs
Refer to any previous proposals considered by Committee, existing track and access layout. What are perceived shortcomings?

Survey
A detailed site survey picking up all physical features and shapes, is essential. It will result in time and cost savings.

Geotechnical reports
Essential information during design phase – what lies beneath the existing ground or track level?
Can that material be reused?

Hydrological reports
Required for flood prediction and stormwater design

Outside influence
Stewards, trainers, jockeys and owners all have views on an existing track, or what should be incorporated in a new or upgraded track.
Difficult to satisfy all due to varying requirements in terms of fast/slow tracks, camber, turf species, etc. but it is likely 2 or 3 elements will be consistent – horse and jockey safety, lack of bias and good track availability.

Heritage / EPA issues
Environmental aspects are vital during construction and use, particularly for a new track.
Heritage issues for traditional tracks need to be considered e.g the main straight ‘rise’ at Royal Randwick

Water quality
Given the large quantity of water required to maintain the track, the quality and available quantity of this water needs to be carefully examined.
Does the opportunity exist for recycling?

Return Brief Procedure.
The brief should be considered by the client / designer prior to acceptance / agreement.
Can the Client’s expectations be met?
Irrigation review
In a track upgrade a thorough review of the existing system must be undertaken to assess capacity, adequacy, condition, location, etc. Possible (future) recycling?

Track Requirements To Be Taken Into Account At Design Stage

Minimum widths
Depends on fields planned, site available and funds. Greater width allows for future rail shifts – and more frequent meetings.

Access for Barriers
Important operational requirement to ensure barriers can be quickly removed from circuit.

Crossings
Consider tunnel crossing or portable low level bridge – safety and maintenance aspects of track crossings become onerous.

Ambulance Track
Consider form of ambulance track access, potential for ‘spooking’, track surface.

Security fencing
Consider animal / human security / aesthetics – safety aspects paramount.

Banked turns
Need careful consideration – where is turn in relation to finish?
Consider transition from straight track profile to fill to outside of turn.
Currently 6% seems to be preferred maximum, subject to radius

Lighting requirements
Consider provision for possible future lighting, without further disturbance to the track.

Race Requirements

Race lengths
What range can be accommodated on the available site?
Can modifications to the geometry help increase this?

Timing
Sectional and overall – also for trials

Finishing post
Is it adequate or is a new post required?

Access to parade ring, winners circle
What do the club, the owners and the stewards want?
Is access readily available to and from the raceday stalls?

Sight requirements from stands, paddock and for stewards
Some starts may be obscured by rails. Are most races watched in part on television?
Carparking and other site constraints need to be considered.

Stewards towers
Vehicular access is usually required close to each tower
What other services are required?
**Ground Staff huts/toilets/water**
Necessary maintenance functions and raceday logistics need to be considered.

**Materials**

**Supply of rails**
Are they to be new or existing refurbished?

**Outside rail requirements**
Fixed or removable? Or a fence instead?

**Special post type**
May be required in sandy profiles. If upgrading consider ground staff time in shifting rails.

**Removable rail sections**
For barriers, chutes, maintenance.

**Timing equipment**
Sectional and from each start - control and signal equipment required?

**Communications**
Starter, stewards – landline or wireless? What about television?

**Preferred irrigation**
Type of sprinkler
Uniformity on the site or upgrade over time to a new standard and quality?

**Modifications to wheels of starting barriers**
Wider tyres may reduce short term track damage.

**Recovery pegs for rails, start position**
Ground staff require clear, reliable, track permanent reference marks.

**Running Surface**

**Conventional approach – “spend on grandstand”**
Over the years we have seen tens of millions of dollars spent on grandstands and corporate facilities – sometimes to the detriment of the track.
(‘If the track is substandard the whole facility is substandard.’)

**Performance standards**
Hardness – horse injury, consider also jockey safety
Drainage – maintain good turf cover without track becoming sloppy
Longitudinal / cross slopes – pure geometry versus reality and perceived advantages.

**Soil profile**
Conventional / preferred by some as ‘true racing surface producing good, dead, slow, heavy tracks
Sand profile / ideal for drainage but specification of sand, turf species, climate must be carefully considered.
Reinforced Sand Profile / required careful selection of turf, sand and reinforcement medium.
A couch or kikuyu in some locations may not require reinforcement.
Future
Maybe synthetic or a natural / synthetic hybrid

Construction Phase

Project Delivery
Project Management
Select /Open Tender
Lump Sum
Direct Negotiation
Other
Cost plus
Most important to deal with experienced consultants / contractors/ builders
Question genuine offers of help from owners / committees / other- preferable to make ‘arms length appointments’

Quality control
Material procurement / specification linked
Independent testing
Quality of materials critical to track performance

Involvement of ground staff / work by Club
Desirable to keep permanent staff closely involved through design and construction phase.
Downtime on track maintenance by Club during construction should be minimized by diverting resources to possibly other maintenance items.

Irrigation
Existing irrigation may need to be maintained to areas other than the track

Vehicular Access during construction
Safety, security and minimal disturbance to other site users. Preferred routes to be signposted.

Racing Program / Track Work Training Schedules
During construction it is necessary for contractor to fit in with the on-going activities.

Materials storage / mixing
Is part of site available, or will it interfere with other activities?

Site sheds location
Line of sight obstructions to be avoided if other race activities continue on the site during construction.

Union requirements
Contractors need to be aware of any requirements unique to site.

Constraints on working hours
Apart from statutory requirements, should be advised to the contractor

Water available for construction
Is it potable? Who will provide it, who will pay for it, and what is maximum available to contractor in worst conditions (new turf, hot dry winds)?
Electricity for site sheds
Is electricity readily available at the preferred location for contractor’s sheds? Is a telephone connection available?

Toilets for Construction personnel
It may be preferable to allow use of permanent installations rather than have extra sheds on the site.

Access by construction personnel to on site facilities
Is there a site canteen, bus shuttle service, off street parking, etc available, which a contractor may not be aware of?

Advertising, Promotions
Secrecy requirements – does the client have any special requirements, in anticipation of major events, promotions, etc?

Provision for TV, radio, CCTV – is provision made for the most up to date equipment to be installed?

Special hoardings – long term or for each race – should be considered in overall context of fence, winning post design – vehicular access to move, install?

Flagpoles – consider use by sponsors.

Special funding, promotional items – sponsorship needs, conflicts during construction.

Contractor / Supplier advertising – discuss opportunities with Club for temporary or long term signage and off-site advertising.

Post Construction
Commencement of Racing – following trials and establishment period. Club staff should be familiar with track characteristics and confident regarding irrigation, turf maturity, etc.

“As built” information – vital records of exactly what was built. Necessary to ensure proper maintenance is provided for drainage, irrigation, etc.

Staff and Ground Staff Induction
Involvement in whole process- desirable to maintain morale, establish confidence in maintenance requirements. Assistance and advice to construction team is of benefit to all.

Understanding of construction program – the logistics may be mystifying but there is usually a very obvious explanation.

Understanding of construction procedures – staff may be unfamiliar with some plant and equipment and rationale behind some procedures. An explanation is usually not difficult and encourages labour cooperation.

Understanding of maintenance – may differ from the previous track. Irrigation and fertilizer application rates are likely to be critical items.
Works by Contractor / Ground Staff – some works can best be done by ground staff, such as rail removal and erection. The opportunity exists for the sharing of specialist equipment for some small work elements (turf cutter, excavator for site maintenance)

**Common Pitfalls**

Suggestions to avoid common pitfalls

Thorough review of water supply / irrigation pre design vital.

Assess staging options to minimize Construction disturbances and to maintain access, water supply, drainage etc.

Ensure accurate and current survey (in appropriate format) is available.

Arrange for a suitable geotechnical or subsurface investigation to assess excavation conditions, water table implications, actual soil profile etc – rather than relying on “hear say” passed on and established from “old timers”.

Constant liaison with ground staff, trainers, jockeys, etc.
Racetrack Profiles

Options

Some of the more commonly available profiles being marketed are outlined in the following diagrams.
Stabilizer Racing Surfaces

Stabilizer Solutions, is a company dedicated to the Horse Racing Industry and has been for the past 10 years. We are a well-established company focused on providing quality and satisfaction. Stabilizer Solutions has become the only product effective enough to be incorporated into all areas of Racetrack Profile’s/Surfaces, the following Stabilizer products listed have a proven track record. This has become evident worldwide.

Stabilizer Racing Surfaces is a solution to Racetrack Management and Construction. Stabilizer Solutions main strength is its versatility as it is specifically designed to work in Sand, Dirt and Grassed tracks. It is a proven winner in all weather conditions, having the ability to provide a consistent race surface.

Grassed Tracks
Turf Grids is a polypropylene fibre that is used to stabilize sports turf. Turf Grids increases the load bearing and shear strength of the root zone. Turf Grids provide a durable surface that truly re-enforces the turf and the sand profile. With the increased strength in the root system the turf regeneration becomes quicker because divot sizes are smaller, therefore the plant is healthier.

Dirt & Sand Tracks
Stabilizer Gold is a mixture ideal for sand and dirt tracks. It is a mixture of polypropylene fibres and Stabilizer, a premium organic binder. Stabilizer Gold improves the impact resistance by helping absorb the energy from the impact of the horse. The surface allows the hoof to penetrate but does not slide away as the hoof pushes off, which calculates to good traction and better performance.

The difference is evident for the turf grids that are worked into the soil aid against compaction thus enabling the track to be used in all elements that weather can throw at it.

A jockey quoted “Like running on clouds” after a race.

Here’s the proof:

<table>
<thead>
<tr>
<th>Sand Tracks</th>
<th>Dirt Tracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hippodrome Cote d’ Azure-Nice, France</td>
<td>Hollywood Park Main Track-Ingelwood, CA</td>
</tr>
<tr>
<td>Jockey Club of Turkey</td>
<td>Bay Meadows Main Track Race Course-San Mateo, CA</td>
</tr>
<tr>
<td>Course-Istanbul</td>
<td>Emerald Downs-Auburn, WA</td>
</tr>
<tr>
<td></td>
<td>Hastings Park Racecourse-Vancouver BC, Canada</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turf Tracks</th>
<th>Training Tracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Churchill Downs-Louisville, KY</td>
<td>Coff’s Harbor, Australia</td>
</tr>
<tr>
<td>Bay Meadows Racecourse-San Mateo, CA</td>
<td>Chantilly Training Centre, France</td>
</tr>
<tr>
<td>Philadelphia Park-Bensalem, PA</td>
<td></td>
</tr>
<tr>
<td>Del Mar Racecourse-Del Mar, CA</td>
<td></td>
</tr>
<tr>
<td>Santa Anita Park-Arcadia, CA</td>
<td></td>
</tr>
<tr>
<td>Lone Star Park-Grand Prairie, TX</td>
<td></td>
</tr>
</tbody>
</table>

Will your track be next?
Contact Robert Davey or Matthew Buck at Evergreen Stabilizer Solutions for an information pack and/or more information on the ultimate solution that is Stabilizer.
(03) 59452100 ph (03) 59411473 fax email rob@evergreen.com.au/ matt@evergreen.com.au/ 560 McGregor Road Pakenham, 3810 Victoria Australia
Summary

The demand for improved and more consistent racing surfaces, both agronomically and geometrically, has necessitated the reconstruction of many racetracks in Australia. While there is an acknowledgement of the need to construct using materials of consistent and high quality, there still remains a wide range of views on what constitutes an ideal racetrack profile. In reality, there is no single answer, however, there are several important measurable criteria that must be taken into account during the planning and construction process.

Racetrack re-design and reconstruction should only proceed after the following factors have been considered or implemented:

*Industry Criteria* – the planned reconstruction must conform to racing authority criteria and projections.

*Racing Schedule* – a sufficient non-racing/training period must be possible to allow the new track time to settle and turf to establish.

*Cost/Benefit* – extent of the reconstruction must be tailored to an acceptable cost/benefit ratio.

*Track Survey* – an up to date survey of current racetrack and course shape, topography and fixtures must be undertaken as a basis for the re-design and to calculate reconstruction costs.

*Engineering Assessment* – expert assessment of sub-soil type, strength and permeability, to an appropriate depth, is an essential prerequisite to planning.

*Contractor Expertise* – due to the precise technical standards required, contractors with proven experience in sportsfield construction are critical.

*Contract Agreement* – must encompass all aspects of the works including detailed plans, drawings, schedules, machinery access, operational conditions and material standards.

*Materials Quality & Availability* – soils, turf and other materials used in reconstruction must be of a specified standard and readily available as needed.

*Comparative Inspections* – visits to comparable, recent racetrack reconstructions will provide lessons from other clubs’ experiences.

*Water Inflow & Outflow* – availability and quality of water for irrigation, automatic watering, scope for recycling, effective, maintainable drainage and environmentally acceptable means of excess water disposal are important cost and operational considerations.
3. Irrigation and Drainage

Introduction

The control of water, whether it is water applied through irrigation or the removal of excess water via drainage, has a significant impact on the preparation and performance of racing surfaces. Efficiency of water use on racecourses is also becoming more important due to considerations of cost and the environment. Nevertheless, a survey in recent years found that most racecourses used experience and weather forecasts to judge water application, and were constantly occupied with drainage maintenance. Water disposal and recycling were minor priorities.

Soils that are excessively wet produce slow tracks where there is a high degree of turf damage and soil compaction. Soils that become excessively dry, while producing fast racing surfaces, can result in increased horse injury (particularly with shin soreness). Inadequate irrigation equipment and poor water application techniques will result in variable soil moisture and a variation in the racing surface. Variations in the racing surface can result in claims of track bias and an increased uncertainty in the “running”.

Modern racetracks are well drained and wet weather has less of an effect on track conditions. However, water quality and efficient water use are key factors affecting the long-term management of racetracks. With increasing demands on potable water supplies and the increased cost of water, means that racetracks are relying more on lesser quality water that has increased levels of contaminants (e.g. soluble salts, sodium etc). Racetracks are also difficult to irrigate because of track geometry and width and the demands of preparing tracks for racing.

The advent of the latest techniques in racetrack reconstruction, with the emphasis on providing a “good” racing surface at all times, has revolutionised water use practices to the extent that it is now possible to account for virtually every drop. Modern technology has enabled the application of very sophisticated equipment and easily maintained, automatic systems for measuring water requirement, rapid and accurate water application, and removal of excess water. Similarly, advances in methods of water storage, testing and re-use have radically improved water use efficency.

The following papers and discussion notes summarise the principles of efficient irrigation and drainage, and outline current systems and methods.
Irrigating Racetracks - The Fundamentals

by Geoff Connellan, Burnley College, University of Melbourne. Doomben, 1998

Introduction

The increasing expectations on the performance of turf surfaces is placing greater demands on turf managers. The racetrack manager, like other turf managers, needs to cope with these increasing demands in an environment of limited resources.

The role of irrigation in turf management is vital, as it impacts on many aspects of turf, including surface quality, maintenance, labour requirements and operating costs.

There are considerable opportunities for the improvement of existing and new irrigation systems through developments in irrigation technology. The performance of racetrack irrigation systems should be continually evaluated and monitored to ensure that all of the needs and demands of the facility are being satisfied. New developments in irrigation technology are providing additional tools to assist in the management of irrigation systems.

Irrigation of Racetrack Turf

In considering the irrigation of racetrack turf, it is important to recognise that there are particular characteristics and requirements of turf in terms of irrigation.

These aspects of turf impact on the design and the management of the irrigation system. They are:

- Uniformity - Individual turf swards draw water from only very small distances, the irrigation system must therefore apply water with a high degree of evenness or uniformity.
- Limited root depth - The active root systems of turf occupy only a comparatively shallow depth of soil, often 100 to 150 mm, and so, in order to avoid wastage through over watering, the application depth must be precise.
- Responsiveness - Turf responds very rapidly to changes in the soil moisture status and so, if inadequate levels of moisture are present in the root zone, during periods of high water demand, then turf will become rapidly stressed.

Turf irrigation must therefore be capable of applying predetermined amounts of water to the turf root zone with a high degree of uniformity and with minimum wastage.

In addition to these generic needs of turf, racetracks have additional requirements or constraints. They are:

- Firm consistent surface - Overwatering can not be tolerated (No waterlogging).
- Very even application - An even surface is essential and this means an even application of water to the soil root zone.
- Limited time available - The time window in which to apply the water often places significant constraint on the irrigation system when issues such as training requirements, unfavourable weather conditions and staff availability are taken into account.
- Racetrack areas and shapes - including curves and bends, that are difficult to effectively accommodate with the radial distribution pattern of sprinklers.
The consequences of these constraints, as far as the irrigation system is concerned, are:
- Sprinklers which can achieve a high degree of uniformity, when distributing water over long distances (eg. 25 to 28 metres).
- Sprinkler application rate that needs to be matched to soil infiltration properties.
- System controlled and managed so that the correct depth applied at the right time.
- Equipment that functions effectively and is reliable in operation.

**Racetrack Irrigation Systems**

**Sprinklers**

The requirements of racetrack in-ground sprinklers is possibly the most demanding of all turf equipment. A consequence of the large distances to be covered is that the sprinkler heads will have high flow rates and consequently operate at high pressures. Ideally they will be capable of performing effectively in moderate winds.

Turf managers should be conscious of the effect of wind on the sprinkler distribution profile. A guide to the broad effects is presented in Table 1.

Table 1. Sprinkler performance and wind speed

<table>
<thead>
<tr>
<th>Wind condition</th>
<th>Wind speed</th>
<th>Uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calm</td>
<td>0 to 5 kph</td>
<td>High uniformity</td>
</tr>
<tr>
<td>Breeze</td>
<td>5 to 10 kph</td>
<td>Good uniformity</td>
</tr>
<tr>
<td>Windy</td>
<td>10 to 15 kph</td>
<td>Fair uniformity</td>
</tr>
<tr>
<td>Windy</td>
<td>Over 15 kph</td>
<td>No irrigation</td>
</tr>
</tbody>
</table>

Unfortunately, there is limited data available on the performance of specific sprinklers in windy conditions. Standard sprinkler testing at the Center for Irrigation Technology (CIT), Fresno, California and the Australian Irrigation Technology Centre (AITC), Adelaide, is carried out indoors, under calm conditions. Droplet size distribution testing is available at CIT (Solomon, Zoldske and Oliphant, 1996). In addition to providing valuable information on wind sensitivity, droplet sizes are also of interest in terms of evaporation losses, wind drift losses and soil compaction.

Some of the sprinkler head design and operating conditions that influence sprinkler distribution performance are:

- **Nozzle trajectory angle** - the water stream height and hence exposure to wind is determined by the trajectory angle. Higher water streams are more sensitive as wind speed increase with height.
- **Droplet size** - water stream with large drops are less affected by wind. Nozzle orifice diameter, shape, inlet design, operating pressure all influence droplet size.
- **Time of day** - wind speeds are higher during the day than during the night. Irrigation is best carried out during the night and in particular early morning.

Achieving a high degree of uniformity, with single high flow rate sprinkler heads, is very difficult. Highest irrigation uniformity is generally achieved using low flow nozzles mounted on a boom and closely spaced. Droplet size, droplet trajectory and closeness to the ground (target) of the nozzle all contribute to a more even application with booms.

Reliability in functioning effectively and continuing to operate is of paramount importance for racetrack sprinklers. The maintenance of the irrigation system needs to ensure that nozzles are clear, seals are functioning, retraction devices working and the rotation drive mechanism operating effectively.
Performance of Irrigation Systems

The purpose of an irrigation system is to deliver a predetermined depth of water to the root zone of the turf at the appropriate time. The key issues are the ability to deliver the required depth and timing.

Sprinkler irrigation systems are deceptive in terms of the application of water. They can appear to be very even in application because a lot of water is being distributed over a relatively confined area. In fact every sprinkler irrigation system exhibits a degree of unevenness. Some are particularly poor.

The potential reasons for this lack of evenness include:
- Poor sprinkler distribution profile.
- Unfavourable environmental operating conditions - wind.
- Incorrect operating pressure.
- Poor pipe and valve sizing.
- Sprinkler head or equipment not functioning effectively.

Regular evaluation and auditing of the irrigation system is recommended to assess the uniformity, effectiveness and management of the irrigation system.

Testing Your Irrigation System

There are several important irrigation system performance parameters that managers should monitor. Two key measures are the system application rate and the uniformity of the system. Both can be readily checked using techniques developed by the irrigation industry. The assessment is carried out using the "catch can" test. Calibrated receptacles or collection cans are positioned in a grid pattern so that when the sprinklers are operated the variation in application depths can be measured.

A statistical analysis is carried out on the results and a value of uniformity determined (Zodolske and Solomon, 1986). The recommended uniformity measure for turf is the Distribution Uniformity (DU) coefficient (Connellan, 1997). It is recommended that the DU of a system should be greater than 75%.

Irrigation Scheduling

Principles

The decision making process as to: How much water to apply? and; When to apply it? is referred to as Irrigation Scheduling.

The scheduling of racetrack irrigation is particularly demanding due to the need, not only satisfy the turf water needs, but also to provide a surface with specific physical properties. Overwatering has very significant consequences on racetrack turf.

The depth of water that should be applied is generally expressed in terms of the water required to bring the soil water storage from the designated minimum level (referred to as the Refill Point) up to the full level (this usually means that the soil is at Field Capacity).

The Refill Point is the level you allow the soil water to be depleted before irrigation is initiated. It is necessary to know the soil water storage capacity to effectively manage irrigation. This property is referred to as the Plant Available Water (PAW). The value of PAW is determined through the depth of the root zone and the Available Water (W) of the soil.

In a turf situation, where the root zone depth is 200 mm and the soil is a sandy loam (W= 100 mm per metre depth of soil), the PAW is 22 mm (PAW = 200 x (110/1000)).
The decision of, ‘How much to apply?’, is based on the how much depletion will be allowed in the root zone. If it is decided to allow 50% depletion, then irrigation will be initiated when 11mm has been removed from the storage reservoir.

The timing of the irrigation depends on how long it takes for the allowable depletion depth (11 mm in this example) to be extracted from the soil volume. If 5.5 mm is removed per day, then it will take two days to reach the Refill Point and then irrigation will be initiated.

**Estimation Of Turf Water Use**

The depth of water transpired by the turf and evaporated from the soil is referred to as Evapotranspiration (ET) rate. The amount of ET, usually measured in mm per day, can be estimated using the following expression:

\[ \text{ET turf} = \text{Crop Factor (F)} \times \text{Evaporation from Class "A" pan} \]

The value of Crop Factor (F) typically ranges from 0.65 to 0.90 for Cool season turf grasses and in the range of 0.25 to 0.70 for Warm season turf grasses (Handreck and Black, 1991). As a general rule, Cool season grasses use approximately, 30% more water than Warm season grasses growing under similar climatic conditions.

Evaporation pan data (Epan) is available from the Bureau of Meteorology. During summer the value of Epan can exceed 10 mm in a day. If the Epan value was 10 mm and the turf had an F value of 0.7, then the daily water use (ET) of the turf would be 7 mm (ET = 0.7 x 10 mm).

**Racetrack Irrigation Scheduling**

Racetracks are often irrigated by applying a reasonably shallow depth, for example, less than 5 to 7 mm. There are various reasons for this approach, including turf managers being conservative and not wanting to over water, and also there are limitations in equipment and systems that prevent deep applications. The travel speed of mobile irrigation equipment, flow rates, performance of pumping plants and pipework often limit the depth of water that can be applied.

Racetrack managers should be conscious of the consequences of shallow, irrigation applications. They include:

- Encouragement of shallow rooted turf - drought resistance is limited and the surface has less ability to withstand stress (Neylan, 1992).
- Water losses at each irrigation are higher.
- Limited opportunity to utilise nutrients in the shallow root zone.

Knowledge of the actual soil moisture level and changes under the varying influencing climatic and irrigation conditions is very useful to the irrigation manager. There is much to gained through the actual measurement of soil moisture.

**Developments in Irrigation Technology**

The irrigation industry, both internationally and locally, has placed considerable resources into improving the performance of turf irrigation systems. In many cases these developments relate to the monitoring of the turf, soil and the environment and the control of equipment and the total system. The ability to deliver the required amount of water is the objective of the irrigation system. Currently there are large variations in the amount of water applied to maintain turf growing under similar conditions (Keig, 1994). Technology is available to improve the efficiency of turf irrigation systems.
Developments include:

- Control systems - increased intelligence, monitoring capability, flow management and communication options.
- Soil moisture sensors - improvement in accuracy and reliability, user friendliness and input capability for control.
- Weather stations - lower cost, portability, improved ET estimation and environmental monitoring for prediction plant health risk conditions.
- Pump drives and controls - variable frequency drives (VFD) for increased efficiency, improved hydraulic performance, greater flexibility in operation, remote monitoring and control.

**Summary**

The ability to maintain the correct moisture level during periods of rainfall deficiency is critical to the success of racetracks. Good irrigation systems do not just happen, they are the result of good design, selection of quality equipment, sound installation and competent management.

Racetrack managers should inform themselves of the developments in irrigation technology which have the capability of providing current information on the operation and performance of the irrigation system and the turf. It is now not necessary to guess conditions, they can be measured and recorded.

The irrigation industry has much to offer racetrack managers. Maximising these potential benefits is a challenge for both irrigation companies and racing clubs. Priority should be given to addressing this challenge.

**References**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Details</th>
</tr>
</thead>
</table>

**General Discussion**

*Booms versus Sprinklers?*

- A boom applies water evenly, however, if you need to apply water quickly you need to calculate boom flow rates and you may need several boom applicators.
- Booms require more labour and some tracks cannot afford the manpower.
- Turns are a problem for fixed sprinklers.
- Equilateral triangle layout is best for sprinklers.
Moisture sensors?
moisture sensors at Moonee Valley are working well. These are tensiometers at three different
depths. They measure nutrient levels and temperature also.
Ballarat is experimenting with the "gopher" system which looks to have potential. It is a
portable instrument measuring moisture levels down fixed tubes along the running rail

Sub-soil irrigation systems?
very suitable for horticulture and widely used in these situations, however turf may be a
problem because of root intrusion into outlets. Uniformity of distribution could also be a
challenge.
We can do everything from keeping your gardens looking perfect with a range of Spray heads and nozzles, to irrigating your main track using our large fully top serviceable valve-in-Head rotors.

Our range of conventional and 2-wire Standalone controllers - up to 103 stations, can be upgraded to a central as budget allows.

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Phone: (61) 8 8363 3599  Fax: (61) 8 8363 3687
Alternative Water Sources for Turf Irrigation

by John Neylan, AGCSATech. 2000

Water is essential for sustaining and maintaining the quality of life we are used to in Australia. For most Australians in urban environments their water arrives at the turn of a tap, clean and free of disease. Because we expect a high quality water source, it is often taken for granted and there is very little concern shown for the economic, environmental and social costs associated with its supply.

Australia is a dry continent and our water resources are essentially finite. It is fortunate that we have available to us millions of litres of subterranean water that has been stored over millions of years to supplement our surface catchment areas, which are confined mainly to the coastal fringe. In some areas that rely on underground water, the draw down has exceeded the rate of recharge, resulting in salt water intrusion. In a recent review of Melbourne’s water supply (Melbourne Water Resources Review, 1992) it was stated that the current growth in water use (2.2% per annum) is not sustainable beyond the year 2006. Australia is drought prone, which puts increasing pressure on the available water and there is a need to carefully prioritise where the water is used, whether it be in households, agriculture, irrigating turf or industry. Acknowledging that the available water is finite there is a need to redistribute this water, and to exploit alternative sources.

The maintenance of a high quality turf relies on having access to a good quality and constant water source. The time is approaching where high quality potable (drinking) water will not be available for turf areas, and lower quality water, such as recycled wastewater and high salinity bore water that are high in salts and other contaminants, will have to be used. This has increased the emphasis on research goals toward environmental stress resistant and water efficient turfgrasses (Kenna and Horts, 1993).

Water Quality Criteria

The quality of a water supply is judged by the amount of dissolved and suspended materials which are present (VIRASC, 1980). High quality in a water is associated with the low amounts of these materials, however, in practice quality must always be considered in relation to the intended use.

When assessing the quality of bore, dam, recycled water or run-off water, the soluble salt level is a good indicator of water quality. However, the chemical breakdown is required with particular emphasis on sodium, calcium, magnesium, pH and carbonate concentrations.
Table 1: Salinity Hazard of Irrigation Water

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Electrical Conductivity (uS/cm)</th>
<th>Total Soluble Salts (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Salinity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waters for which no detrimental effects will usually be noticed.</td>
<td>0 – 750</td>
<td>0 - 500</td>
</tr>
<tr>
<td><strong>Medium Salinity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water which may have an affect on sensitive plants. Some leaching is required.</td>
<td>750 – 1500</td>
<td>500-100</td>
</tr>
<tr>
<td><strong>High Salinity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waters can have adverse effects on many plants and require careful management. Water should not be used on soils with restricted drainage.</td>
<td>1500 – 3000</td>
<td>1000 – 2000</td>
</tr>
<tr>
<td><strong>Very High Salinity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water can only be used on very salt tolerant plants under conditions of good drainage and excess irrigation to provide leaching.</td>
<td>3000 – 7500</td>
<td>2000 - 5000</td>
</tr>
</tbody>
</table>

Reference: Malcolm, 1962

Table 2: Guidelines for Interpretation of Water Quality for Irrigation of Turf

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No Problems</th>
<th>Increasing Problems</th>
<th>Severe Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Salinity)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Soluble Salts (mg/l)</td>
<td>&lt;500</td>
<td>1000 – 1500</td>
<td>&gt;2000</td>
</tr>
<tr>
<td><strong>(Permeability)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAR (meq/l)</td>
<td>&lt;8</td>
<td>8 - 18</td>
<td>&gt;40</td>
</tr>
<tr>
<td>SARadj (meq/l)</td>
<td>&lt;6</td>
<td>6 – 9</td>
<td>&gt;9</td>
</tr>
<tr>
<td>Residual Sodium Carbonate (meq/l)</td>
<td>&lt;1.25</td>
<td>1.25 – 2.5</td>
<td>&gt;2.5</td>
</tr>
<tr>
<td><strong>(Specific Ions Toxicity)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chloride (mg/l)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foliar Absorption</td>
<td>&lt;106</td>
<td>&gt;106</td>
<td></td>
</tr>
<tr>
<td>Root Absorption</td>
<td>&lt;142</td>
<td>142 – 355</td>
<td>&gt;355</td>
</tr>
<tr>
<td><strong>Sodium (mg/l)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foliar Absorption</td>
<td>&lt;69</td>
<td>&gt;69</td>
<td></td>
</tr>
<tr>
<td><strong>(Boron)</strong></td>
<td>&lt;1</td>
<td>1 – 2</td>
<td>&gt;2</td>
</tr>
</tbody>
</table>

Reference: Ayers and Wescot, 1976

High salinity water causes an increase in soil salts and as soil salinity increases it becomes more difficult for plants to extract water from the soil. This is due to an increase in the osmotic pressure of the soil water, i.e. the salts “hold” the water so strongly that plants cannot remove it and therefore appear to be under drought stress even when adequate moisture is present.

Table 1 outlines the different classes for irrigation water based on the soluble salt content. As a general rule, water with salts exceeding 1000 mg/l severely limits its use on turf, however, this is dependant on grass species (also variety), soil type, thatch level and irrigation management.
Salt tolerant grasses growing on well drained soils, that are readily leached of salts, can be irrigated with saline water with up to 2000 mg/l total salts. Excessive and frequent applications of water are required so that leaching occurs and the soil is prevented from excessively drying out.

Where sodium forms a large proportion of the total salts in water, soil permeability problems can occur. High concentrations of sodium in the irrigation water will increase the concentration of exchangeable sodium in the soil and as the exchangeable sodium content increases there is a breakdown in soil structure in high clay content soils. This reduces permeability, aeration, infiltration and soil workability. The most commonly used method to evaluate the potential of sodium to cause soil problems is to calculate the Sodium Adsorption Ratio.

The sodium adsorption ratio (SAR) is defined by the equation;

$$\text{SAR} = \frac{\text{Na}^+}{\left[\left(\text{Ca}^{++} + \text{Mg}^+\right) / 2\right]}$$

where Na, Ca and Mg represent the concentrations in milli equivalents per litre of the respective ions. On clay soils an SAR greater than 8 gives cause for concern and efforts have to be made to minimise the breakdown in soil structure. On sandy soils where permeability is less of a problem the cation exchange sites become saturated with Na at the expense of Ca, K and Mg.

Permeability problems are also related to the carbonate (CO$_3^-$) and bicarbonate (HCO$_3^-$) content in the irrigation water and this is not considered in the SAR calculation. When drying of the soil occurs part of the CO$_3^-$ and HCO$_3^-$ precipitates as a Ca-MgCO$_3$ thus removing Ca and Mg from the soil water and increasing the relative proportion of sodium. The effect of CO$_3^-$-HCO$_3^-$ on soil permeability can be calculated by the residual Sodium Carbonate (RSC) method or by using a modified SAR equation. The adjusted SAR includes the influence of carbonate and bicarbonate ions and their effects on calcium and magnesium. The presence of high concentrations of CO$_3^-$ and HCO$_3^-$ can cause nutritional disturbances such as reducing the availability of calcium and the uptake of iron.

Sodium and chloride are the most damaging ions, with chloride being particularly toxic. Plants accumulate sodium and chloride to the exclusion of calcium, magnesium and potassium causing nutritional disturbances. However, there is significant variation in plant tolerance to sodium and chloride, enabling the selection of more tolerant plants to be used under saline conditions. Table 2 details the levels of various ions that can be associated with soluble salts and their acceptable levels.

**Recycled Wastewater**

Recycled wastewater, primarily treated sewage effluent, is increasingly being used for irrigating turf. There have been a number of detailed reports (Lang et. al. 1977, GHD 1977 and NSW task force on reclaimed water 1982) investigating and detailing the feasibility of reusing treated sewage effluent. In a Department of Resources and Energy (1983) report it identified that in Australia the total amount of treated sewage was about 1300 gigalitres/annum of which 56 gigalitres/annum (4.4 percent) is reused in irrigation. There have been identified about 100 – 150 turf sites on which recycled wastewater is being used, of which a number are racetracks. However, recycled water remains an under utilised and valuable source of water for turf.

Recycled wastewater, unlike most other water resources, contains nutrients such as nitrogen, phosphorus potassium, heavy metals and boron. The nutrients can have a significant impact on turf management, particularly nitrogen which is in a soluble and readily available form. This nitrogen must be accounted for in a fertiliser program and the balance between nitrogen and potassium maintained. Recycled water used on fine turf can produce lush, excessive growth that becomes thatchy and is more susceptible to disease and heat stress. Trials have shown that on fine, bentgrass turf using recycled water for irrigation can supply 60 – 100 percent of the required nitrogen, all of the phosphorus and about 30 percent of the potassium (Neylan 1985).
Heavy metals such as zinc, iron, copper, nickel, lead, chromium and cadmium occur in recycled water. Iron, zinc and copper are essential for healthy turf but in excessive amounts these elements are toxic. Heavy metals in recycled water can be a problem where the main source of effluent is of industrial origin, however, recycled water that is mainly of domestic origin, has a low heavy metal input which is unlikely to be toxic to turf.

Boron occurs naturally in some soils and groundwater as well as in recycled water. Boron is used in detergents and soaps and most treated effluent contains 0.5 to 1.0 mg/l of boron. Boron is essential to turf growth but levels greater than 2.0 mg/l can be toxic. The effects of boron depend on plant species tolerance and soil conditions. Well drained soils that are readily leached generally do not accumulate boron as boron is a mobile element and is easily leached through the soil. In general, recycled water of domestic origin does not contain toxic levels of boron.

When dealing with treated wastewater there are health considerations that must be taken into account. All wastewaters contain varying levels of microbiological activity and potentially can be considered a health risk. All states have public health regulations governing the quality (microbiological) and use of recycled water. The regulations are generally based on the NHMRC (1980) guidelines and are designed to provide guidance to authorities, users and the general public on the conditions governing its safe use. The guidelines are designed to safeguard public health and therefore particular attention is given to microbiological quality (and not chemical).

Another potential source of recycled water is the wastewater from the domestic laundry, bathroom and kitchen. This water is referred to as greywater and research is currently being undertaken to investigate its potential use (Christova-Boel. Persomm. 1994). About one third of domestic water is used in this situation and if re-used on turf and gardens has the potential to replace about 18 percent of our current domestic water demand (Melbourne Water Resources Review, 1992). Depending on the type of soaps and detergents used, high levels of sodium, boron and carbonate/bicarbonate can occur in greywater.

Water Quality Monitoring

Recycled water, bore water and greywater can contain varying amounts of soluble salts, nutrients and contaminants. Water quality can vary from site to site, from year to year and throughout the year. It is therefore, essential to monitor the water quality on a regular basis. Bore water must be tested for pH, total soluble salts, calcium, magnesium, sodium carbonate and bicarbonate. Recycled wastewater also needs to be analysed for nitrogen, phosphorus and potassium. Heavy metal analysis is not essential unless there is a known source of contamination.

If the water quality is within acceptable parameters an analysis prior to starting irrigation and then in the middle of the irrigation season is recommended. The salts in bore water and recycled water can become concentrated during the summer and particularly if the water is stored in open storages. Wherever substantial variations can occur then more regular analysis is required. The use of a permanent salinity probe at the point of take-off will provide a safety valve against using highly saline water.

If recycled water is to be used or the available water is of marginal quality, then a thorough site investigation is essential before the irrigation is implemented. Where recycled effluent is used, a monitoring program is usually required by the regulatory body and is generally described in a set of guidelines. The key factors to be investigated include;

- Water quality
- Quantity of water available
- Proximity of reuse site
- Site suitability (soils, grass type etc.)
- Public acceptability
All these factors affect the cost of using recycled water as well as affecting turf management practices. The site suitability investigation is absolutely essential, so that any potential problems can be pre-empted and appropriate management techniques implemented before a problem occurs.

**Turfgrass Tolerance to Salinity**

High levels of soluble salts in the turf rootzone are detrimental to most turfgrasses. Excess soluble salts may affect growth by osmotic inhibition of water uptake (physiological drought) by the specific ions (Harivandi et. al., 1992). Salinity affects different species in different ways and the effects may vary depending on the age of the plant where salinity effects are generally greater at germination compared to the mature plant. Salinity tolerance in turfgrasses is related to the plants ability to reduce NaCl uptake.

There have been a number of studies to investigate salt tolerance in turfgrasses and the mechanisms affecting salt tolerance. Younger et. al. (1967) observed significant variation in the salt tolerance of creeping bentgrass varieties. The main effect of high salinity was to reduce top growth and the old variety “Seaside” had the highest salt tolerance and “Penncross” the least tolerant. It was noted that “Seaside” had high variation between individual plants and Engelke (Pers. comm. 1992) has selected new varieties with improved salt tolerance and turf quality based on this variation.

McCarty and Dudeck (1993) reported that when germinating bentgrasses in high salt solutions, “Streaker” red top and “Seaside” creeping bentgrass were the most salt tolerant. “Kingston” velvet, “Exeter” colonial and “Highland” colonial had intermediate tolerance while “Pennlinks”, “Penncross” and “Penneagle” creeping bentgrass were the most salt sensitive.

Dudeck and Peacock (1993) carried out a study on warm season grasses and demonstrated that “Emerald” zoysiagrass, FSP-3 Seashore paspalum and “Tifway” couchgrass were the most salt tolerant. “Floralawn” St Augustinegrass, “Tifway II” couchgrass and FSP-1 Seashore paspalum had intermediate salt tolerance while Centipedegrass and Bahiagrass were very salt sensitive. Dudeck and Peacock (1993) also demonstrated that as salinity increased, plant K levels decrease and to a lesser degree a decrease in Ca, Mg and P.

In germination studies, Lunt et. al. (1961) found that weeping alkaligrass and “Alta” tall fescue were most salt tolerant while Kentucky Bluegrass, creeping bentgrass and colonial bentgrass were less salt tolerant. The drop in germination is due to osmotic stress with early increments in salinity retarding germination while higher concentrations reduce germination percentage.

Salinity effects on turfgrass growth have been summarised by Harivandi et. al. (1992) as;

1. Reduced water uptake due to osmotic stress.
2. Reduced nutrient uptake such as K may be depressed by absorption of Na.
3. Root biomass may increase to improve water absorbing ability.
4. Na and Cl reduce growth by interfering with photosynthesis.
Harivandi et. al. (1992) have also listed the common turfgrasses and their estimated salt tolerance (Table 3).

Table 3: Estimated Salt Tolerance of Common Turfgrasses

<table>
<thead>
<tr>
<th>Cool-season turfgrass</th>
<th>Rating *</th>
<th>Warm-season turfgrass</th>
<th>Rating *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td></td>
<td>Name</td>
<td></td>
</tr>
<tr>
<td>Alkaligrass (Puccinellia spp.)</td>
<td>T</td>
<td>Bahiagrass (Paspalum notatum Fluegge)</td>
<td>MS</td>
</tr>
<tr>
<td>Annual bluegrass (Poa annua L.)</td>
<td>S</td>
<td>Burmudagrass (Cynodon spp.)</td>
<td>T</td>
</tr>
<tr>
<td>Annual ryegrass (Lolium multiflorum Lam.)</td>
<td>MS</td>
<td>Blue grama (Boutleoua gracilia (H.B.K) Lag. ex. steud.)</td>
<td>MT</td>
</tr>
<tr>
<td>Chewings fescue (Festuca rubra L. spp. commutata Gaud.)</td>
<td>MS</td>
<td>Buffalograss [Buchlon dactyloides (Nutt.) Engelms.]</td>
<td>MT</td>
</tr>
<tr>
<td>Colonial bentgrass (Agrostis paluatris Huds)</td>
<td>S</td>
<td>Centipedegrass [Eremochla ophiuroides (Munro) Hackell]</td>
<td>S</td>
</tr>
<tr>
<td>Creeping bentgrass cv. Seaside</td>
<td>MS</td>
<td>Kikuyu (Pennisetum clandestinum)</td>
<td>MT</td>
</tr>
<tr>
<td>Creeping red fescue (Festuca rubra L spp. rubra)</td>
<td>MT</td>
<td>Seashore paspalum (Paspalum vaginatum Swartz.)</td>
<td>T</td>
</tr>
<tr>
<td>Fairway wheatgrass [Agropyron cristatum (L) Gaertn.]</td>
<td>MS</td>
<td>St Augustinegrass [(Stenotaphruum secundstam (Walter) Kruntze)</td>
<td>T</td>
</tr>
<tr>
<td>Hard fescue (Festuca longifolia Thuill.)</td>
<td>MT</td>
<td>Zoysiagrass (Zoysia spp.)</td>
<td>MT</td>
</tr>
<tr>
<td>Kentucky bluegrass (Poa pratensis L.)</td>
<td>MS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perennial ryegrass (Loloium perenne L.)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rough bluegrass (Poa trivilis L.)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slender creeping red fescue cv. Dawson (Festuca rubra L. spp. trichophylla)</td>
<td>MT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tall Fescue (Festuca arundinacea Schreb.)</td>
<td>MT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western wheatgrass (Agropyon smithii Rydb.)</td>
<td>MT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The rating reflects the general difficulty in establishment and maintenance at various salinity levels. It in no way indicates that a grass will not tolerate higher levels with good growing conditions and optimum care. The ratings are based on soil salt levels (EC$_e$) of:
  Sensitive (S) = <3 dS/m, Moderately Sensitive (MS) = 3-6 dS/m, Moderately Tolerant (MT) = 6-10 dS/m, Tolerant (T) = >10 dS/m.

Reference: Harivandi et. al., 1992
Managing High Salinity Water

If water of high salinity is the only available water supply there are several management techniques that can be used to minimise salt damage. These include:

1. Establish salt tolerant species and varieties of turfgrasses. Establishment will most likely have to be done using a freshwater source.
2. Ensure that irrigations are deep and beyond the rootzone to leach salts out of the rootzone and to prevent accumulation. The amount of water required for leaching can be calculated:

   \[
   \text{Leaching requirement} = \frac{\text{EC}_{\text{iw}}}{\text{Ecdw}}
   \]

   Where \(\text{EC}_{\text{iw}}\) is the electrical conductivity of the irrigation water and \(\text{Ecdw}\) is the electrical conductivity of the drainage water (VIRASC, 1980). One method of calculating the leaching requirement is to assume that the concentration of the drainage water is the same as that of the saturation extract (\(\text{EC}_e\)) at the bottom of the rootzone. An appropriate value can be chosen from table 3 and then the calculation made. For example, if creeping bentgrass has an \(\text{EC}_e\) of 4 dS/m and the irrigation water is 2 dS/m (say 1400 mg/L) the leaching requirement is 50 percent. That is, the amount of irrigation required is 50 percent greater than if freshwater is used. There are other tables in the literature listing the salt tolerance of a variety of ornamental and crop species (eg. Maas and Hoffman 1977).
3. Do not allow excessive drying out of the soil so as to avoid short term high salt concentrations.
4. Maintain adequate soil permeability through subsoil aeration and thatch control.
5. Irrigate at night to avoid salt burn.
6. Irrigate with freshwater whenever possible to aid leaching.
7. Conduct soil analysis to monitor soil soluble salt and cation levels. Adjust as required, eg. apply gypsum to counteract Na accumulation.
8. Maintain adequate nutrient levels including K, Ca, Mg and P.
9. Construct on sandy soils whenever possible.

Conclusion

As we are now in a new millennium, our sources of available freshwater are coming under increasing pressure to serve our development and population growth. The consequence of this is that turf areas will have to be irrigated with alternative water sources, potentially of lower quality. In using water of this type, the turf manager must be aware of the potential contaminants, their impact on turf quality and how to manage them.

The use of recycled water will provide a means of utilising a wasted resource, however, not without an appropriate site investigation and on-going monitoring. This will ensure that the correct decisions are made and that long term environmental damage does not occur while maintaining a turf of acceptable quality.
References

Irrigation Workshop
Morphettville, 1999

Important principles to follow for water management on racecourses:

1. **Measuring water needs and application**
   - is appropriate measuring technology available?
   - do we have resources to use the technology, ie, staff, etc.?
   - staff training will lead to understanding of measuring techniques, soil and plant water relationships, resulting in data collection and reporting, analysis, recommendations and forecasting.

2. **When to water and how often**
   - Problems:
     - scheduling watering to meet the needs of racing and training without affecting adequate turf growth
     - flexible, adequate irrigation systems
     - data on weather, evaporation, infiltration, soil profile, etc.
   - Solutions:
     - measuring devices
     - generation of a data base for information
     - an irrigation “Master Plan”
     - emphasis on developing deep root systems

3. **Water quality requirements**
   - Problems:
     - water not meeting turf requirements
     - salinity levels too high
     - balancing nutrient levels in recycled wastewater
     - acceptable “water quality” is very dependent on soil type and grass species
   - Solutions:
     - determine what “water quality” grass can handle, eg, salt tolerant species can take higher salinity levels
     - “shandie” water applications, ie, alternate top quality and lesser quality water
     - regularly monitor water quality
     - strive to improve drainage

4. **Reclaiming surplus water**
   - Problems:
     - ability to store large volumes of water
     - consistent quality of reclaimed water
     - “safety factor” in installing dams
   - Solutions:
     - establish dams during reconstruction work
     - work with local government
     - fence off any dams installed
     - set up water monitoring program to ensure that quality is maintained
Drainage of Race Track Surfaces

by Keith McAuliffe, NZ Sports Turf Institute. Melbourne, 2000

What is meant by drainage?

Drainage by definition refers to the removal of water from a system, in this case a race track. Rapid water removal will, in turn, aid soil aeration (for healthy turf) and improve soil stability and firmness for better going under-foot.

Drainage encompasses removal of water by both surface and sub-surface means.

Importance of Drainage to Horse Racing

From the racing industry's point of view, a poorly-drained track will mean higher incidence of track closure, lost meetings, slower track times and greater risk of injury (to both horse and rider). Poorly-drained track conditions would be the major cause of meeting cancellation and substandard track performance (at least throughout New Zealand).

From the Track Managers's viewpoint, a poorly-drained track will mean:

- Reduced use of the surface
- Less flexibility with timing of operations
- More renovation time and cost
- Lower course standards, including an uneven surface and higher weed content.

General points regarding Race track Drainage

Of all the uses to which sports turf is put, horse racing would debatably be the most damaging to the playing surface and the most difficult to control.

Every site (track) is different and there is no such thing as a standard recipe.

Drainage design is a specialist business and there are many pitfalls for the inexperienced. It pays to get the help of a specialist during the planning and design phases in order to ensure the most cost-effective system is used.

Drainage improvements need not always be costly. In some cases it may not even be necessary to install pipe drains, with the use of appropriate physical treatment doing the job.

Any drainage work must ensure that "soft spots" are avoided. For example, it will be essential to ensure there is no future sinkage or soft spots arising as a result of any trenching. Further, it will be important to avoid large cracks that may develop with mole ploughing or similar, and which could lead to instability or uneven firmness.

The risk of over-draining (over-drying) a track surface must be considered in some cases.

A racing club faced with a poorly-drained track surface can either do nothing about it and take a risk that meetings do not coincide with heavy rainfall, or they can look to rectify the drainage by reconstruction or other means.
Case Study: An example of how to identity the drainage needs of a race track surface

Observations and inventory

A track has a reputation for being waterlogged for several weeks, sometimes up to six weeks, per year. The track is located in a relatively heavy rainfall area and several major meetings have been cancelled in recent years. Race times over winter are slow and the track has the reputation as being on the heavy side.

The soil profile examination shows that there is approx. 20cm of heavy silt loam top soil overlying approx 20cm of a compacted silty clay loam sub-soil, overlying relatively better-structured silty clay from 50cm on. Rooting depth is confined to the surface 20cm and there are reddish stains at the 30 to 50cm depth.

The track has a camber from outside to inner rail of approx. 1%, with a 2% gradient down the front and back straights. There is a major storm water drain system serving the area, which could be used as an outlet for any pipe drain system.

Interpretation and recommendations

The on-going waterlogging problem with the track obviously suggests some form of drainage improvement is required. The soil wetness problem is further illustrated by the red stains (iron mottles) that are in the soil profile.

Soil profile findings indicate that the drainage problem stems from a heavy, impermeable sub-soil, which is acting as a pan and holding up the downward flow of excess soil water.

There are several treatment options that could be looked at in this instance, with the selection depending on issues such as available funds.

A system that is likely to be cost effective for many tracks is a close-spaced, narrow trench width pipe drain or sand slit system, used in conjunction with appropriate physical treatment. The good fall both along and across the track would allow for a constant trenching depth to be used. In most cases the pipes or slits would be laid across the track, connecting into an inner ring main drain.

Specific pipe drainage design criteria

1. **Design parameters for effective surface drainage** - Although most drainage should take place through the soil profile, provision should be made for surface runoff during storm events. A surface water guttering or collector drain system should be incorporated into the overall design.

2. **Determining the limiting factor(s) for water removal via a drainage system** - Bearing in mind that each track will be different, it is important to identify the reason for any drainage impedance. A thorough analysis of the soil profile will be needed to assess the depth to and thickness of any barrier layer(s).

3. **Pipe materials and sizes** - Again, sound advice and planning will ensure that the suitable pipe materials and sizes are used. As a matter of note, with turf drainage the limiting factor is generally getting the water to the pipe (i.e. drain spacing), and not the carrying capacity of the pipe itself. The main line is an exception to this.

4. **Pipe direction** - In most cases lateral drains are usually laid across the track. However, there are many different options available.
5. **Pipe depth** - As a general rule, aim to place pipe drains below the depth of any proposed physical treatment; for example, if deep verti-draining is a possibility, keep the minimum pipe depth (to the top of the pipe) at 400mm. In some cases (e.g. with a rising water table) it is more effective to place pipe drains deeper. However, in most cases the role of the pipe drain is to provide an outlet for excess surface water, and there is little benefit in placing pipes below any sub-surface pan.

6. **Pipe spacing** - Generally speaking the closer together the better. It is a matter of balancing the soil drainage characteristics and system design with available finances.

7. **Pipe grade** - There are recommended minimum grades for different types and sizes of pipe drain materials.

8. **Drainage backfill** - Selection of backfill (both type of material and depth over the pipe drain) is an important component of the drainage system. The backfill serves a number of uses, including acting as a link between the pipe drain and any free-draining surface layers (or the surface itself).

9. **Secondary treatments** - For most soils, just having pipe drains installed is not enough. It will be necessary to use appropriate physical treatment to improve soil water movement and to get the water through the soil to the pipe drain.

**Summary**

Racing is big business in Australasia (particularly Australia) and a club can have millions of dollars tied up in stands, parking and other facilities. Yet the entire success or otherwise of a race meeting depends on how the track surface performs.

Many of our race track surfaces have inadequate drainage. Managing a poorly-drained track is little more than a lottery. On the basis that total reconstruction of a race track surface is not affordable for the majority of our clubs, the next best alternative is to look to improve the drainage of the track and surrounds. For optimal results the drainage work will need to be carefully planned so that the unique features of the site are accounted for. *There is no such thing as a standard recipe when it comes to drainage design.*
Best methods for drainage:

1. **Pros and cons of different options**

   Group considered that course proper drainage was the basis for discussion.

   Two types were considered:
   - parallel drains running longitudinally around track with outlets at 50 metre intervals
   - lateral drains at 5 metre centres laid on an angle discharging to perimeter drain

   Preferred option was a subsoil lateral system discharging to a perimeter collector drain inside the running rail.

   Factors to consider include:
   - depth of drain to be clear of track maintenance works, rail post spikes, irrigation mains and sub-mains and other services
   - size of trench and pipe
   - backfill material suitably graded to provide best drainage medium and compliment the track soil profile

2. **Installation problems and solutions**

   Obviously best if installed as basis of a new track construction
   - Specialised work best undertaken by contractor with modern trenching and backfilling equipment
   - Close supervision needed to ensure quality

3. **Maintenance procedures – type and frequency**

   Verti-drain process to assist movement of water through profile to drains
   - NZ “mole” drain procedure to alleviate compaction and open up sub-soil drainage paths (60 mm drain lines)
   - Sand slitting
   - Periodic program of these procedures required as well as more frequent pressure flushing of drainage lines

4. **Renovation techniques**

   Sub-soil drains have a limited life due to eventual siltation
   - Maintenance procedures important
   - Open inside collector drain best option as this is readily accessible for maintenance cleaning
Summary

Of all the sports turf situations, racetracks provide the greatest challenge to irrigation designers and operators in achieving effective and efficient irrigation. The width and geometry of racetracks makes it difficult to achieve a high degree of water application uniformity using fixed sprinklers. Sprinklers are often operating at their maximum distance of throw, making them more susceptible to wind effects and the turns on racetracks make it difficult to achieve a consistent sprinkler pattern and distance between sprinklers.

Irrigation scheduling is a significant challenge for most racetrack managers, particularly when preparing a track for a race meeting. The racing industry would appear to benefit from the increased use of irrigation management tools, such as weather stations and moisture sensors.

The availability of a regular, good quality water supply is becoming increasingly important for many racetracks in Australia. Many water supplies are high in soluble salts, sodium and chloride and this requires a more intensive level of maintenance so that these contaminants have a minimal effect on the soils and turfgrasses. It is very important that all non-potable water supplies are regularly tested so that preventative actions can be taken before a problem occurs.

Drainage by definition is a simple concept i.e. the removal of excess water. However, there are many interrelated factors that must be considered when a drainage system is designed and installed. Important issues that must be evaluated include; the soil profile, existing contours and falls, the degree of drainage required, where the discharge points will be located and ongoing drain maintenance and soil conditioning.

Factors to consider for efficient water use are:

- Water availability
- Water quality
- Measuring water need
- Measuring water used
- Efficient (accurate) application
- Rapid application
- Frequency of application
- Surface drainage
- Sub-surface drainage
- Water storage
- Water recycling
4. Turf Management

Introduction

Turf – the playing surface for the “Sport of Kings”. It is little wonder that turf management is the most important (and worrying) aspect of the racetrack manager’s job. Reputations rise and fall on the quality of the turf on racedays, which is not necessarily the fault of the manager.

Turf health and condition on a racetrack is a reflection of the soil physical and chemical characteristics. Where the track profile has: good drainage; is well aerated; and adequate nutrient levels; a strong, healthy and resilient turf can be maintained. If the soil is compacted and drainage is poor, plant growth will also be poor, even in the presence of adequate nutrition. Wet tracks and turf that is in poor health, is more easily damaged, which is then reflected in a down-grading of the racing surface.

Turf systems are complex (but not necessarily complicated) in that they involve several key components that interact with each other to affect the management of the surface, often in a changing climate. These include:

- Soil type and condition
- Soil fertility
- Water management
- Aeration
- Grass type
- Insect pests
- Weeds and Diseases

Imposed on this is a high level of usage and it is easy to see the importance of having a good knowledge of these components and how to manage them effectively.

The papers in this major section of the manual address these important issues to provide expert guidance for a vital part of the racetrack manager’s task.
Turfgrass Selection for Sustainable Racecourse Management

by David Aldous, Institute of Land and Food Resources, University of Melbourne-Bunley

Introduction

Within Australia's broader geographical landscape, there are chief discernible differences between the wet and dry seasons (Langer, 1972) as well as the location and use of cool, transitional, and warm-season grasses (Beard, 1973).

Cool-season turfgrasses are widely distributed throughout the cool humid, cool subhumid, and the cool semiarid climatic regions of Australia, that include Tasmania, except in the extreme north east corner, regions on or near the Great Dividing Range in Victoria and New South Wales, small areas in Western Australia and the southern-most extension of the Stirling Ranges. The northernmost cool-season region includes the high altitude areas of the New England ranges.

Transitional growing grasses are confined to a narrow coastal strip in Victoria and southern NSW, as well as on the northern and western sides of the cool season zone. The Atherton Tablelands, in Queensland, is considered transitional, as is a patch of the Gregory Ranges. Most of the southwest corner of Western Australia is marked as transition, as is a strip just inland from the Great Australian Bight.

Australia's warm-season grasses extend from these transitional zones to include the warm humid, warm subhumid and warm semiarid climes, which basically include the remainder of Australia, much of north Queensland, Western Australia and the Northern Territory.

The capital cities of Darwin, Brisbane and Perth are classified as warm-season, Sydney, Adelaide and Canberra as transitional, Melbourne on the cusp of the cool and transition zones, and Hobart as cool season.

Turfgrass Growing Conditions and Life Cycle

Optimum air temperatures for the shoot growth of many cool season grasses, such as Kentucky bluegrass (Poa pratensis), range from 17 to 24C, with optimum soil temperatures for root growth from 10 to 18C. Shoot growth ceases when maximum daily air temperatures are above 32C, whereas root growth ceases when soil temperatures are greater than 25C (Beard, 1973). These temperatures are often exceeded on cool-season grassed areas in Australia over summer. Warm-season turfgrasses, such as couch or bermudagrass (Cynodon dactylon), have optimum temperatures ranging from 25-35C (McMilliam, 1978) but cease their growth when the daily minimum temperatures are in the region of 12-13C (Wilson et al, 1986). Winter dormancy restricts the use of warm-season grasses in southern Australia (Beehag, 1997).

Cool-season turfgrass species are adapted to rapid periods of growth during the cool, moist periods of the year, and usually exhibit dormancy, during the short warm to hot summers. They commence growth in autumn, grow strongly over winter, flower, and set seed in spring (Aldous & Neylan, 1997). Warm-season perennial grasses are always summer-autumn growing, often sensitive to frost, with many species flowering throughout the summer and autumn. Generally warm-season growing grasses provide for good turf over summer but are inadequate in winter, whereas cool season growing grasses provide a good surface over autumn and winter but are not ideal in summer.

The permanent turf grasses are predominantly perennial, warm-season types, with cool season annuals or perennials, often behaving as annuals, when used in combination with the warm-season perennials. The upper one third of Victoria has a longer winter and a shorter warm growing season. As a result both warm and cool season perennial grasses can be used. These areas present problems with cool season grasses because of the relatively high summer temperatures, high humidity and drought conditions. On the other hand, warm-season grasses can exhibit a dormant season of up to six months in these areas and may be subject to winterkill.
Turfgrass Selection and Surface Quality Characteristics for Racecourse Management

Turfgrasses for racecourses should have sufficient root strength to hinge turf divots to the soil, be hard wearing, recover quickly from damage, and demonstrate good winter growth. Chivers (1999) suggests that, in addition, the ideal turfgrass racing surface should remain green and vigorous throughout the racing season, produce a medium density coverage of leaves at a 75-100 mm mowing height, as well as a sward capable of strong rhizome production to rapidly fill into the divots and hold together the sandy soil profile. Neylan & Mullaney (1996) suggest that kikuyugrass should also display a strong, deep rooting system, rapid spring and summer growth and a strong capacity to spread, to lessen the damage created by horse traction.

Racing surface quality is a function of the physical properties of the immediate surface layer, such as the sward and the soil conditions on the track, and can be influenced by factors such as traction, hardness and response (Canaway, 1980, 1985, Waddington, 1993; Neylan et al., 1999). To achieve this, the turfgrass plant should also display the characteristics of wear tolerance, persistence, and recoverability. In addition, the racetrack soil properties, such as drainage, moisture content and binding strength, are also known to influence surface traction. Soil fauna and microflora, are other important components that may influence racing quality.

In a recent survey, which represented 100% of all metropolitan clubs and about 18% of all other race courses in Victoria, kikuyugrass (Pennisetum clandestinum) was the dominant warm-season grass species, with only one metropolitan racetrack, other than in Victoria, having a predominantly perennial ryegrass (Lolium perenne) grass sward (Neylan & Mullaney, 1996). Country tracks were mainly kikuyugrass (57%), with other tracks, mainly in Victoria and Tasmania, consisting of rye grass swards (over 33% of country tracks). Similarly for metropolitan tracks, kikuyugrass still continued to be the dominant grass sward, either as a monoculture of kikuyugrass, or in combination with ryegrass, the latter oversown to fill in bare patches and provide winter growth.

In these mild climates, pure kikuyugrass has been found to require less water to maintain itself, and the perennial ryegrass blend providing greater strength in the turf because of its deeper and more vigorous root system. Although there was also a preference for kikuyugrass and kikuyugrass-ryegrass swards for country tracks, other cool-season turfgrasses species such as Kentucky bluegrass (Poa pratensis), and the dwarf tall fescues (Festuca arundinaceae) as well as the warm-season couch or bermudagrass (Cynodon dactylon) have been used in combination with kikuyugrass in this state (Neylan & Mullaney, 1996; Neylan & Stubbs, 1998). Chivers (1999) concludes that combinations of rye and bluegrass are better suited to the cooler environments, with kikuyugrass, oversown with ryegrass, more useful in the warmer transition zones of the state.

Turfgrass Descriptions

The major warm and cool-season turfgrasses, used in the racecourse industry, are described as follows:

Warm-season Turfgrasses

Kikuyugrass (Pennisetum clandestinum)
This warm-season turfgrass was first reported by the Union of South Africa's Department of Agriculture in 1910-11. However, it was not until 1919 that seed from the Belgian Congo was introduced into the Botanic Gardens in Sydney, New South Wales (Whittet, 1960). Described as a low growing, coarse-textured, summer growing dioecious perennial that spreads by seed, rhizomes & stolons, kikuyugrass prefers the temperate/sub-tropical climates of the world, where temperatures do not fall below 8-10C for significant periods of the year (Aldous, 1998). The grass has also adapted to the higher elevations of 2-3,500m.
Kikuyugrass does not stand severe frosts, but demonstrates good drought & wear tolerance as well as medium salt & shade tolerance. Kikuyugrass can tolerate strongly acidic and saline soil conditions, heavy rainfall and water inundation, heat and cold stress, and can establish in heavily compacted soils. It recovers rapidly from wear, requires little in the use of pesticides for maintenance and can tolerate recycled/grey water, including waters that contain heavy metals. The grass’s reduced requirement for pesticides, water, and fertilizer (40% less than the annual fertilizer currently applied to hybrid couch or bermudagrass (*Cynodon dactylon*) areas), continues to make kikuyugrass an ideal grass for racecourses.

**Couch grass** (Australia & Africa), **Bermudagrass** (USA & West Indies) (*Cynodon dactylon*)
Described as a warm-season, prostrate, sward-forming summer growing perennial grass, Bermudagrass, is found continuously across all land masses between latitudes 45N and 45S. Coldhardy forms can be found in Europe and Asia near latitude 53N, and grow at elevations of 4000m in the Himalayas (Taliaferro, 2000). In Australia, active Bermudagrass growth is confined to most of the warmseason growing states of Queensland, NSW, and Western Australia, although the grass can also maintain itself in Victoria, South Australia, and the Northern and Australian Capital Territories. Bermudagrass prefers dry to very dry, sandy to slightly loamy, sometimes salty, soils and can tolerate both acidic & alkaline soil conditions & flooding, but will not thrive on water logged or submerged soils.

In Australia there are approximately twenty *Cynodon* selections cultivated as sportsturf. Intraspecific Bermudagrass hybrids, such as Tifdwarf, Tifgreen, and Santa Ana, exist and are used in special purpose turf as would be found on golf and bowling greens, cricket wickets, sports fields and lawn tennis courts (Siviour, 1987; Robinson and Neylan, 1993; Beehag, 1997). Such interspecific hybridisation has involved *C. dactylon* (common couch) and *C. transvaalensis* (South African couch). South African couch, or Germiston grass, was introduced into Australia from South Africa in 1930 (Whittet, 1960), where other selections such as *C. plectostachyus* (African stargrass) was in 1920 and Cape Royal Couch, an improved strain of common couch, originally from the Frankenwald Experiment Station, Johannesburg, Union of South Africa, in 1955 and released in Australia in 1960.

**Cool-season Turfgrasses**

**Tall fescue** (*Festuca arundinacea*)
Described as a coarse-textured, coolseason, erect, bunch perennial grass, that occasionally develops short, thick rhizomes, tall fescue is best adapted to the cool temperate regions of Australia & New Zealand where it makes its best growth on wet, fertile soils, but will also tolerate heavy soils. Tall fescue tolerates drought more than most other sod forming cool-season grasses and works well in erosion control grass mixtures. Turf type tall rescues are now available in dwarf types, which can be maintained at a shorter mowing height.

**Perennial ryegrass** (*Lolium perenne*)
Described as a cool-season, frost resistant bunchgrass, perennial ryegrass can behave as an annual, short-lived perennial or erect, decumbent perennial, depending on environmental conditions. Perennial ryegrass has adapted to moderately moist and high fertility soils, of pH's 5.5-7.0, and where the rainfall is evenly distributed over the year. Perennial ryegrass exhibits medium to good wear tolerance, medium to poor drought tolerance, and medium shade and salt tolerance. Categories of perennial ryegrass now available in Australia include the high quality fine leaf "turf-type" varieties, the "sports turf type" varieties, the pasture type varieties, and the annual and tetra-ploid varieties of ryegrass (Coles, 1996). Identification can prove difficult when *L. perenne* spps. hybridizes with other *Loliums* such as *L. rigidum* & *L. multiflorum*.

**Kentucky bluegrass, English meadow grass** (*Poa pratensis*)
Described as a cool-season, fine textured, dark green to bluish green leaf, loosely turfed rhizomatous frost resistant perennial grass, Kentucky bluegrass is native to the Old World where it occurs naturally throughout the temperate and sub-Artic regions of Europe and Asia (Reed Funk, 2000). Principally
spread by seed, rhizomes & sod, Kentucky bluegrass prefers open sunlight & regions of higher rainfall, cool temperatures & mild summers, where the soils are neutral to slightly acidic and moderately fertile. Kentucky bluegrass exhibits a medium to good wear tolerance, but has poor salt and shade tolerance. Johnston and Johnson (2000) classify Kentucky bluegrass cultivars into older cultivars and improved types. Common types are characterised by an upright growth habit, susceptibility to fungal leaf spot, early spring green-up, good seed yield, and good tolerance to environmental stresses. Improved types have a more prostrate growth habit, a slower growth rate, higher shoot density, darker green colour, and improved resistance to a range of turfgrass diseases. In Australia, other closely allied species include Poa bulbosa L., (bulbous poa) & Poa nemoralis L., (wood meadow grass), both of which have turfgrass potential.

References


Heritage Seeds - The Company

Heritage Seeds was formed in October 1990, specialising in the development and marketing of high performance proprietary turf seed, forage seed and cereal varieties for the Australian and export markets. Heritage Seeds has a product range as broad as the Australian landscape and stands alone combining national distribution with export to over 50 countries.

Heritage Seeds has the largest private seed and plant research facility in Australia with Research and Development programs that extend around the globe.

New varietal discovery and quality seed production, together with excellence in customer and supplier relationships, combines with the 'can do' ethics of our people to give Heritage Seeds the leading edge in seed technology.

Our focus for the new millennium is on emerging seed technologies and Research and Development, which will combine to yield plant cultivars that demonstrate seed solutions for the turf manager. Whether it is for the racetrack itself or the lawn amenity areas of the course, Heritage Seeds has the expertise to develop the solution that most benefits you.

Through strategic marketing and supply alliances throughout Australia and internationally, Heritage Seeds is well entrenched in the Australian turf seed industry.
The company distributes and markets the leading turf varieties and represents the global turf Seed Company - Barenbrug.

As the industry leader take advantage of our technology, experience and expertise.
The Key to Healthy Turf

by Keith McAuliffe and David Howard, NZ Sports Turf Institute. Melbourne, 2000

What is Meant by “Healthy” Turf?

Healthy turf conjures up an image of a surface that offers “soundness”, “vitality”, “robustness” and “easy management”.

It implies the sward is:
- resistant to stresses (e.g. diseases; insect attack; climatic extremes)
- resilient to wear and/or recovers rapidly after wear
- easy to maintain

The above definition does not include a reference to quality. The goal of producing a healthy turf is invariably in conflict with the objective of producing a playing surface. For example, achieving fast tracks could be counter to turf health; aiming for year-round greenness could be in conflict with achieving good soil conditioning and root zone aeration.

Benefits of Healthy Turf

Benefits include:
- easier maintenance (not living on a knife edge)
- lower cost of maintenance (less fungicides, less water)
- environmentally friendly
- better year-round, long term performance, especially recovery from use

What Determines Turf Health?

In our modern society we are constantly being reminded about how our health is affected by our environment and what we eat (e.g. “we are what we eat”). Drawing comparisons, the turf plant is not too dissimilar. The environment in which the turf grows, and the nutrients it is provided with, will determine it’s health.

It is a mistake to consider the turf system purely in terms of what is seen above ground. What happens below ground has an important and often over-riding effect on above ground performance.

1. The Turf Root Zone

The root zone provides the environment and foundation for root development and in turn overall turf health.

Common problems with turf root zones include:
- lack of aeration and insufficient air-filled pore space, resulting in rapid onset of anaerobic conditions and root death
- excessive hardness/compaction - imposing physical restrictions on root (and water movement)
- poor drainage with the resulting excess water and limited aeration causing waterlogging layering, restricting vertical root and water movement
- excessive thatch which can limit root zone aeration by acting as a sponge and inhibiting gaseous flow, and/or by create problems such as water repellency
- insufficient and/or uneven depths of root zone material.
2. The Depth and Extensiveness of the Root System

Turf root systems are, in comparison with other crop systems, alarmingly shallow. We need to acknowledge this as a major constraint. It should also be recognised that the common turf grass species turn over (replace) the bulk of their root system annually.

Shallow rooting has consequences, including:
- greater watering frequency
- reduced stress tolerance
- providing a competitive advantage to shallow-rooted species
- diminished soil structure development at depth, which in turn impacts on drainage and aeration.

A shallow rooting system will put the turf plant in a vulnerable position, as and when any other stresses eventuate.

How can rooting depth be improved?

Management practices that can help improve rooting depth include:
- adopting an appropriate physical treatment programme
- regulating the irrigation programme
- modifying the make-up of the root zone

3. Surface (leaf) Management

What is done with/to the surface has a major impact on turf health. The above ground parts of the plant (leaf/shoots) is where the solar energy is transferred into plant tissue and plant energy. Any changes in leaf/shoot density can affect the ability of the plant to photosynthesise and in turn affect turf health.

It should also be remembered that there is a strong correlation between the leaf and the root system. The leaves provide the roots with carbohydrate, while the roots supply the water and nutrient.

Management factors that will influence turf health include:
- height of cut/frequency of cut.
- timing and amount of traffic - especially in relation to growth rate and recovery from stresses (e.g. heat stress) on the turf.
- watering system management
- maintenance programme e.g. frequency of aeration
- fertiliser programme

4. General

The Turf Manager is often faced with balancing the needs of the club against turf health. Inevitably not all decisions can aim to optimise turf health. For example:
- close mowing will place the turf under added stresses
- cutting back on fertiliser will be at the expense of turf vigour and recovery
- frequent application of fungicides to control disease-causing organisms will also inhibit activity of beneficial organisms.
Thatch & Organic Matter

by Prof. P.M. Martin, University of Sydney. Rosehill, 1996

Positive aspects of Thatch:-

- cushioning effect (horse)
- protective effect (turf)
- structural effect (turf)

Negative aspects of Thatch (mostly when too much has accumulated):-

- moisture retention, sponginess
- disease promotion
- interferes with pesticide penetration
- unlevel surface, puffiness, scalping
- slow surface
- reduced impact resistance

Positive aspects of Organic Matter:-

- increased biological activity
- improved nutrient retention
- improved water holding power
- better grass growth.

Negative aspects of Organic Matter (when too much has accumulated):-

- increased tendency to develop dry patch disorder
- excessive moisture retention
- impedes downward drainage
- boggy patches develop
- reduced rate of nutrient release
- reduced grass growth (especially roots)
- slippery, slimy surface if exposed when wet.

Thatch and Organic Matter have major effects on track performance and track drainage. A reasonable amount of both are needed for normal turf development and to derive the positive benefits to turf, horse and environment mentioned above. Excessive amounts of either or both lead to poor turf quality and slow and dangerous tracks.

Thatch and Organic Matter must be carefully managed to achieve optimum results:-

- cultural practices
- fertilizer programme adjustments
- make more use of lime
- observation and testing.
Soil Analysis for Racetracks

by John Neylan, AGCSATech

Soil testing, both physical and chemical, provides the Racetrack Manager with an excellent diagnostic and monitoring tool. Soil testing provides; a means of identifying and assessing the constraints to soil use, soil chemical constraints for turf growth, a way of deciding on fertiliser and soil amendment requirements, and nutrient balance. Soil physical tests for construction purposes provide information on drainage, moisture retention, aeration porosity and compaction.

Regular soil testing can also be used as a monitoring tool for;

- Monitoring of changes over time
- Assessing the responses to fertilisers and amendments
- Determining the accumulation of undesirable elements (e.g. salts, sodium)
- Monitoring the effects of low quality water or reclaimed wastewater
- Environmental monitoring (EMP's)

Chemical Testing

Chemical testing is a widely used tool in turfgrass management and its interpretation evolved from the need to assess;

- Quality of soils to support plant growth
- Nutritional problems
- Fertiliser needs

A typical analysis includes;

- pH (water), pH (calcium chloride) on a 1:5 extract
- Electrical Conductivity (salinity) on a 1:5 extract
- Phosphorus (Olsen)
- Extractable Cations (calcium, magnesium, sodium and potassium)
- Available Potassium

There are many laboratories that undertake soil analyses for agriculture and horticulture, however, it is very important that an experienced turf agronomist interprets the results.

Soil Physical Testing

Soil physical testing is an essential tool when selecting soils for construction and topdressing. Undertaking the appropriate soil tests ensures that the preferred soils can be specified, that their characteristics are understood, and a quality control procedure can be implemented.

Even on established racetracks, a soil physical analysis will tell you about the physical and performance characteristics of that soil, which then allows for the appropriate management techniques to be implemented that optimizes the performance of the track.

A typical analysis includes;

- Particle size distribution
- Compaction and Hydraulic Conductivity
- Volumetric water
- Aeration Porosity
- Dry Bulk Density
How to take a representative soil sample

The results of soil analysis are only as good as the sample sent to the laboratory. Soils can vary considerably over relatively small areas, even on what appears to be a uniform turf surface. When soil sampling, the aim is to even out this natural variation so that the sample is representative of any given area.

A representative soil sample consists of soil cores taken from within a uniform area of a particular soil and turf type. For each sample, at least 25 individual cores must be taken and combined. On fine turf areas such as golf greens and bowling greens, the sampling depth must be at least 0-7.5cm. For golf fairways, sportsfields and racetracks, the sampling depth is at least 0-10cm.

When sampling any turf area it is important to avoid including cores from any areas that are obviously different, e.g., due to soil type, grass type, turf condition and topography. If in any given turf area there is an obvious difference, e.g., area of thin or bare turf, sample this area separately. On large turf areas, where there are changes in topography, this often relates to differences in soil type and drainage conditions and should be sampled separately.

When taking the samples, move randomly across the area in a zig-zag pattern.

When taking a soil sample it is important to not only take a representative sample but also to make sure that;

- Clean sampling equipment is used.
- Any contamination with other soils, fertilizers and chemicals is avoided.
- Sample at least 3 - 4 weeks after the last fertilizing or as close to the end of the fertilizer cycle as possible.
- Sample 3 months after liming.
- Provide sufficient volume of soil (> 25 cores or about 250 - 500 grams).
- The sample submission sheet is filled out correctly.
Plant Tissue Analysis as a Management Tool

by Dr. Robert N. Carrow, University of Georgia, Griffin

The nutritional status of turfgrass sites can be evaluated by soil testing, plant systems, and tissue testing (plant analysis) (1). Plant analysis can be used as a diagnostic tool or for nutrient monitoring (5). In either case, objectives are to determine potential nutrient deficiencies/excessive levels and to guide fertilisation needs. Essential components of a good tissue testing program are:

- Obtaining a representative sample
- Preparing the sample for analysis
- Accurate analysis of the sample for the target nutrient or nutrients
- Correct interpretation of the results
- Proper recommendations from the data

Diagnostic Sampling

The diagnostic role has been the traditional use of tissue testing for turfgrass situations. It is to confirm a suspected nutrient deficiency or nutrient/element toxicity prior to applying corrective measures. Samples are obtained from (a) an area exhibiting the stress symptoms. Samples from turf where the symptoms are just appearing are much better than from areas with severe symptoms or dead turf and (b) from an adjacent area that does not show any symptoms.

Mowing clippings are used for turfgrass tissue analysis with mowing at the normal height used on the site. Clean mower baskets are acceptable with care to wash off any soil that may contaminate the clippings. If clippings are transferred to a bucket, use of a plastic container is preferred.

Monitoring Sampling

Use of tissue analysis to monitor plant nutrient status over a growing season has been a common practice for orchard and greenhouse crops. However, interest has increased over the past ten years for monitoring of turfgrass sites. For monitoring, tissue samples are collected as described previously but from the same location on a periodic basis. Sampling should be at the same location on a specific site – such as always at the front of the representative green. Frequency of sampling normally varies from monthly to weekly.

Sample Preparation

Turfgrass clippings often contain sufficient dust or soil on the leaves to influence micronutrient values. A subsample (about 1 cup, 350ml) of the clippings can be obtained from the mower basket after mixing; followed by washing in a plastic strainer with a weak soap solution; and rinsed with running water. Washing and rinsing should be done rapidly and leaves should not be left to “soak”. If samples are to be mailed to a laboratory for analysis, they should be air dried or dried in a microwave oven to approximately air dried conditions. Paper bags are preferred for shipping rather than polyethylene which can speed decomposition. If analysis equipment is available on the site, drying will be according to the laboratory procedure used.

Analysis

Traditional laboratory procedures (“wet lab” procedures) for analysing total nutrient content of turfgrass samples are based on digesting the tissue into strong acids followed by analysis, usually by atomic emission spectroscopy or automatic nitrogen analysis. These are very accurate since they measure the total quantity of each element in the sample. Disadvantages of wet lab procedures include cost of
equipment and expertise required to operate the equipment. Thus, wet lab analyses require samples to be sent to a lab, digested, and then analysed. The time and cost to obtain tissue analysis data has precluded use of wet lab analysis of tissue testing for routine nutrient monitoring.

The Near Infared Reflectance Spectroscopy (NIRS) procedure has been promoted by Karsten Turf and the Toro Company as a means to obtain rapid tissue analysis information for diagnostic or monitoring purposes either by a on-site NIRS unit or by overnight shipping to a lab with results obtained in 1 to 3 days. Nutrients or elements analysed include: N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B, Na. NIRS has been used for several decades for determining N, total protein, carbohydrates, lipids, other organic chemicals, and moisture content in forages, grains, and oil crops (2, 3, 4, 6, 9).

The basis of NIRS is to determine reflectance of specific wavelengths over the infrared range (750 to 2500 nm) and relate the degree of reflectance to a specific compound or element. Infrared wavelengths are absorbed mainly by:

- C-H bonds; common in carbohydrates
- N-H bonds; common in proteins, amides, and amino acids
- O-H bonds; common in water

Two other types of tissue nutrient analyses are sap nutrient content and remote sensing instruments using visible (400 to 750 nm) and/or infrared (750 – 2500 nm) wavelengths. Sap nutrient content is based on measuring the nutrient level in sap expressed from leaves or a grass stem. This measurement indicates nutrient levels in the xylem and phloem which is not necessarily related to total tissue content. Interpretation of the data as to what the values mean have not been defined for turfgrasses, also, expressing sap from turfgrass tissues usually results in considerable tissue injury and mixing of cell contents with xylem and phloem sap.

Remote sensing devices using certain wavelengths or combinations of wavelengths reflected off turfgrasses may be related to N content of leaves or other nutrients that may cause chlorophyll loss when deficient (Fe, S, Mg, Mn) (3, 4, 7). Generally these devices are measuring reflectance of wavelengths related to chlorophyll activity but do not distinguish whether loss of chlorophyll is due to N, Fe, S, Mg, or Mn deficiencies or some other reasons (high temperature, salinity, etc). Also, visual observation of the turfgrass often reveals chlorosis as quickly as remote sensing.

Interpretation

NIRS. Since the NIRS procedure introduces the potential for error in estimating actual tissue nutrient content due to lower correlation with actual nutrient values (as determined by wet lab) than would be ideal, care must be taken in assessing the readings when using this for diagnostic or monitoring purposes. For monitoring use, some guidelines to aid in interpreting data are:

When monitoring, the turf manager normally has a past history from the site. If readings for a sample data appear to change dramatically, then obtaining a second sample may clarify the results.

A low correlation (r²) of NIRS estimates to wet lab values implies that a single NIRS reading could be in error from the actual value but several readings could be obtained from subsamples of a site. The “average” of these should be more accurate than a single value. This technique can also be used when making diagnostic readings for a problem area.

For monitoring, highly accurate values are not essential as long as true trends can be determined.
**NIRS or Wet Lab.** The basic approach for using tissue analysis data is to compare measured values to published “sufficiency ranges” for the grass. Nutrient levels below the sufficiency range implies a deficiency growth decreases rapidly as well as visual nutrient deficiency symptoms would be expected if the low end value for a sufficiency is accurate. Thus, a measurement below the sufficiency range (i.e. in the “the critical range”) implies an existing deficiency and immediate corrective action should be taken.

Unfortunately, sufficiency ranges vary with grass species and cultivar and limited data have been published a the species or cultivar level. Treholm et. at. (8), for example, reported that tissue K content of *Paspalum vaginatum* ecotypes ranged from 2.00% to 3.90% under medium soil K levels, which illustrates variance across ecotypes or cultivars of a single species. Published ranges are usually averages over cultivars within a species or combination of grasses (i.e., bentgrass and annual bluegrass). When monitoring tissue values on a specific site, the turf manager may be able to define a “sufficiency range” acceptable to their use by comparing nutrient level to plant appearance and growth. As a first approximation, common sufficiency ranges are (1):

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>% Weight</th>
<th>Nutrient</th>
<th>ppm</th>
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<tbody>
<tr>
<td>N</td>
<td>2.8 – 3.5</td>
<td>Fe</td>
<td>50 – 100</td>
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<tr>
<td>P</td>
<td>.20 - .55</td>
<td>Mn</td>
<td>20 – 100</td>
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<tr>
<td>K</td>
<td>1.5 –3.0</td>
<td>Zn</td>
<td>20 – 55</td>
</tr>
<tr>
<td>Ca</td>
<td>.50 – 1.25</td>
<td>Cu</td>
<td>5 – 20</td>
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<tr>
<td>Mg</td>
<td>.15 - .50</td>
<td>Mo</td>
<td>1 – 4</td>
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<tr>
<td>S</td>
<td>.20 - .50</td>
<td>B</td>
<td>5 – 60</td>
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</table>

Within the sufficiency range, as soil nutrient levels decrease, tissue nutrient levels generally do not decrease but remain at a reasonably level plateau. Obviously this makes monitoring of tissue nutrient content less effective for determining potential oncoming deficiencies. Factors that concentrate nutrients and cause tissue values to increase above the normal plateau include anything that reduces growth such as: low soil nutrient content of another nutrient; unusually low or high temperatures for the grass species; low rainfall or irrigation to create a moisture stress; PGR’s; traffic stress; pest stresses. Sometimes a nutrient content may be greater than the sufficiency range. This can occur after application of a water soluble fertiliser or foliar application. Because turf leaves are routinely mowed off, tissue levels usually are not above the sufficiency range for very long unless growth is very slow.

In contrast, factors that dilute tissue nutrient concentration and cause tissue levels to decrease (but still remain in the sufficiency range) are: favourable temperature and moisture for optimum growth; growth stimulation by N; lack of growth limiting stresses. If a nutrient is truly limiting, tissue levels will eventually reach the critical range, but the change from a fluctuating plateau in the sufficiency range to a decreasing critical value may often by rather sudden rather than a gradual event. For many nutrients, this change is also visible in the form of visual deficiency symptoms.

In climates with prolonged periods of rather consistent climate, less fluctuation in seasonal tissue nutrient levels will be evident. Also, soils with low nutrient retention and high rainfall, are sites where tissue nutrient content values can be more predictive of plant needs (and soil nutrient status) than a climate with rapid weather changes.

With the increasing use of effluent water on turfgrass sites, nutrient content in the water must be considered when interpreting tissue tests. Also, tissue tests are best interpreted when comparing to good soil test results where soil tests evaluate the plant – available nutrient status of the soil.
Recommendations

Recommendations from plant tissue analysis ultimately are used to make adjustments in the fertility program. Good recommendations depend on accurate and reliable information from quantitative sources (tissue tests, soil tests, irrigation water quality tests) and personal evaluation (plant visual symptoms). Integrating all these sources of information is always better than reliance on any one technique or source of information.

References

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Journal</th>
<th>Pages</th>
<th>Year</th>
</tr>
</thead>
</table>
Fertiliser Programs for Racetracks

by John Neylan and Phil George, AGCSA (formerly Turfgrass Technology Pty Ltd).

Doomben,1998

It is not that long ago that fertiliser programs for racetracks were based on superphosphate and chicken manure. However, it has been realised that race track turf requires the same balance and quantities of nutrients as any other well maintained sporting surface. With the high usage of racetracks, quick recovery is necessary and can only be achieved with a well balanced fertiliser program. There are also an increasing number of racetracks constructed from very sandy soils where nutrient leaching is a factor that affects the fertiliser strategy.

Factors to Consider when Designing a Fertiliser Program

The fertiliser program must:-
  - Suit the situation (and satisfy specific needs)
  - Be adaptable
  - Fit within budget restraints
  - Supply adequate amounts of essential nutrients at the time of application

Designing the Program to Suit your Situation

Each turf situation has specific requirements and the fertiliser program depends on:-

Grass Species involved
Different grasses have different needs eg. Turf Type Ryegrass and Kentucky Bluegrass have higher nutrient requirements than Couchgrass or Kikuyugrass.

Amount of Use
Heavily used areas require more nutrients to improve wearability and recovery than low use areas eg. Racetracks receive heavy and intensive wear all year round and therefore, need more fertiliser for repair of the track as well as high potassium levels to improve the wear of the grass.

Time of Year
Turf areas may have different nutrient requirements depending on the time of year eg. Kikuyu and Couchgrass require high N and Iron in the spring to break dormancy and high P and K to build up plant reserves as it goes into dormancy.

Maintenance Practices
  - More fertiliser is needed at renovation for better recovery of the areas.
  - At lower mowing heights often higher fertiliser levels are required to improve wear tolerance.
  - Extra fertiliser needs to be applied when clippings are removed to compensate for the loss of nutrients
  - Reduced fertiliser inputs are needed when recycled water is used. The use of recycled water may reduce fertiliser application by 50-100% in coarse turf (racetracks).

Soil Type
Sandy soils require more frequent and smaller applications of fertiliser compared to heavy soils. Where the soil has a high salt content, fertilisers with high salt levels should be avoided. e.g. avoid using Muriate of Potash or Ammonium Nitrate and instead use Sulphate of Potash or Ammonium Sulphate.
Adaptability of Program

It may be necessary to modify fertiliser programs to allow for variations in:-

Climatic conditions, eg. heavy rains may increase the rate of leaching, therefore fertiliser should be applied more often.
Soil types eg. Racecourses may have several tracks built on different soil types. Therefore, each soil type requires a different program. Generally heavier soils require less P and K due to less leaching.
Degree of wear. More fertiliser should be applied during periods of heavy wear to improve the recovery of the turf surface.
Cultural practices. Alteration in cultural practices may necessitate a change in the fertiliser program.

If the turf looks “hungry” then it should be fed.

Budget Restraints

The choice of a fertiliser program may be limited by finances eg. a country racetrack may only fertilise 3-4 times a year.

Supply of Adequate Amounts of Nutrients

Unnecessary and incorrect nutrient use is costly and can be harmful and it is therefore essential to determine the types and amounts of nutrients required.

The nutrient requirement of turf can be determined in several ways;

Soil Nutrient Analysis

With fertilisers, the knowledge we have concerning the importance of particular elements and their relationship to other elements is increasing and becoming more complex. To assist in making decisions regarding what fertilisers are used and in what quantities, soil analysis is an important tool. A soil test will tell the turf manager what elements are present and at what levels.

The growth of the grass and its colour gives a good indication of the nitrogen levels, but what about potassium, calcium, magnesium etc. Other than nitrogen, visual deficiency symptoms of these elements rarely occur.

In recent years there has been an increase in the number of amended sand racetracks. Sands have a low cation exchange capacity and combined with a high drainage rate, nutrients are readily leached through the profile. In new sand constructions that we have monitored, elements such as calcium, magnesium and potassium and even phosphorus are readily leached. Through the use of soil analysis, the nutrient status can be determined and the appropriate amendments applied. The soil test ensures you apply what is required so that money is not wasted on inappropriate fertilisers.

The standard soil analysis usually includes;

- pH (water and calcium chloride)
- Electrical conductivity/Total soluble salts
- Available phosphorus
- Extractable cations (calcium, magnesium sodium, potassium)
- Percent base saturation (calcium, magnesium, sodium, potassium)
- Calcium-magnesium ratio
**Leaf Tissue Analysis**

Plant tissue analysis is the most accurate way to determine the level of nutrients utilised by the turf and whether deficiency, toxicity problems or nutrient imbalances exist.

Plant tissue analysis is extremely useful where controlled release fertiliser programs are used as soil tests do not always reflect the nutritional status of the soil accurately in this situation. With controlled release fertilisers releasing nutrients at about the rate at which they are taken up by the plant, there is very little excess that is adsorbed onto the soil exchange sites. In this situation plant tissue analysis is the only means of determining whether or not the controlled release fertilisers are supplying adequate amounts of nutrients.

With the increase in sand profiles being constructed and in particularly USGA specification profiles have a very low cation exchange capacity (CEC), a low buffering capacity and are readily leached of nutrients. Consequently, sand profiles can quickly become deficient.

Plant tissue analysis when used in combination with soil nutrient analysis provides a beneficial guide in developing fertiliser programs for specific turf situations.

It is also the most accurate method of monitoring the level of trace elements such as manganese, zinc, copper and iron as well as available nitrogen. Soil analysis for such elements is very difficult to interpret accurately because the extraction techniques used, do not always reflect the availability of these elements and tend to overestimate the concentration available to the plant. However, with plant tissue analysis an accurate determination can be made as to the trace element status of the plant.

A standard plant tissue analysis package is available which includes both major and trace elements.

<table>
<thead>
<tr>
<th>Major Elements</th>
<th>Trace Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Copper</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Zinc</td>
</tr>
<tr>
<td>Potassium</td>
<td>Manganese</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Iron</td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td></td>
</tr>
</tbody>
</table>

**Fertiliser Response Trials**

Plant responses to specific fertiliser treatments can be determined with simple fertiliser response trials.

**Trial and Error**

**Deficiency and Toxicity Symptoms**

Plants exhibit specific symptoms that are associated with particular nutrient disorders. Plant growth may be seriously affected by the time that deficiency or toxicity symptoms appear.

**Factors to Consider when Choosing a Fertiliser**

**Uptake Rate of Nutrients**

The availability of soil applied fertilisers normally depends on microbial activity and soil temperature. The solubility of a fertiliser influences its speed of availability.
Table 1  Solubilities (g/L of cold water) of some Fertilisers

<table>
<thead>
<tr>
<th>Fertiliser</th>
<th>Solubility (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium Nitrate</td>
<td>1500</td>
</tr>
<tr>
<td>Sulphate of Ammonia</td>
<td>590</td>
</tr>
<tr>
<td>Urea</td>
<td>650</td>
</tr>
<tr>
<td>Urea Formaldehyde</td>
<td>480</td>
</tr>
<tr>
<td>Superphosphate</td>
<td>16</td>
</tr>
<tr>
<td>Muriate of Potash</td>
<td>290</td>
</tr>
<tr>
<td>Sulphate of Potash</td>
<td>10</td>
</tr>
</tbody>
</table>

Ammonium nitrate is taken up by the plant rapidly followed by urea. Superphosphate is taken up very slowly.

Normally artificial fertilisers provide nutrients in a more readily available form than organic sources and the response to application of artificial fertilisers is quite rapid.

Many fertilisers are manufactured as controlled release and slow release fertilisers. These fertilisers enable one to take advantage of nutrient availability over a long period of time.

Effect on Soil Salinity
Table 2 shows the salt index of some of the fertilisers. The higher the figure the more toxic is the salt level.

Table 2  Salt Index of some Fertilisers

<table>
<thead>
<tr>
<th>Fertiliser</th>
<th>Salt Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Nitrate</td>
<td>101</td>
</tr>
<tr>
<td>Ammonium Nitrate</td>
<td>105</td>
</tr>
<tr>
<td>Ammonium Sulphate</td>
<td>69</td>
</tr>
<tr>
<td>Calcium Nitrate</td>
<td>53</td>
</tr>
<tr>
<td>Urea</td>
<td>75</td>
</tr>
<tr>
<td>Diammonium Phosphate</td>
<td>34</td>
</tr>
<tr>
<td>Monoammonium Phosphate</td>
<td>30</td>
</tr>
<tr>
<td>Superphosphate</td>
<td>8</td>
</tr>
<tr>
<td>Triple Superphosphate</td>
<td>10</td>
</tr>
<tr>
<td>Muriate of Potash</td>
<td>116</td>
</tr>
<tr>
<td>Sulphate of Potash</td>
<td>46</td>
</tr>
<tr>
<td>Potassium Nitrate</td>
<td>74</td>
</tr>
<tr>
<td>Magnesium Sulphate</td>
<td>44</td>
</tr>
</tbody>
</table>

Nutrient Leaching

There is an increasing concern for the potential of fertilisers and pesticides applied to turf areas to leach and contaminate ground water and surface water. Losses of both nutrients and other pollutants through leaching or run-off are wasteful and benefit neither the turf or the environment. Management strategies are therefore needed to minimise or eliminate leaching and run-off.
Irrigation is one of the major cultural and management practices influencing both the run-off and leaching of chemical pollutants. Irrigation scheduling and in particular the frequency and amount of irrigation, have a large effect on the potential movement of pesticides and fertiliser from the soil, and that excessive irrigation must be avoided.

Sportsturf areas are readily identifiable users of fertilisers and pesticides and are often considered to be point sources of pollution. With the trend towards using high sand content soils of high permeability and low nutrient holding capacity, the opportunity for nutrients to be lost by leaching is increased. Many sandy soils have a low moisture holding capacity and are easily over-watered. The combination of rapid drainage, low nutrient retention and the volume of water passing through the rootzone, influences the rate of leaching of fertiliser ions such as nitrate (NO₃), phosphate (PO₄) and potassium (K).

In trials undertaken on racetracks we have found that on a medium - coarse sand similar to that used in USGA type profiles, there were lower concentrations of NO₃ and PO₄ in the soil water when slow release fertilisers were used (tables 1 and 2). On a fine sand the levels of total nitrogen and nitrate nitrate in the soil water were considerably lower for slow release fertilisers compared to soluble types (tables 3 and 4) however, there was very little difference in the PO₄ levels for either the slow release or soluble fertilisers indicating a greater ability for the finer sands to retain phosphorus.

Table 3 Medium - Coarse Sand Soil Type

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Sampling Depth</th>
<th>24/6</th>
<th>25/6</th>
<th>26/6</th>
<th>27/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble</td>
<td>Upper Rootzone(150mm)</td>
<td>1.1</td>
<td>1.6</td>
<td>1.5</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(300mm)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>2.2</td>
</tr>
<tr>
<td>Slow release</td>
<td>Upper Rootzone(150mm)</td>
<td>0.90</td>
<td>0.60</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(300mm)</td>
<td>*</td>
<td>*</td>
<td>1.2</td>
<td>0.56</td>
</tr>
</tbody>
</table>

* No sample was collected.

Table 4 Medium - Coarse Sand Soil Type

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Sampling Depth</th>
<th>24/6</th>
<th>25/6</th>
<th>26/6</th>
<th>27/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble</td>
<td>Upper Rootzone(150mm)</td>
<td>9.1</td>
<td>13.0</td>
<td>23.0</td>
<td>31.0</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(300mm)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>3.3</td>
</tr>
<tr>
<td>Slow release</td>
<td>Upper Rootzone(150mm)</td>
<td>9.0</td>
<td>9.4</td>
<td>7.7</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(300mm)</td>
<td>*</td>
<td>*</td>
<td>4.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>

* No sample was collected.

Table 5 Fine Sand Soil Type

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Sampling Depth</th>
<th>19/8</th>
<th>20/8</th>
<th>21/8</th>
<th>22/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble</td>
<td>Upper Rootzone(200mm)</td>
<td>25</td>
<td>16</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(400mm)</td>
<td>6.5</td>
<td>9.2</td>
<td>9.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Slow release</td>
<td>Upper Rootzone(200mm)</td>
<td>9.8</td>
<td>7.0</td>
<td>8.1</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(400mm)</td>
<td>4.6</td>
<td>4.7</td>
<td>4.3</td>
<td>4.2</td>
</tr>
</tbody>
</table>
Table 6   Fine Sand Soil Type

Nitrate + Nitrite (ppm)

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Sampling Depth</th>
<th>19/8</th>
<th>20/8</th>
<th>21/8</th>
<th>22/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble</td>
<td>Upper Rootzone(200mm)</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(400mm)</td>
<td>16</td>
<td>14</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Slow release</td>
<td>Upper Rootzone(200mm)</td>
<td>9.1</td>
<td>11.0</td>
<td>11.0</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(400mm)</td>
<td>6.9</td>
<td>7.6</td>
<td>7.3</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Table 7   Fine Sand Soil Type

Phosphorus, reactive as P (ppm)

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Sampling Depth</th>
<th>19/8</th>
<th>20/8</th>
<th>21/8</th>
<th>22/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble</td>
<td>Upper Rootzone(200mm)</td>
<td>0.14</td>
<td>0.03</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(400mm)</td>
<td>0.09</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Slow release</td>
<td>Upper Rootzone(200mm)</td>
<td>0.06</td>
<td>0.05</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Lower Rootzone(400mm)</td>
<td>0.06</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Heavy rainfall shortly after fertilisation with soluble nitrogen can produce leaching regardless of the irrigation method. Irrigation after nitrogen application probably leaches some of the ammonium nitrogen before it is nitrified and is better to apply nitrogen throughout or near the end of the irrigation period.

In trials conducted by Turfgrass Technology on a sand profile, sensor controlled irrigation increased the longevity of the nitrogen source from 5 to 30 days. In this trial, the profile was not permitted to reach saturation and to initiate drainage and leaching. This showed that with manual irrigation the nutrients were leached into the perched water table within 5 to 6 days while under sensor control the applied nutrients were at adequate levels for 22 days.

Moisture sensors must not be used in isolation. The combination of sensor treatment irrigation and rainfall approximated evapotranspiration calculated for the same periods based on weather data. This indicated the system was meeting turfgrass water requirements since no moisture stress was observed on the plots, while at the same time eliminating unnecessary irrigations.
Research
Soil Nutrient Analysis
Soil Physical Analysis
Plant Tissue Analysis
Disease Diagnosis
Nematode Diagnosis
Water Analysis
Advisory Services

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for Turf Managers

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Aligning ourselves with the best expertise available, these diagnostic services will provide the highest level of technical support available.

For many years Australia has lacked any continuity in developing a solid research program. Any profits generated through the operation of AGCSA Tech will be used to fund research projects. With the support of established funding bodies such as the Horticultural Research and Development Corporation (HRDC), this is seen as a practical means to provide a continuity of research. The AGCSA has already allocated funds towards establishing two research projects.

In addition, there is a proposal in with the Queensland EPA to develop an “Eco-efficiency” manual and training course for Queensland golf courses. This is an initiative of the Qld EPA to ensure that golf course activities meet environmental best practice standards. This project is only possible where the Qld EPA has a partner that is an industry organization. The AGCSA and the Queensland Golf Course Superintendents’ Associations will provide this necessary link as well as the manpower and industry knowledge required to undertake such a project.

AGCSA Tech offers an independent advisory service that encourages a proactive approach to turf management. Our key consultancy package provides a more objective and analytical means of assessment, that over time will remove much of the subjective and anecdotal comment that is often associated with turf management. This is a program for the well organized turf manager that wants to objectively monitor turf performance over time. We believe that this will provide a very important planning tool.

AGCSA Tech will also be available to undertake problem solving consultancies, prepare specifications and provide project management where required.

There is an increasing requirement for golf clubs to demonstrate that they are environmentally sound. The development of Environmental Management Plans (EMPs) for golf courses is another key advisory service provide by AGCSA Tech and three are already underway.

Research is only successful if the results of that research is put in the hands of those who need it. Through the AGCSA workshop series and the Australian Turfgrass Management magazine, AGCSA Tech will implement a highly effective extension program.

The new service provides an important expansion in AGCSA member services. From June 2000 AGCSA Tech will be put to the test and we look forward to helping you produce better quality turf surfaces.
Pest Control in Racetracks

by John Neylan and Phil George, AGCSA (formerly Turfgrass Technology Pty Ltd).
Doomben, 1997

Racetracks, as with all other turf surfaces, are subject to invasion by weeds, disease and insects. Under favourable conditions pests can cause considerable damage to the grass and disruption to the racing surface.

In recent times there have been several pests that have resulted in turf damage on racetracks.

**Weeds**

There are many weed species that can invade racetrack turf of which most are easily controlled. However, there are several difficult to control weed species including Poa annua, Nut grass, Paramatta grass and Crowsfoot.

**Poa annua**
Poa annua is an annual weed, with perennial biotypes, that is highly invasive and difficult to eradicate. It is a problem mainly in cool season grasses that favours compacted soil conditions and high moisture. Where it invades the surface it can form a shallow rooted mat that provides very poor traction and surface stability.

In ryegrass/bluegrass, ethofumesate (500/gL) at 5L/ha has provided good control. In warm-season grasses, propyzamide is highly effective in controlling Poa annua.

**Nutgrass** (*Cyperus rotundus*) and **Mullumbimby Couch** (*Cyperus brevifolius*)

Nutgrass is a perennial sedge with an unjointed triangular stem that is a widely distributed weed that occurs in many turf situations. Nutgrass can be a very difficult weed to control because of the underground tubers ("nuts"). These tubers give rise to new shoots and rhizomes.

Mullumbimby couch is a perennial sedge and is distinguished from Nutgrass by the flow spike. Mullumbimby couch has an elongated knob-like spike whereas Nutgrass has a number of flower spikes arising from a single point.

There are several registered herbicides for sedge control with the new herbicide, halosulfuron-methyl (Sempra) proving to be very effective.

**Paramatta grass** (*Sporobolus indicus*)

Paramatta grass is an erect, tufted perennial with a very dense, long seed head. The tufted nature of the grass forms an irregular surface, it is unsightly and difficult to mow.

The only registered chemical for Paramatta grass control is atrazine, however, this is for warm season grasses only and the results are often variable.

**Summergrass** (*Digitaria sanguinalis*)

Summergrass is an annual weed that is widely distributed and highly invasive. It has a fibrous root system and clusters of soft stems which grow close to the ground and may root at the nodes.

Summergrass is a prolific seeder and invades thin, damaged and worn turf.

There are several registered pre-emergent and post-emergent herbicides for the control of Summergrass. In recent times the pre-emergent herbicides oxadiazon (Ronstar) and Dithiopyr (Dimension) have proven to be very effective.
Insects and Nematodes

Nematodes
Nematodes naturally occur in soils and are generally a problem only when there are high numbers. There are numerous species of nematodes many of which are harmless. However, there are several parasitic species that can cause significant turf damage. The parasitic species include:

- Helicotylenchus sp.
- Xiphenema sp.
- Hemicycliophora sp.

Plant parasitic nematodes are transparent, microscopic "worms" that have well developed stylets which they use to penetrate plant cells.

Nematode damage can often be attributed to other pests with the foliar symptoms being, severe chlorosis, declining growth and gradual thinning. Nematodes are favoured by mild to warm (20-30C) soil temperatures, high moisture and sandy soils.

Fenamiphos (Nemacur) is the only registered pesticide for nematode control.

Billbug (*Sphenophorus brunniennis*)
The Billbug has become a major pest of Kikuyu grown in areas subjected to high moisture and waterlogging. Infected turf turns yellow to brown and can be easily plucked away with the finger tips. Larvae can be seen at the soil surface beneath damaged turf. The larvae are 100 mm long, legless, with a brown head. Damage usually occurs from mid-November to late December. Chemical treatment to control adults should be made in August/September.

Scarub Grubs
Scarub grubs such as the African Black Beetle (*Heteronychus orator*) and the Black Headed Cockchafer (*Aphodius tasmaniae*) can cause significant damage on turf. The scarubs feed on leaves and roots which weakens the turf. The associated surface disruption can often be due to incidental "pests" such as birds and foxes that peel the turf back in search of grubs. The damage is often patchy but severe.

There are numerous insecticides registered for scarub control including chlorpyrifos, diazinon, cyfluthrin and isophenphos. In recent times imidacloprid (Provado) has proven to be very effective.

Cutworm (*Agrotis sp.*) and Armyworm (*Spodoptera maurita*)
Cutworms are caterpillars, the larvae of members of the moth family Noctuidae. They grow to a length of 30-40 mm, are about 5 mm in diameter and are brown to black in colour. Cutworms feed at night on grass leaves and often shear plant stems at ground level, hence the name "cutworms".

Armyworms are also caterpillars of the moth family Noctuidae. They grow to a length of 45 mm, have smooth bodies and are dark in colour. Army worms feed on a wide variety of grasses including Kikuyu, couchgrass and paspalum. They usually occur in large numbers and move in a group in search of food. Armyworms feed on leaves, stems and seedheads.

Being surface feeders both groups are easily controlled with a variety of insecticides including chlorpyrifos, diazinon, cyfluthrin and trichlorfon.
Fungal Pathogens

Fungal diseases are not a major problem in racetrack turf, however, under the right conditions of temperature, moisture and humidity they can impact on turf quality.

*Kikuyu yellows (Verrucalvus flavofaciens)*

Kikuyu yellows is the most important disease of Kikuyu in Australia. This disease is a water mould which infects the roots, causing them to rot. This is followed by stem and leaf invasion leading to a bright yellow colouration. Patches can vary from 10 cm to over a metre in diameter.

The disease is noticed in spring and progresses through summer and autumn. The damage can be severe with large bare areas as a result. Control of the disease is difficult, however, encouraging good root development, maintaining adequate soil P and K and drenching the soil in the spring with the fungicide triadimenol (Bayfiden) provides some control.

*Leaf Spot Diseases*

Under conditions of high leaf wetness, high humidity and moderate-high temperatures, leaf lesions can appear due to a variety of fungal pathogens. Racetrack turf can often be susceptible to leaf diseases because of the leaf damage that occurs during racing.

The main leaf spot diseases are usually associated with Drechslera sp. and to a lesser extent Curvularia sp. The effects generally make the turf unsightly without causing extensive damage, however, sward thinning can occur.

The leaf spot diseases are easily treated with a number of registered fungicides.

Pest Control Strategy

There are very simple rules involved in establishing an effective pest control strategy including:-

1. good observation - look for early symptoms
2. monitor weather conditions - most insect pests and fungal diseases occur under a particular set of conditions
3. correct identification of the pest
4. look for any other condition that may be contributing to the pest outbreak, eg. soil compaction, poor drainage etc.
5. select the most appropriate, registered pesticide. Select the lowest toxicity.
6. apply the pesticide as per label directions
7. implement other cultural techniques that encourage the desirable plant and discourage the pest.
Racetrack Cultivation and Soil Conditioning

by David Howard & Keith McAuliffe, NZ Sports Turf Institute. Melbourne, 2000

Introduction

Race Track Managers theoretically have a good deal of influence over the outcome of a race (similar in many respects to a cricket ground curator's influence over a cricket match). There are no legal requirements pertaining to what track conditions must be served up, so the Track Manager does have considerable leeway to alter track performance. Arguably, first and foremost in the mind of Track Managers is the desire to provide safe riding conditions. Injury to riders or horse, followed by cancelled track meetings, must be the worst nightmares of every Track Manager.

Historically, most of our tracks were constructed using local soil materials and agricultural methods for land shaping and drainage. Some worked well, others didn’t. Although many of our tracks have since been reconstructed or intensively drained, many still remain vulnerable to water logging if inclement weather coincides with a race meeting. In other words success or otherwise of managing a track is somewhat of a lottery.

The Track Manager has a number of "tools" to help prepare the surface. Tools include:

- fertilizer programmes
- grass types and undersowing/oversowing methods
- watering systems
- mowing height and mowing equipment
- cultivation equipment/physical treatment

For the purpose of this paper the focus will be on the physical treatment component, and in particularly the types of cultivation equipment available.

Key Considerations when Selecting a Physical Treatment Option

There are a number of aspects that should be considered before finalising a physical treatment programme for a track, including:

- Every track will be different and even areas on the same track can require different renovation approaches. The specific problems associated with the track profile need to be determined. This will require an intensive examination of the soil to a depth of at least 400mm.

- Determining the drainage or conditioning requirements of a soil is a relatively complex and specialised business. It often pays to seek a professional opinion before determining a programme. An expert should not only be able to identify the major problems inherent with the track, but also advise on what treatments are most likely to work.

- A racing surface is likely to have quite different renovation requirements to say agricultural land, or even other sports turf surfaces. For example, the zone of compaction with a race track surface is generally deeper than with other turf systems (compaction generally below 100mm).

- There is a need to assess how each form of physical treatment could react, in terms of both efficiency of soil conditioning and effect on surface levelness and stability. It is a matter of marrying-in what the track requires with what each form of physical treatment can offer.

- Consider the timing of treatment. Timing should bear in mind both the climate and the racing calendar.
Cultivation/Physical Treatment Tools available

**Hollow tine corer**
Most hollow tine corers penetrate the soil to a shallow depth of approximately 60-70mm. Extracted soil cores can either be removed or rubbed back into the surface. A standard coring operation affects generally less than 5% of the total surface area.

Traditionally, coring has been used to help control surface compaction and/or to help incorporate new topdressing soil. Although the benefits of coring are debatable in many cases (bearing in mind that only a small percentage of the surface is affected), coring can be used as a renovation tool to help prepare a seedbed, level a surface or aid the incorporation of fresh topdressing soil.

**Spiker/slicer unit**
A spike/slicing machine is used to punch slots into the soil, generally to aid water and/or root penetration. Spiking units are often used to help open up a soil after surface sealing.

The amount of surface area affected by one pass of a standard spiker/slicer is very small. The extent of any benefit from spiking is debatable, especially if used during soft winter conditions.

**Verti-drain**
The Verti-drain is often likened to a mechanised fork. Verti-drain units are currently used extensively throughout Australasia to help improve soil conditions to a depth of up to 300mm (although penetration depth is often restricted by the soil hardness).

The large, deep channels created by a Verti-drain unit can help with both root and water penetration to depth. Benefits are likely to be site specific, depending on the depth to any free draining subsoil.

**Oscillating blade devices**
There are several makes and models of oscillating blade units (eg., Shatter master, subaire) that are used to improve soil conditions. The theory behind using such devices is that they help to develop soil structure through shattering the soil as well as aid horizontal water movement by creating continuous channels in the subsoil. The soil conditions at the time of carrying out this form of treatment are very important. Success can be wide-ranging.

**Mole plough/ mini-mole plough**
The mole plough unit involves pulling a torpedo below ground to create a horizontal, unlined channel. A mole plough can aid horizontal water movement through a soil and help improve soil structure through the resistance created. In the right soil conditions moling/mini-moling can be a very effective drainage tool, particularly if there are lateral drains in a track which can be moled across.

Again timing of moling/ mini-moling is of critical importance to the outcome.

**Thatch control**
There are various machines available on the market for removing/controlling mat/thatch build-up. Mat accumulation is not a problem in most New Zealand soil-based tracks. However, mat/organicmatter accumulation can be a problem in sand-based turf systems or where a stoloniferous turf species (eg. Kikuyu) is used.

Surface organic matter accumulation may also be necessary where a surface goes jelly-like over a wet spell (mainly a problem with sand-based turf systems).
How Often should Soil Physical Treatment be Carried Out?

There are numerous things to consider when determining the optimal frequency of a physical treatment programme, in particular:

The finances available to the club. A small club is unlikely to own machinery and will need to pay a contractor for operations such as Verti-draining.

The amount of soil improvement needed. It is unrealistic to expect major improvement in soil conditioning with just one pass of a physical treatment unit. The build-up of soil structure and improvement in soil conditions generally takes place over a matter of years.

As a matter of note, the development of a plant root system (often following on from the physical treatment operation) is often a requisite for having good soil conditions and soil improvement.

Frequency of treatment will depend to some degree on the amount of disruption caused by the operation. There is understandably reluctance to use a disruptive form of physical treatment too close to a race meeting. Unfortunately race meetings often co-incide with the best time of the year to carry out the physical treatment from a soil's point of view (e.g. during periods of active grass growth).

It would be fair to say that the amount of physical treatment carried out on our track surfaces has, traditionally, fallen well short of what is required for long term performance.

Summary

Having good conditions for turf growth and the right conditions on race day are key goals for a Track Manager. There are a number of cultivation tools available to the Track Manager to help improve the characteristics of the soil.

What equipment is best used will depend upon the nature of the problem/objective of the exercise. In some cases the goal could be to control the build-up of organic matter. In other cases it may be to enhance rooting depth or break up base compaction in order to improve drainage.

It must be remembered that every site will be different and there is no such thing as a standard recipe when it comes to selecting a race track cultivation programme.
Racetrack Preparation

by Tony Field, Hong Kong Jockey Club, and Jim Murphy, NZ AgResearch. Moonee Valley, 1997

Track Managers prepare turf surfaces for racing and the rest of the world passes judgement on raceday. In New Zealand, track managers have been helped to understand how well their surfaces are doing before they are raced on. Research has led to some general rules about how tracks behave as well as some specific measurements that show how the racetrack is functioning. The moist New Zealand climate has meant the major concern is preparing for, and coping with, winter racing.

The sand and clay content of racetrack soils had a big influence on how the racing surface behaved

New Zealand racetracks are found on a wide range of soil textures. These are classified on the sand, silt and clay contents. They range from light seaside sands to heavy volcanic clays. Heavy clay soils often have poor natural drainage and racetracks sited on them need to have drainage systems installed below the rootzone to pull extra water from the surface. Light or sandy soils generally have good natural drainage unless there is a layering of different textured soils in the surface 500 mm.

A high proportion of fine clay particles gives soils extra strength. This is important because it affects how deep a horse goes into a wet racing surface. But it is the soil structure, or how the different particles are arranged in the soil, that is more important for growing turf and for coping with winter conditions. Even sandy soils can hold too much water if they are not well-structured. Good structure comes from aggregation of soil particles by natural processes that gives larger channels between aggregates for movement of air and water into and through the rootzone.

Vigorous grasses grew best where the racetrack soil had good structure

Horses gallop on turf, but with such force that they would hardly register whether there were grass leaves on the racing surface or not. Their hooves do react to the parts of the plant at or under the soil surface. Some cushioning comes from the crown of the grass plant but mostly it is the live roots and rhizomes of plants, along with the remains of dead ones, which give resiliency to the soil. When the surface is firm, the types of grasses grown on the track are relatively unimportant, but when soils are wetter than moist the grasses give important extra strength to the racing surface and ensure divots are hinged and do not fly around.

Soils have good structure when the solid matter is aggregated into lumps or crumbs

When a soil has poor structure, it only has fine pores between the weakly aggregated particles. These fine pores hold too much water and not enough air, and the soil stays wet too long and grows weak turf. These are compacted soils. A well structured soil has a higher proportion of air-filled pores and so grows strong turf as water drains from the upper layers quickly after rain.

If soils are compacted they have higher bulk density. That is, there is a greater mass of soil packed into a unit volume with less air spaces. However, bulk density itself is by not a very useful measurement as some soils swell when wet and so water reduces the bulk density; others have more organic matter, and the density of the particles themselves may vary depending whether the soil is volcanic or alluvial in origin.

For comparing racetracks we have used relative bulk density. To calculate this we first measure the maximum bulk density for the soil from the racetrack at a range of water contents in the laboratory. Then at any time we can go back to the track and measure the bulk density and water content and express the
bulk density as a percentage of the maximum at that water content. A relative bulk density of 100% will have no air-filled pores under normal conditions.

Turf quality was poor when the relative bulk density was above 90%.

In New Zealand, we find the optimum range of relative bulk density for growth of desirable species to be 85-90%. Above 90%, in a cool, moist climate, *Poa trivialis* and *Poa annua*, meadowgrasses or wintergrasses, dominate ryegrass. The ryegrass finds the soils too wet and will only do better with more large air spaces. So, once the groundwork has been done, relative bulk density is one of the more useful, easily-measured indicators of track conditions.

Among cool season grasses it is the shallow rooted, weak grasses that are more tolerant of wet, compacted soils. Warm season grasses are found only on a few northern racetracks in New Zealand and will tolerate compacted soils because most of their growth is in the drier period of the year. My observations from North American tracks indicate that Bermudagrass (*Cynodon dactylon* or couch) will grow in very compacted soils and, on Hong Kong tracks, the hybrid Bermudagrasses are far more competitive than ryegrass where there has been any loss of structure in the sand profiles.

Relative bulk density measures the packing of the soil particles but we are really only interested in the channels between the aggregates. The volumes of large and fine pores can be measured directly and how well they function for oxygen diffusion or water movement can also be estimated on the racetrack.

Pores are normally filled with air only if they are large enough to drain freely under winter conditions.

For growing strong turf, we want a good volume of larger pores that are drained quickly under gravity. To measure the actual volume of different sized pores in a soil we take a core sample, fill it with water then measure how much comes out as we increase the suction. For soil-based racetracks, we have found that the volume drained at a tension of 100 cm of water gives us a good indicator of how much air will be found in the soil under stable winter conditions.

The satisfactory limit for this indicator, drained at 100 mb(?) tension, is 8% of the soil volume. In winter, tracks with less than 8% stay in a very heavy state. With larger volumes, tracks will drain to a penetrometer reading of about 4.5 cm, which is on the borderline between a Soft and Heavy track under the New Zealand classification system. Most of the major tracks are measured each winter to assess how the maintenance regime is doing in keeping the track functioning well.

Renovation in mid to late spring is the only way to recover soil structure after winter racing on racetracks.

Racing on wet ground destroys much of the soil structure. The number of acceptable winter racing strips on a track is therefore very limited. A second meeting on the same strip will give poor traction conditions, even if the turf has had time to recover. Mechanical aeration of the track sometime between mid spring and early summer gives time during the dry season for structure to develop and be stabilised by grass roots, and so give improved traction for the following winter. In general, we found that autumn renovations are very ineffective for improving soil structure and in fact can lead to poorer racing conditions if followed soon after by heavy rain.

Sand profiles should not compact but can deteriorate because larger pores are blocked by a build-up of organic matter or migration of fine particles.

When soil has poor structure, fine clay and silt particles block up any larger pores that might form between the larger sand grains. In natural sands there is often a wide range of sand particles so that the same thing can happen. For this reason the grades of sand for sand profiles on sports grounds or racetracks are carefully specified so that they have only a narrow range of particles sizes.
As sand profiles age there is an accumulation of organic matter near the surface. The organic matter comes from dead plant parts. Much of it comes from stem bases and roots that are replaced at least once a year. This organic matter tends to coat the sand particles and clogs up the larger pores. Under these conditions sands can behave like compacted soils holding too much water and growing weaker, shallow-rooted grasses.

**Mixing sand with the native soil on a racetrack has given mixed results**

Increasing the proportion of sand particles in a soil will change the texture of the soil but not necessarily lead to improved soil structure. There are two main problems: firstly, the process of mixing the sand into the soil destroys any structure that had been there before the reconstruction began, and secondly, making the range of particles wider can lead to more, rather than less, packing, at least in the short term.

In 1991 I visited Melbourne for a week and, with the co-operation of local track managers, looked at soil structure on areas of Caulfield, Moonee Valley and Sandown racetracks that had recently been changed towards a sandier soil texture. Compared with the optimal range for a sand profile, the results show that:

The old section at Caulfield had properties that were similar to those we measure on the better soil-based tracks

All reconstructed areas had high bulk densities and low total pore volumes (porosity) between the tightly packed particles. These tracks would have been very hard when dry and so would get slippery on top with light rain.

Reconstruction increased the air in the soil but lost water holding capacity, at least in part because of low organic matter content.

<table>
<thead>
<tr>
<th>Soil property</th>
<th>Optimal</th>
<th>Caulfield</th>
<th>Sandown</th>
<th>Moonee Valley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (g ml-1)</td>
<td>1.2 - 1.6</td>
<td>1.4</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Porosity (% v/v)</td>
<td>40 - 55</td>
<td>47</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>Air-filled pores (%)</td>
<td>&gt;15</td>
<td>9.5</td>
<td>10.8</td>
<td>16.4</td>
</tr>
<tr>
<td>Water holding capacity (%)</td>
<td>22 - 26</td>
<td>27</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Organic matter (%w/w)</td>
<td>&lt;4</td>
<td>6.2</td>
<td>2.5</td>
<td>1.4</td>
</tr>
</tbody>
</table>

So improving the soil air and water movement by introducing more larger pores has been at the cost of harder tracks which hold less water for turf growth. We have seen cases where mixing in sand has lifted the air-filled pores to 25%, but always along with low water holding capacity and high bulk density.

**The penetrometer helps racetrack managers prepare and classify tracks**

Renovating tracks by sections has another down side. The going or traction conditions may differ from one area to another, even if the same procedures were followed with the same materials. This, of course makes the track manager’s job a harder one.

Everyone wants a good description of the traction conditions that will be experienced by the horses on raceday. The racetrack penetrometer, which was developed in France, is the best tool that is presently available for getting an estimate of these. The force applied to the penetrometer needle is similar to that on a similar sized piece of the horseshoe of a galloping thoroughbred. So the depth the needle penetrates after the first drop is similar to the initial penetration of the hoof. And, as the efficiency of the push off is closely related to this depth, it is no surprise that the winners time for a race can be predicted well from a penetrometer reading.
The penetrometer reading is this measure of depth in centimetres. The method used in Australia gives a reading that is related to this depth, but by including the second and third drop readings, the original reading may be modified by conditions deeper in the soil where the hoof does not penetrate. Monsieur Romanet at Longchamp designed the second and third drops to help correct the first reading if it was affected by surface irregularities; they were not intended to be included directly in the calculation.

In New Zealand we have made a big advance in using penetrometers by finding out how to take into account the effects of different soils on the readings. Let us consider the penetrometer reading when a horse runs 3 seconds slower over 1400 m than would be expected on a Firm or Fast track. On a strong clay soil the reading would be about 3.3 cm and on a sandy track about 3.6 cm. As the upper level for an Easy track is a reading of 3.5 cm, the clay track would be classified as Easy and the sand track as Soft for horses running similar times. In fact the loss of traction compared with a perfect track is the same in both cases. On stronger soils horses, and the penetrometer, go in less but the soil holds the hoof more than on a weaker soil where the hoof goes in further but is easier to pull out.

After measuring soil properties we can now give a calibration chart to any track so that they can use a penetrometer and then display a reading that means the same thing to everyone. All tracks with readings of 3.5 cm would be expected to give racetimes 3 seconds slower for 1400 m than under the best summer conditions. In 1996, there were 29 racetracks releasing information on a national scale in New Zealand. The system works up to readings of 7 or 8 cm which may be unimaginable in Australia. And of course, individual track managers use the penetrometer to produce readings leading up to raceday that suit all horses and all trainers!

Good racetrack management has similar objectives, whether on the sand profiles of Hong Kong or on New Zealand soils

The responsibilities of the Grass Tracks Consultant at the Hong Kong Jockey Club include similar objectives to those we had in our New Zealand work. That is, to help the Track Manager understand how his turf tracks are doing and how to make and interpret measurements that will give him better information about them.

Each of the racetracks at Happy Valley and Shatin are raced on nearly once a week over a 9 month season. Racing starts on warm-season hybrid Bermudagrasses, then races for 6 or 7 months on ryegrass with the Tifton grass coming back in towards the end of the season. The 350 mm deep sand profile was constructed with a near-ideal sand, imported from China, and has mesh reinforcements in the surface 150 mm.

Or at least that was the initial profile. Now the oldest sections of the tracks have a 35 to 45 mm surface layer rich in organic matter that has been built up in the 8 to 10 years since construction. In the Shatin track this layer was starting to hold too much water and suffer excessive damage during the 1995/96 racing season. In the last offseason, two approaches were taken to overcome them. In the first approach the surface was removed from the two alternative home bends along with the underlying mesh layer which was replaced and returfed. The second approach was to intensively core and topdress the rest of the racetrack surface with sand. The whole racetrack has functioned really well so far this season. The surface was cored again at the time of ryegrass oversowing and has been vertidrained twice during short breaks. Volumes of air-filled pores beneath the surface are monitored at 3-monthly intervals.

Almost all of the Happy Valley racetrack was reconstructed in 1985. Most was stolonized, with the last sod laid on the turfed area in September followed by the first race meeting two months later. In all, 21 race meetings were held on the track through the remaining seven months of the season. That intensity of use on newly established turf slowed the rate at which the surface matured. This season we will race on 31 days and the strong ryegrass cover we have now is giving a good racing surface. The extra organic matter added to the surface by the ryegrass will increase further the stability under racing. This is far more important on the tightly turning 1400 m Happy Valley track, built amongst high buildings, than on
the very open 1900 m track at Shatin. There, newly laid sod was raced on after two months and performed satisfactorily. Of course, the hybrid Bermudagrass sod at Shatin was laid early in the warm growing season whereas the sod at Happy Valley was laid as temperatures were falling.

The approach to managing both racetracks is similar, but more intensive than for soil-based tracks. We now understand how the sand surface ages and the management needed to look after root-zone conditions so that we can grow vigorous grass that will stand up to the racing. In effect, both racetracks must be treated very like large sandbased golf greens. Coring removes surface organic matter that is then replaced with sand to maintain the pathways for air and water into and through the profile. Verticutting into the surface is used to remove some thatch and to stimulate basal growth and stolon branching of the warm season grass. The vertidrain is used to help reduce surface hardness and to introduce more openings into the rootzone. And, of course, the penetrometer is an important tool used to give us information about our watering needs as we approach a raceday.

In the area of irrigation management there are two big differences from our past experiences in New Zealand. Firstly in estimating water requirements. Water budgets were introduced as a guide to help the Tracks Manager with water use. However, long term averages for evaporation, which are very good for predicting water losses under an oceanic climate, could vastly underestimate water losses at Hong Kong when dry air was blowing in from China. During these periods not enough water could be put on to the tracks to lift the penetrometer reading above 2.5 cm. Although this reading may be thought ideal by most racecourse managers in Australia and New Zealand, it is too firm for Hong Kong racing.

Secondly, watering is needed to get the best racing conditions for different reasons at the two racetracks. Shatin behaves more like a soil-based track and water gives cut in the ground and slower race times. The Happy Valley surface holds less water and times slow down as the sand dries out. Without adequate water the track is too hard and fast at Shatin and the track too slow with too much damage at Happy Valley.

**Last thoughts**

The worst problem a racetrack manager faces is not knowing whether he has done enough track renovation to avoid running into problems in the coming season. Most maintenance procedures are needed all the time, every year, no matter how well the turf is growing. To skip one is to invite disaster. And managers need test results from the rootzone. Not nutrient tests, because apart from pH and phosphorous availability, the rest are of little use. It is tests of soil structure which can tell him whether his efforts to keep compaction under control are getting results. In the past few years, the Racing Industry Board has made this information available to most racecourse managers in New Zealand. This information has given them more power in dealing with those racing people who think they could prepare a racetrack better than the racecourse manager.
Turf Nutrition

Assessing soil and plant nutrient levels
Types of fertiliser (soluble/slow release) and response rates
How much fertiliser, when and how often
Other requirements, eg, soil conditioners

Assessing soil and plant nutrient levels:

Problems:
- consistency in testing, eg, different pH analyses in water and calcium chloride
- varying costs, eg, $50-$150
- frequency of testing (annually ?), is there any set rule

Solutions/Recommendations:
- individual managers must determine best approach for their situation
- maybe a central company could undertake all testing which would assist resolving consistency and cost problems

Types of fertiliser (soluble/slow release) and response rates:

Problems:
- leaching on sandy type profiles
- spreading methods to get an even coverage
- peaks and troughs in available nutrient when using immediate release products
- costs

Solutions/Recommendations:
- using soil test analyses to develop your fertiliser program
- immediate release products are favoured due to cost advantages and long term knowledge of the products
- controlled release products have a longer life span, therefore less applications

How much fertiliser, when and how often:

Problems:
- many products on the market
- different ratios of NPK
- different nitrogen products
- what is best ?

Current practices:
- immediate release products are generally applied at rates varying from 100-250 kilograms per hectare
- NPK ratios range from 12:10:10 to 20:0:16
- majority of fertilisers used are low in P and K was about 75% of N
- immediate release products are applied on average of every four weeks
- controlled release products are applied at 200-250 kg/hectare, with NPK ratios of 30:1:5 to 24:2:9, and applied 10-13 weeks apart depending on the season
Other requirements, eg, soil conditioners:

Problems:
- burning of turf
- watering the product into the profile
- application methods, eg, liming requires large machinery which can damage turf surface

Solutions/Recommendations
- each manager to assess individual needs and control application problems

Raceday Preparation & Repair

Issues
Preparation of the racecourse facilities
Ensuring the track is in top condition
Determining rail movements
Repairing the track during and after the meeting

Preparing the racecourse facilities:

- aim to present course in “neat and clean” condition
- problems can include costs, property damage and such things as Sky Channel not working

Ensuring the track is in top condition:

- problems mainly due to weather and watering, eg, sprinklers sticking
- solutions lie in preparation and management to ensure a good, safe, consistent surface
- watering during the day is recommended

Determining rail movements:

- aim to provide the best available surface on the day
- problems mainly connected with lack of manpower and costs
- recommended that the rail should be moved all the way around to give a better and more even recovery rate

Repairing the track during and after the meeting:

- problems encountered are usually due to bad weather conditions
- during the meeting divots can be filled in by hand and the track rolled and brushed
- after the meeting procedures include filling divots, watering, rolling, sweeping, fertilising as required
- soil tests, verti-draining and renovation should also be undertaken when possible
Renovation & Mowing

Issues
- Reasons for renovation and how often
- Renovation equipment options and preferences
- Mowing height and frequency for various tracks
- Equipment maintenance

Renovation:

Objectives:
- to relieve compaction
- to improve drainage
- to control thatch

Solutions:
- will vary according to local conditions, ie, turf type, soil type, etc.
- methods used include verti-drain (used by most clubs and dependent on weather conditions, track condition and race dates); renovator; slicing; coring; application of gypsum/sodex
- other renovation work includes topdressing and oversowing
- topdressing should occur during the growing season but is usually restricted by time constraints
- oversowing rates vary from 150-500 kg/hectare and methods include broadcast and brush in, Italian seeder, etc., and extra seed in fill during track repairs

Mowing:

Heights:
- vary from species to species
- usually between 4-6 inches (10-15 cm)

Frequency:
- 3-4 times per week in growing season
- up to 2 days before a meeting (allow time for turf to grow out tyre marks, etc)
- far less during winter months

Machinery:
- front deck mowers used by most clubs
- others include Howard, tow behind and gang mowers

Maintenance:
- use a designated operator who is familiar with the machinery, mowing schedule and course layout, eg, location of drainage and irrigation pipes
- use designated and skilled staff (mechanics) for servicing
- borrow/exchange equipment with neighbouring courses or sporting clubs with user to cover any repair costs.
Sterline Racing P/L

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Summary

Having a good understanding of the soil conditions on your racetrack is a key to managing it effectively. Knowledge of the soil types and their depth, the presence of compaction layers, thatch depth and root health provides invaluable information for planning the annual track maintenance program. By having a good understanding of where the potential problems may occur, it is then possible to program the most effective renovation strategy using the most appropriate equipment. For example, if a compaction problem is occurring at 150mm, it is pointless to use cultivation equipment that only treats the top 75mm of the profile.

Grass health and in particular root growth, is an important key in maintaining a high quality racing surface. A strong, healthy root system reduces devoting and improves traction, which results in less damage and reduced need for repair. A good root system is dependent on having a well aerated profile. In the case of racetracks where compaction is probably the single biggest problem, then regular aeration is essential in maintaining conditions that are most conducive to good root growth.

It is important to understand that all racetracks are different, with different combinations of soils, grasses and climates. Using the available monitoring tools makes for more effective and efficient turf management.

Soil physical testing is an essential means of selecting soils for construction and topdressing. Soil chemical and plant tissue testing are very useful tools in managing soil fertility and planning fertiliser programs. Better soil management through regular soil monitoring, not only improves plant health, it also makes for more effective management.

Insect pests, weeds and disease affect all racetracks in Australia and it is important to understand;

   - What are the most common local pests?
   - When do they occur?
   - What are the conditions under which they occur?
   - What are the most effective control measures?

With a more ecologically responsible approach to turf management, many turf managers are implementing Integrated Pest Management (IPM) programs that provide more effective control with reduced environmental impact. The key elements to IPM are;

   - Good observation
   - Regular monitoring of weather conditions
   - Accurate pest identification
   - Understanding lifecycles
   - Strategic pesticide application to have the most impact
   - Understanding of other conditions affecting pest outbreaks (eg compaction, poor drainage etc.)

To produce and maintain a high quality racing surface requires good knowledge of the turf system, good observation and preventative maintenance.
5. Training Tracks

Introduction

Grass
Grass training tracks are usually the poor relation at many race courses where they are often poorly constructed, excessively used and receive minimal maintenance.

Grass training racks are required to provide a safe and useable surface, irrespective of the weather, and a surface that is similar in performance to the course proper, however, the high level of use makes this a difficult task.

While there have been numerous course proper reconstructions, the grass training tracks have generally not been refurbished to the same degree other than an improvement in track geometry and, in particular, the removal of reverse cambers.

Given the high level of use, grass training tracks require at least the same level of management as the course proper.

Synthetic
Synthetic or artificial (i.e. non-turf) surfaces are a very important part of training complexes. Synthetic surfaces have the potential to provide a high usage track that does not require the same labor-intensive inputs necessary in maintaining grass tracks. While grass is the preferred surface for training tracks, the potential improvement in synthetic tracks is likely to see them used more frequently for both training and possibly racing.

Synthetic surfaces continue to be developed and improved and there is yet to be developed the perfect surface. The principal requirements of synthetic surfaces include:

- Uniformity
- Unaffected by wet weather
- Requires little or no water
- Safe and convenient
- Low injury potential
- Cope with very high use

While there are many different types of synthetic surfaces, including sand, wood chip, and polymer coated sand, the “perfect” surface is yet to be developed.
Grass Training Tracks

Papers given at Doomben, 1998

1. Paper by Jeff Haynes, Racecourse Manager, Warwick Farm

Over the years of maintaining racecourses and training centres I have had the chance to look after grass training tracks with different types of grass surfaces.

The grass training track is probably the most over used and labour intensive track surface on a racecourse. With the demand from trainers to be able to gallop on grass as much as possible, it makes it difficult to make a good grass surface available. Even though over the years we have developed excellent sand tracks and artificial tracks, trainers want grass. After a week of rain the demand to use the grass is always on the trainers agenda. Most trainers would prefer to gallop on a bog grass track than gallop on good sand or artificial track. The main comment from trainers is "we race on grass so we must gallop on grass". With the advent of Sunday racing, more pressure is put onto racecourse management to make the grass available 5 days per week instead of four.

The two training grass surfaces I have managed have different maintenance practices. The Rye/Bluegrass surface of Victorian tracks takes a lot more maintaining and repairing than the Kikuyu tracks of New South Wales.

Rye/Bluegrass seems to divot a lot and in the winter months can look like a ploughed paddock. The amount of labour needed to repair the grass can be enormous and the track is expected to be available within 2 days. The procedure was to organise the galloped areas to be used every 4 weeks to give the area a chance to recover.

Repairing after gallops included groups of 3-4 staff painstakingly raking back the divots and placing them right way up into the holes. This could take anything up to 2-3 days depending on the amount of damage done to the grass. When the raking back is finished the area is usually rolled and then filled with soil and seed mixture. This is done by placing the soil and seed mixture into the holes by hand with either buckets or shovels, which again takes time and is monotonous but is the only way it can be done.

I did find it difficult with only one grass track to do any renovating because we could not take the grass out of play due to the demand from trainers. Grass tracks need to be renovated at least once a year due to the punishment they receive but it does not always happen.

Since moving to Sydney, I found the wonder track grass "Kikuyu". The amount of punishment this grass can take is outstanding. Most of the year this grass can grow 7.5 cm in a couple of days and can provide a thick mat of grass which is perfect for track work.

The maintenance practises for Kikuyu vary from Rye/Bluegrass when preparing and repairing after grass gallops. In the growing season ( 9 months of the year ) we leave the grass up to 15-17.5 cm long for gallops and the divoting is minimal due to the grass taking the punishment. After gallops we would mow the galloping area then fill with soil (no seed). Sometimes it could take 1-2 hours to repair a track after two days of track gallops.

With the fact that the Kikuyu grows so quickly, the galloped area can be used again within 7-10 days if need be. Although we like to use each area every 2-3 weeks to give the galloped area plenty of time to recover. The big time saver is no raking back.
In the winter months after track gallops, because there is no growth we would use a limiser, which is a catcher with a PTO driven brush on the front mounted on the 3 point linkage on the back of a tractor. This would run over the galloped area pulling up any loose divots then we would fill as normal.

I do however have the advantage in Sydney of three grass tracks, which includes the Course Proper. We use the Course Proper a fair bit because we only race 23 times per year. This gives me a chance to close a grass track for renovation when it is needed.

Level of usage of grass tracks, if left up to the trainers, would be everyday, can vary depending on grass track available. Tuesday is the main day most trainers prefer but we gallop Monday, Tuesday, Thursday, Saturday and repair our galloped area twice a week. To save wear area we set our hats 5m apart and move them across 2m for the next gallop, giving us only a 7m area to repair.

2. Paper by Brent Humphries, Operations Manager, South Australian Jockey Club

I have been asked to speak on the management of grass training surfaces and before I commence my talk I would like to stress that my experience is from an administrative point of view. My former position as Manager of Operations with the South Australian Jockey Club involved more of an overseeing responsibility rather than hands on, which is capably carried out by the Racecourse Managers - Mario lonni at Morphettville and Victoria Park, and Dave Wood at Cheltenham Park.

There are four topics that I have been asked to comment on that relate to the Management of Grass Training Surfaces:

Interaction between the Club and the Trainer.

Obviously I can only speak from a South Australian point of view and unfortunately, the interaction between the SAJC and trainers is very limited. There are reasons for this. Firstly, the SAJC, in the past, is no different to most Principal Clubs in that, as it is spending the money on the facilities, therefore it wants to have the say as to how that money is spent. Secondly, although there is an organisation called the SA Branch of the Australian Trainers Association in Adelaide, its members do not include any of the top trainers and therefore it is not seen to be fully representative, and as such any input from trainers is from a narrow base.

As you are all aware, there are some trainers who think they know how tracks should be prepared. I have tended to listen to them rather than dismiss their ideas straight away, and if I think they make some sense, and are looking after the good of all trainers, and not just their own needs, then there is a possibility that we will make some changes. However, I have to be quite frank and confirm what most of you already know, and that is most trainers look after only themselves and are quick to blame the track before looking at possible other causes when a horse breaks down.

The Trainers "wants" and what the Track Manager can provide.

As with the course proper, the Track Manager's first priority for all training tracks is to present the best surface available given the prevailing conditions, and to ensure that it is safe. Having provided that, it is then up to the trainers and their trackwork riders to utilise the tracks as they see being the best for their horses.

The SAJC has over 300 horses in training all year round at Morphettville and 50-60 at Cheltenham Park. We do allow trainers to have special gallops at Cheltenham Park, either next to the rail on the middle grass, or outside markers on the course proper. Similarly, interstate, and of course local trainers, have plenty of opportunities to use the grass at either training venue. Also, grass tracks are made available on Saturdays when there is metropolitan racing on the Monday following.

A few years ago we had an interstate trainer locate a satellite stable at Morphettville. For some time he tried to convince Mario lonni, the Morphettville Racecourse Manager, that he should utilise the inside
4 metres of the middle grass for normal track gallops, and secondly, allow the strip that is used for gallop mornings to be about 10 metres wide. This request has been denied and we continue to "save" the inside 4 metres for trials, and for the odd special gallop, and we allow approximately 5 metres (room for at least 2 and sometimes 3 horses) for galloping to be carried out. We have been doing this for a long time and, as it has proved successful in providing a good surface, and allowed us to present a grass track for gallops throughout the year, there is no need to change a "winning" formula.

In my opinion, the SAJC provides the majority of wants of most trainers, and where possible we accommodate them, providing their requests are not outlandish.

Cost of Maintenance versus Returns from Training.

In 1996-97, the SAJC spent approximately $370,000 on maintaining their training tracks. Of that amount, approximately $300,000 would be attributed to maintaining the Morphettville inside grass training surface, which is used about 40 weeks of the year for gallops on Tuesdays and Thursdays. In that same period the SAJC received $189,000 in grass gallop fees from trainers. So as you can see, training fees only account for about 50% of the costs of maintaining training surfaces. I am sure this lop sided cost versus revenue situation is no different with your club. It is a "catch-22" situation that clubs are forced into, because if they did not provide the training facilities, then trainers will site themselves in the cities which have racing clubs prepared to provide what they want.

As an aside, it costs the SAJC approximately $450,000 each year to maintain Victoria Park Racecourse which has no training facilities. That works out at a cost of about $25,000 per race meeting before any profit can be considered. As well, stakemoney and other race meeting costs boost the actual cost of holding a race meeting to very high levels.

Does Training on Grass have a Future?

I am prepared to make what I think is a relatively easy prediction, that all of us here in this room will be long gone before there are no longer grass training tracks available to horse trainers. I say this with the thought that we will continue to race on grass for the foreseeable future and therefore training on grass will still be a requirement. Every Tuesday at Morphettville, approximately 100 horses gallop on the inside grass track. I know that there are some trainers who are proponents of the American dirt tracks and there are a few that do not gallop their horses at all, and use either the beach or swimming pool to condition their horses. However, in my opinion training on grass will continue in the future as it has in the past.

3. Paper by Warren Williams, Racecourse Manager, Doomben

Income versus Expenditure on grass training tracks. Is it a balanced equation?

Doomben racecourse has two grass training tracks. No. 2 of 2.2 hectares and No. 3 of 2.7 hectares, a total of 4.9 hectares of grass. Turf species is Kikuyu. Irrigation is by automatic electronic solenoid and Impact head. There is no sub-surface drainage and soil is silty loam.

220-240 horses train each day for six days a week. Grass tracks are used for fast work only on three days per week (Tues, Thurs, Sat).

Income from training includes, Training Fees of $5 per horse per month, Grass Gallops at $2 per horse ($5 with a partner), and Grass Jump Out Fees of $10 per horse.

Expenditure on maintenance includes Mowing, Aeration, Nutrition, Pest and Disease Control, Patching Soil and Labour.

Balance Sheet over 12 months, based on 220 horses and 4.9 hectares of turf is:
<table>
<thead>
<tr>
<th>Income</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training fees</td>
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</tr>
<tr>
<td>Grass gallops</td>
<td>$15,600</td>
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<tr>
<td>Grass jumpouts</td>
<td>$5,760</td>
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<tr>
<td>Barrier trials</td>
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<td><strong>Total</strong></td>
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<tr>
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<td>Nutrition</td>
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<td>Pest/disease</td>
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<tr>
<td>Labour</td>
<td>$42,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$78,580</strong></td>
</tr>
</tbody>
</table>

4. **Paper by lan Chivers, Racing Solutions**

In this paper I propose to discuss the performance of a number of grass training tracks from those racecourses that I have been visiting for some time. From these observations I will then make comments on the characteristics that I believe apply to give an "ideal" construction.

Over a number of years I have been able to observe the performance of numerous grass training tracks in Australia and New Zealand, and to note the comments of the relevant racecourse managers. This allows me to make some comparisons on the relative performance of the common forms of training tracks.

There are basically two types of grass training tracks, those that have been fully constructed, and those that have next to no construction.

The fully constructed tracks commonly have a one-way crossfall towards the rail, a sandy-loam profile, a full agricultural drainage system and a fixed irrigation system. In short, they are constructed much as we would construct a new course proper.

In contrast, the others have negligible construction, with a flat or crown construction, no drains, a heavy soil profile and a rudimentary irrigation system. In many ways this was how racecourses were constructed before more “enlightened” designs and methods were adopted.

Fig. 1  Fully constructed (top) and partially constructed (bottom) tracks
My observation is that the best performance is not from the fully constructed tracks, but from those with a negligible level of construction. In particular, it seems that those tracks that have a crown construction and comprised of a silt or loam growing medium perform far better than any others. The form of irrigation system is not as important and the presence of drains seems entirely irrelevant. The two key factors are the crown construction and the silt or loam soil type.

I cite the following training grasses as examples:

Bendigo, Caulfield, Geelong, Moe, Mornington, Newcastle, Palmerston North (NZ), Sale, Warrnambool, Warwick Farm.

In a relative sense, these tracks carry a far greater burden of traffic than do their immediate neighbour, the course proper. Even allowing for the ability to closely dictate the pattern of wear for the full width of the track, usage can be twice to three times as much as that received on the course proper. Yet they do not break up or lose their grass cover entirely, as can be the case with some of the newer (full) constructions.

On some training grasses, direct comparisons can be made between the fully constructed parts and the parts with negligible construction. In these cases the areas with the full construction inevitably perform poorly in comparison to the remainder of the circuit.

How is this the case and what explanations can be made?

My hypothesis is that:

The crown construction more effectively takes the water away from the training surface, and in particular, it does not force water towards the inside rail. This higher efficiency almost completely eliminates the need for drains in the surface.

Silt, or loam, soils are more easily compacted and can be sealed off over the winter period. This then does two things. It increases surface runoff and it reduces the penetration of the water into the soil surface. The former removes excess water quickly from the track, whilst the latter prevents water retention within the top 100 mm of the growing medium.

It is the retained water that leads to softer soil conditions in a sandy soil and permits greater divoting. By reducing the amount of water retained in the top 100 mm, divoting is minimised and plant losses are reduced.

As a result of the greater compaction within the topsoil, the plant density is lower. Each plant, therefore, is larger and with a more extensive root system than occurs on the course proper. Once again, this implies that the plants are less likely to be removed by galloping horses.

Whilst racing usually cannot occur on these tracks because they either have inappropriate cambers, tight turns or no adequate starting positions, they seem to be able to perform their allotted task with great capacity.

Conclusion

On the basis of more than a decade of monitoring racing and training surfaces, I have revised my views of the ideal construction for a training surface, away from believing that a fully constructed surface would be superior. I now strongly believe that for dedicated training surfaces, the preferred design should be that of a crown construction using loam or silt soils.

This should not be taken to support this form of construction for a new course proper, where I am not advocating that we return to this "negligible" form of construction for the course proper, but applies only to grass tracks that are used exclusively for training.
5. Panel Discussion

The purpose of this session was to develop a discussion around the maintenance and quality requirements of grass training tracks. Each of the panel members made a short presentation and some of the key points were as follows:

**Jeff Haynes**
When located at Mornington Training Centre, during winter there was a minimum requirement of 4 weeks for recovery on cool season grasses.
At Warwick Farm the main grass species is Kikuyu which adsorbs a high level of wear.
In winter, a "littermiser" is used to pick up dead plant material and other rubbish so as to minimise the development of thatch and a greasy surface.
Training tracks are used for other purposes including parking and race trials.

**Brent Humphries**
From an administrative point of view, revenue from training is only about 60% of the total cost for maintaining the grass surface(s).
In the long term, grass training surfaces will still be required even with the development of "synthetic" alternatives (eg. "American Dirt).
Most trainers have little regard for preserving the grass surface for future needs and are only concerned about today. There is very little interaction between the SAJC and trainers.

**Warren Williams**
From a purely economic point of view, the cost of providing the surface far out weighs the revenue.

**Ian Chivers**
Of the many training tracks inspected, those that have a "crowned" shape and constructed of fine textured soils appear to suffer the least damage.
The reasons proposed in support of these observations were;
- crown provides good surface drainage
- fine textured soils are compacted and are better able to shed surface water
- turf sward is less dense leaving fewer, larger plants that have a deeper root system and less easily dislodged (i.e., less divoting)

**General Discussion**

At Toowoomba Racing Club they have 500-600 horses in training and training fees have been increased from $5 to $25 without losing any horses or trainers. Trainers do not mind paying extra if a good quality facility is provided.
The overall opinion was that training fees are too low. Brent Humphries said that the SAJC fees were $25 and he considered this to be too low.
In New Zealand, subsidies for training were withdrawn with a 100% increase in fees. There was no decrease in the number of horses in training as a result of the increase in fees.
Fees were increased from $43 to $80/horse/month, $10 for jump outs and $80 for trials.
At Warwick Farm the fees are $34/horse/month.
There are many small owners and trainers in rural areas and it is believed that an increase in training fees will be a disadvantage to them and allow the bigger owners and trainers to take over.
The proposition of a crowned training surface raised the issue of negative camber and the dangers that this can present. Several track managers challenged the proposal that crowned training tracks are accepted within the racing industry. Both Lindsay Davies (Rosehill) and Warren Williams (Doomben) said that horses would not gallop on the reverse camber.
It was felt that horses that found themselves on a negative or reverse camber were more likely to suffer greater injury.
The question was asked what constitutes an acceptable grass training surface. Several points were made as follows:

- surface doesn't have to be lush but needs to be consistent
- must be safe
- don't want to see dust flying when in use
- must be maintained the same as the course proper
- don't use the grass on wet mornings
- must have a good root system
- Kikuyu is the predominant grass type in warmer areas with Tall Fescue and Perennial Ryegrass in cooler zones
- construction type (ie. soil type, shape, drainage etc) was considered to be more important than grass type.

The issue of consulting and communicating with trainers was discussed and the following points were made;

- very few tracks have a formal consultative process
- most tracks deal with a trainers representative or individual trainers. Group meetings tend to end up in non-productive "gripe sessions".
- at Flemington meetings are held every 2 months with all senior trainers invited. At the initial meeting 12 out of 60 participated with the most recent meeting having 4 participants. Meetings are considered unproductive and one on one meetings are more beneficial.

Mr Ray Hawke, representing New Zealand racing summarised their situation as;

- New Zealand trainers never worry about the level of damage caused by training
- New Zealand trainers are not concerned about there being too much rain and what surface damage may result from training on wet tracks.
- There is very little consultation with trainers regarding training tracks
- At the Cambridge Training Centre there is a meeting once a month with trainers and owners. These meetings are considered to be reasonably effective.

Ross Bradfield (Flemington) commented that there now seems to be less reliance on grass surfaces and more work on artificial surfaces. The move to other surfaces in preference to grass is in a transition phase and is becoming very important at the big training venues.

John Jeffs (Randwick) stated that since the construction of the "American Dirt" track there has been considerably less training on the grass. Anecdotal evidence suggested that the injury rate had declined form 10-12 injuries/day to 1-2 injuries/day since the dirt track had opened.

Alan Shuck (Queensland Jockey Club, Eagle Farm) also confirmed the success of the dirt track and the reduced reliance on the grass. The dirt track was also used for barrier trials and jump outs.

The on-going issue of tracks and injuries was raised and the difficulty in obtaining reliable data. The general opinion was that without reliable information it is difficult to make the right decisions.
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Synthetic Surfaces

Papers given at Moonee Valley, 1997

1. Paper by Lindsay Davies, Racecourse Manager, Sydney Turf Club

_Equitrack_ was introduced into Australia approximately nine years ago. My involvement with the product commenced in July, 1989, when I commenced work at Rosehill.

That initial experience was when Sydney was experiencing very wet conditions which continued through into 1990. The _Equitrack_ at that time, and in those conditions, was hailed as the great all weather track; proving at the time to be the only really reliable galloping surface when most other surfaces were water logged, and almost unusable. Unfortunately, as time passed, it was found that the early promising results and expectations were relatively short lived, and problems arose. The problems that were encountered were further exacerbated when the company that installed these tracks, “En-Tout-Cas”, went through a change of ownership, and subsequently a change in their ability to assist and attend to the increasing problems encountered with the maintenance of the tracks.

Let us at this point look at exactly what an _Equitrack_ was, and the basis for it’s design and use. The actual track mixture is a selection of graded sands that is then blended and put through a batching process, where the sand particles are blended and coated with a mixture of polymers and oils; and then transported to the track and laid in a similar fashion to that used for hot mix bitumen. Once it is cured, which it did relatively quickly, the only preparation it required to prepare it for use was the application over it of a power harrow; which provided a cushion whilst at the same time forming a firm resilient pad to support the galloping horse. The marketing said it didn't need watering in hot dry conditions, and was water resistant and erosion free, and in its early career it lived up to those expectations.

History shows that this particular track surface, as originally laid and maintained, failed, and with the exception of the track at Rosehill Gardens, all other tracks in Australia, with the possible exception of the one at the Hayes’ property in South Australia, have been removed. At Rosehill we were faced with a situation peculiar to our track arrangements in that removing the _Equitrack_ was one thing; but replacing it with some other artificial surface in that location was another question, when one considers that all of the other artificial surfaces available required constant watering and that was not compatible with our adjacent turf racing surface.

We then perservered with the surface and fortunately found salvation through the expertise of Graham Potter who had initially worked with “En-Tout-Cas”. We had maintained contact with Graham during the difficult period when “En-Tout-Cas” were failing to meet our expectations and requirements. Graham had formed his own company and had pursued an interest in the basic _Equitrack_ product, and the concept of a reliable all weather track. The result of our association with Graham Potter is that our track is now an acceptable surface and basically meets the criteria expected of the original _Equitrack_ design. The secret to this success is the application of a product called _Viscapol_ to the track surface which we apply at six monthly intervals. The results have been particularly pleasing both in terms of how the track performs and the ease of preparing it for each days work.

I don't propose or intend to try and convince anyone that _Equitrack_ is a surface worth considering, in fact the sooner the name _Equitrack_ is eliminated the better. I am prepared to state that Graham Potter, through his company, Graham Potter & Associates, is producing a product that is definitely worthy of further consideration. The Hayes family, at their establishment at Lindsay Park in South Australia, are using the product. Having seen that track and being aware of what has been achieved with _Viscapol_ at Rosehill, I hope that Graham Potter continues to be involved with the further development of his product here in Australia. Fortunately he continues to do work for the Jockey Club in the UK and further research and development of the _Viscapol_ product is continuing there.
Why do I appear so keen to pursue interest in a track surface that many believe has been a complete failure? The answer is that the ideal all weather track has still to be produced and I am particularly attracted to a surface that doesn't require watering, is uniform and consistent in wet weather, and is resistant to water and wind erosion; and the experience we have at Rosehill to date is that Viscapol is very close to meeting that criteria.

As this paper is being presented at a conference that I will be speaking at on the subject I will reserve comments on costs and the acceptance of the track by trainers to that presentation. I look forward to the discussion on Artificial Tracks. They are a necessity as a training surface and we must encourage research and development of the right surface for our industry.

We at Rosehill tried to introduce a form to our trainers to encourage them to report to us injuries that their horses suffered when worked on specific tracks. The response has been unsuccessful. I still believe that this should be pursued because there are no statistical facts to show that injuries are sustained more or less on any surface, and that includes grass. One appreciates the reluctance of trainers to report injuries, but let us not lose sight of the fact that trainers are not reluctant to report an opinion on a track surface when the situation suits them; then why not all the time if it is going to produce factual information on the performance of track surfaces.

2. Paper by Ross Bradfield, Racecourse Manager, Victoria Racing Club

My questions are:

   Why do we need synthetic surfaces?
   What are our options for synthetic surfaces?
   What can we learn from recent experiences?

Why do we need synthetic surfaces?

   Racing in Australia is predominantly on turf,
   Training tradition uses grass as the serious work surface,
   Our training methods have closely followed English tradition, which uses large expanses of natural turf,
   Australian trainers have adapted their methods to rely on the availability of grass for fast work (usually 2 to 3 days per week),
   The use of alternative surfaces (sand, dirt, Equitrack, woodfibre and other combinations) have been mainly to provide a safe and convenient surface for "off days",
   The development of synthetic surfaces was pioneered in the UK to provide an acceptable surface during extreme winter conditions (snow, ice, etc),
   This has been extended to incorporate the possibility of conducting race meetings when otherwise a meeting would be lost because of bad weather,
   The rationalisation of training complexes has highlighted the need to provide good, safe working surfaces for an increasing population of horses. All of this needs to be achieved on a commercial basis so as not to bleed excessive funds from the industry and enhance our ability to return positive rewards to owners and maintain prize money levels,
   I refer, of course, to the large Metropolitan training complex which has access to large budgets, but at the same time smaller provincial complexes must address the same issues.

What are our options for synthetic surfaces?

   Until recently, lack of funds, fragmented horse population and ignorance of available surfaces has restricted our choices,
   Generally, up to the mid '80s, the only option was sand
Sand
Sand comes in numerous forms and is placed on a wide range of bases (from natural ground to consolidated crushed rock), usually in direct proportion to the funds available. The results are usually as spasmodic,
The correct sand on a constructed base provides an excellent work surface capable of supporting pace and fast work. The major factors are:
- Funding of the initial construction,
- The selection of material and,
- The correct maintenance procedures
Sand does not cope with consistent wet weather.

Woodfibre
Woodfibre was introduced in 1981 and was hailed as the universal solution to artificial surfaces. Woodfibre had a shelf life and put unacceptable strain on maintenance budgets. This was especially so in Australia where decomposition was accelerated by climatic conditions. The use of hardwood in Australia and softwood in the UK confused the issue, but ultimately the result was the same,

Equitrack
Equitrack failed in Australia. It involved a high initial cost and failed to cope with the range of climatic conditions which prevail in Australia from tropical, sub-tropical to temperate,
The most recent developments in artificial surfaces in Australia have been the American dirt track and Velvetrack,

American dirt track
The American dirt track has most recently been constructed in Sydney (at Randwick Racecourse), Melbourne (at both Flemington and Caulfield Racecourses), Hong Kong and Brisbane (at Eagle Farm Racecourse),
These are high budget tracks with a regular and intense maintenance programme. They are capable of supporting a very large number of horses in training and recover very quickly from the effects of rain.
The main features of the American dirt track are:
- capacity to support large horse populations,
- potential for racing (US and Hong Kong),
- reduction in stress injuries,
- consistent performance through a range of weather conditions,
- high maintenance requirement,
- the Australian dirt tracks are a mixture of selected sand blended with fine pine bark that, when matured and consolidated, provide a firm working pad for horses, with a cushion which ranges from 1-2 inches.

Velvetrack
Velvetrack is an Australian development. Darwin Turf Club installed it as their racing surface and it is used as a training track at the Gold Coast Turf Club. More recently this surface has been installed at Bendigo, in country Victoria,
The working surface consists of an oil based product combined with selected sands,
Cost is very much less than a dirt track but an annual top up of the binding agent is necessary. This annual cost, I am informed, ranges from $50,000, depending on size,
Maintenance procedures are very similar to dirt tracks.
**New Developments**
Santa Anita have recently re-constructed their turf racing surface using stabiliser turf grids. Turf grids are a group of synthetic fibres 1.5 inches (40mm) long which are mixed randomly through the top few inches of the soil profile on which turf is grown.
They stabilise the profile and eliminate or drastically reduce divoting. All the normal turf maintenance procedures can be accommodated without reducing the effectiveness of this product.
Another interesting use of turf grids (“Stabiliser Gold”) in the United States is in dirt tracks to stabilise the surface and replace silt and clay particles.
The results of both of these recent installations will be most interesting.

**What can we learn from recent experiences?**

Demands for training surfaces have changed,
More intense use of training facilities have increased the demand for improvements to surfaces (especially synthetic),
Differing requirements from area to area have increased the demand for more training surfaces and a greater range of materials,
The expectations of owners, trainers and riders are not always able to be achieved,
Comparisons of one track with another are inevitable,
Timing of a new installation is vital,
Cost control much more important now than in the past.

**Conclusion**

The Racing Industry is committed to operating on sound business principles.
The restructuring of our controlling bodies, altered financial arrangements and a rejuvenation of the racing product has placed us in an excellent position to compete for the available gambling and entertainment dollar.
In contrast to our operation of a decade ago, we see ourselves as a viable, high quality entertainment package capable of competing with other forms of entertainment and gambling.
This is in addition to our traditional role of major employer and custodian of a diverse and complex Industry/Sport.
All of this has put tremendous demands on the facility Manager to:
- provide high quality turf for more meetings,
- provide high quality training surfaces for large horse populations
Our challenge as Managers is to strive to improve our performance, recognise the commercial aspects of our Industry and seek out new and innovative techniques to match the demands on us.

**3. Paper by Ian Chivers, Racing Solutions**

As outlined by Ross Bradfield in his paper to this conference, synthetic surfaces of all types have been used as an alternative to grass surfaces for the purpose of conducting training. A range of materials and means of maintaining them have been developed over the years. My aim in this paper is to provide information on the initial capital costs and maintenance requirements of most of the surfaces as a means of comparing them. In this paper I will not comment on the quality of the surfaces provided, but will allow this to be discussed at the conference.

For the sake of comparison I have also included the costs for the construction and maintenance of both a sandy-loam based grass track and for the same grass track constructed using a sand stabilising material.

In all cases, the numbers derived are based on actual construction and operating costs for these types of surfaces in Victoria and New South Wales. I accept that climatic conditions in other places will vary these results, but I believe that the general range of costs are within all likelihoods and that valid comparisons can be made.
<table>
<thead>
<tr>
<th>Surface</th>
<th>Capital Cost ($ per sq m)</th>
<th>Yearly maintenance ($ per sq m)</th>
<th>Longevity (No of years)</th>
<th>Potential usage (days/week)</th>
<th>Annual cost per day of use per sq.m.</th>
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<td>7</td>
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</tbody>
</table>

4. **Panel Discussion**

The question was asked what is a perfect surface. There are many variable and different people that have different definitions. It would be generally described as "a firm surface with a little bit of give".

Because of the high demands on tracks by trainers there is a need for synthetic tracks to cope with the high usage. In general the expectations of owners/jockeys/trainers are too high.

Artificial tracks are seen as very important for situations where there is limited water available. In particular, sands treated with polymer coatings are seen to have an important place in racing/training. Examples of such surfaces include: Vicopol, Velvetrack and Equitrack. In comparison, the American Dirt tracks require a considerable amount of water.

The question was put to the panel whether they believe that synthetic surfaces were trying to mimic grass or providing an alternative to grass. If available, trainers would use grass every day of the year. Due to horse numbers, it is impossible to provide sufficient grass of reasonable quality - therefore the introduction of synthetics. Ideally, synthetics should have similar characteristics to turf if possible. Synthetics provide an all-weather alternative of consistent quality. Trainers probably need to adjust training regimes to adapt to the specific characteristics of particular surfaces.
There was some debate over the costs of maintenance of synthetic tracks and their longevity. This highlighted the lack of available and critical information for decision making. There are also no measures or parameters that quantitatively describe track conditions and can be used to assess the condition of alternative surfaces.

There is a need to keep records on usage and horse injury:

How does the track manager know if an injury was sustained on his track given that the horse in question could have trained on any number of different tracks during the week?

Do trainers run their horses too hard on training tracks and do they race injured?

Are we in a position to tell the trainer what to work their horses on, on any given morning?
Do Hard Training Tracks Cause Horses to Go Shin Sore?

by Allison Lloyd, Faculty of Rural Management, University of Sydney – Orange. Melbourne,2000

Abstract

Shin soreness is a major cause of wastage in the Australian racing industry, occurring in up to 80% of 2 year old horses. This wastage represents a significant economic loss each year. Previous studies have identified exercise speed and track shape as the two most significant risk factors in the development of shin soreness.

This study looks at track hardness as a risk factor and uses a cone penetrometer to measure the amount of force required to push a probe through the profile of various racing and training tracks. This force is a reflection of the hardness of the track, and this data is used to objectively measure different training and racing tracks. Horses which are trained on these same tracks have lateral radiographs taken regularly to monitor bone changes that may lead to the development of shin soreness during training. Other risk factors to be assessed by this study include the horse's exercise intensity and frequency, the training track used, the curvature of the corners, the rider and the rider's weight, the age of the horse and the sex of the horse.

Background

Racing has been called the sport of kings, and is one of Australia's most economically important industries (Bailey,1998). Australia produces the second highest number of thoroughbred foals in the world and the racing industry is reported to contribute $2,400 million dollars to the gross domestic product (ACIL,1992). Million dollar two-year old races, such as the Golden Slipper, encourage owners and trainers to prepare horses to race at an early age when their bones are still developing. It is no wonder then that shin soreness has become one of the most common causes of lost training days for thoroughbred racehorses (Bailey,1998).

Studies have shown that around 80% of all 2 year old thoroughbred horses go shin sore in their first race preparation and that subsequently 34% of these horses will go shin sore a second time (Jeffcott, McCarthy, Buckingham and Davies,1991; Buckingham and Jeffcott, 1990). USA research found the incidence of shin soreness as high as 91% in horses that remain in uninterrupted training (Stover,1987). The most common treatment for these shin sore horses is rest, with most horses being spelled for between 1 and 3 months (Bailey,1998). Statistics show that more than 50% of horses that are trained to race as 2 year olds do not make the track until they are 3 year olds, due to the occurrence of shin soreness. It is not surprising then that shin soreness is now so highly regarded as an important research area.

What is Shin Soreness

Shin soreness, which is also called dorsal metacarpal disease, is a painful condition with associated bone damage, that afflicts the front (or dorsal) surface of the third metacarpal bone (cannon or MC3) (Jeffcott et al,1991). Shin soreness is most common in young thoroughbred horses during their first race preparation, with the current school of thought suggesting that "too much too soon“ is the most important factor. Clinical signs of the condition show as pain when the shin area is touched, and affected horses often show lameness and a reluctance to stretch out at the gallop. At this early stage, the pain will usually subside with suitable stable rest. As the condition worsens, shin soreness shows up radiographically as areas of new bone deposition and callus formation at the bone surface. In extreme cases shin soreness can lead to fracture of the cannon bone.
Normal Bone Physiology

Bones are dynamic (live) and will adapt to stresses placed on them. Three forces can act on a bone. These are: tensile (pulls the bone apart); compressive (pushes the bone together) and shearing (one part slides/glides with respect to another) (Davies, 1995). Bones may be loaded in tension, compression, torsion (twisting), bending or any combination of these, but is strongest in compression (Evans, 1957).

The horse has the ability to alleviate forces placed on the forelimb by flexing through the shoulder and fetlock, but regardless of this, the cannon bone still has to take the vertical compression (Piotrowski, Sullivan and Colahan, 1983). It has been shown that the compressive force in MC3 is equal to the force on the hoof from the ground, plus the tensile forces in the tendons. Thus, the resulting force on the cannon bone can be 4 to 6 times the force on the hoof (Cheney, Liou and Wheat, 1973).

Bone will adapt to the stresses placed on it by changing both size and shape, and by adapting its material properties (e.g. mineralisation). The material properties of bone are changed mainly by internal remodelling, while changes in size and shape are achieved by adding or removing bone (Currey, 1984). Strain is the change in the linear dimension of the bone following the application of an external force (Davies, 1995). Studies have shown high strain and strain rates will stimulate bone formation (Rubin and Lanyon, 1984) and that the resultant size, shape and mechanical properties of the bone are a compromise between the effects of all the forces experienced by the bone in its normal function.

Experiments have also shown that bones require a stimuli, such as fast exercise, to begin modelling, but that further stimuli above this level does not increase the level of bone response (Davies, 1995). Thus, once the bone has received enough stimuli (fast exercise) to start modelling, further fast exercise (stimuli) does not increase the level of response from the bone. Remodelling occurs when bones are repetitively loaded and repetitive stimuli is required to begin remodelling. Remodelling initially reduces the bone's strength while the porosity is increased and the mineralisation is decreased. With continued stimulation such as "too much (exercise) too soon", damage occurs and the repair processes are activated (instead of the remodelling process) and woven bone is formed (Davies, 1995). Woven bone is weaker due to its random structure. Such is the case with shin soreness.

Effect of High-speed Exercise on Bone

High-speed exercise results in enlargements to the dorsal cortex, the area susceptible to shin soreness. Studies show it is the high strains that occur during fast exercise that stimulate bone modelling of the dorsal cortex (shin area) (McCarthy and Jeffcott, 1992; McCarthy, 1989). This adaptation causes the shin to deform less in subsequent exposures to fast exercise. (Since the shin area thickens, the bone is stronger and able to withstand the higher stress placed on it). As only small amounts of fast exercise (or other stimuli) are required to initiate bone modelling, many trainers exceed requirements, causing damage and subsequent shin soreness.

In one experiment, as little as 30 strides at a speed greater than 12m/s repeated four times in five weeks was sufficient to produce a maximal bone response (Davies, 1995). This speed level equates to around 17 seconds/furlong (slower than 'evens'). Continued or increased fast exercise beyond this results in bone damage, which initiates a bone repair response. This is when the lower quality woven bone is laid down over stressed areas on the dorsal cortex, which is then susceptible to further damage and shin soreness as the stimuli continues (Davies, 1995). Young horses appear more susceptible to shin soreness than older horses, as mature bone is not as sensitive to exercise stimuli as younger, growing bone (Forwood and Burr, 1993).

Although bones are dynamic, fatigue results from the formation and growth of microscopic cracks that develop within the bone each time the bone is strained. This is similar to bending a piece of wire back and forth until it breaks. The greater the strain, the fewer cycles required to cause fatigue damage to the bone tissue (Davies, 1995). Thus, a horse exercising at gallop speed requires less number of strides to
cause bone fatigue than the same horse travelling slower at 'three quarter pace'. The fatigue strength of bone is often much less than the static strength, and hence, failure (fracture) may occur in fatigued bones at strains well below those normally required to cause a fracture. It has been suggested that muscle fatigue also results in increased bone strain, so horses which are tired are more susceptible to damage than their counterparts (Yoshikawa, Satoshi, Santiesteban, Sun, Hafstad, Chen and Burr, 1994).

Track Effects on Bone

The horse's limb decelerates immediately following impact with the ground, and accordingly, maximal compressive strains and strain rates increase with increasing speed. Strains also increase when horses are exercised around turns, and thus it is likely that racetrack shape will influence the development of shin soreness (Davies, 1995). Higher strains have been recorded in the outside limb of a horse travelling around a corner, which is most likely due to counteracting the effect of a centrifugal force. Shin soreness usually occurs in the non-lead forelimb and studies have shown that higher strains have also been recorded in the non-lead forelimb, this being the first forelimb to land during the canter or gallop, therefore receiving higher strains than its counterpart (Davies, 1996).

Bone strains increase when the horse becomes tired (fatigued), and it is likely that track factors which influence the time to fatigue of the horse will have a significant influence upon the development of shin soreness. One study showed that the incidence of shin soreness was much greater in a group of thoroughbreds trained on dirt, as compared to a similar group trained on a wood fibre surface (Moyer, Spencer and Kailish, 1991). This study, however, was limited in that it relied completely upon the subjective opinion that there was a difference in the two tracks.

Other research has shown increased injuries on fast (hard) and heavy (sloppy) tracks which resulted from increased horse fatigue (Rooney, 1983). On fast tracks, horses travel at a greater speed and tire quickly, and on heavy tracks, more effort is required to maintain speed causing faster fatigue. Tracks with a soft base and more compliant surface cushion (but not sloppy) reduce the injury potential in thoroughbreds (Rooney and McCrae, 1983). Many of these studies have relied on a subjective assessment of track condition, rather than an objective categorisation of track conditions.

Track condition is usually described as the "going" and is a combination of factors that determine the interaction between the ground and the horse's hooves and limbs. Soil moisture levels have a strong influence on the "going". However, other factors which have an influence upon the reaction between the horse and the ground include: soil type, soil structure, root mass, grass species, turf management practices and temperature (Neylan and Stubbs, 1998). Some Australian racetracks have implemented the use of the racetrack penetrometer to describe the "going" or track condition. It is a device used on less than 50% of metropolitan racetracks and measures the penetration depth of a set rod which is hit with a known weight dropped from a known height (Neylan and Stubbs, 1998). The use of this type of penetrometer is limited and results have been unreliable with a poor correlation to soil moisture content (Uren and Scott, 1982). However, the penetrometer is still the best tool presently available to establish traction conditions experienced by a horse on a particular day (Field and Murphy, 1997).

The penetrometer used in this project is the Rimik CP20 Cone Penetrometer which records the force required to push the probe through the profile. Thus hard tracks require more force, soft tracks require less force. This provides an analytical guide to the hardness of the soil, both on the surface and throughout the profile. The benefit of this type of penetrometer over the racetrack penetrometer is that the soil structure through the profile can be measured, providing information about potential shock absorbency, and thus, limb strain. Factors affecting soil hardness (and thus penetrometer data) such as soil moisture, rainfall, temperature, soil type and structure and turf type and management procedures will be considered.

Thus the question to be answered is: Does the hardness of the training or racing surface cause a horse to go shinsore?
Previous study has identified the major cause of shin soreness as training at a speed that produces too much strain for adequate adaptation of the cannon bone. Track shape (or the tightness of the corners) has also been shown to be significant (Davies, 1995). Research has identified different incidences of shin soreness when horses are trained on different tracks (Moyer, Spencer and Kailish, 1991) however, no categorisation or objective assessment of these tracks has been made, and this is the primary aim of this project.

Methodology

"Epidemiology is the study of disease in specified populations and the quantitative assessment of the factors that determine its occurrence, distribution and severity." (Reid, 1998). The primary aims of these types of projects is to identify the cause of disease or the factors that predispose to disease so that preventive measures can be implemented on the basis of the identified risk factors.

Horses used in the project are in commercial training with local racehorse trainers (Wagga Wagga and Flemington). This provides for observation of thoroughbred racehorses in their normal environment. The major selection criteria for a horse to be included in this project is that it is previously untrained (no preexisting bone damage due to training). Project horses can be of any size, age or sex.

A lateral radiograph of the cannon bone is taken at the beginning of the horse's training program, and then regularly throughout the training program until the horse either goes shin sore or races free of shin soreness. The initial radiograph is used to assess any pre-existing bone damage, and as a comparison for when bone adaptation due to training becomes apparent. Other data to be collected on each project horse includes the horses' age, sex, trainer, rider, season, the daily exercise performed and the track upon which the horse is worked.

Measurements recorded from the radiographs include the total thickness of the bone (T), the width of the medullary cavity (M), and the thickness of the dorsal (D) and palmar (P) aspects of the third metacarpal bone. This data is then used to calculate the radiographic index (R1). RI = [(D+P)/M] x [D/P] as described by Larkin and Davies (1996). In this study, horses below 2 on the index went shin sore during work at half speed or even just cantering, whilst horses that gradually reached indexes of 3.3 to 4 raced free of shin soreness.

Track assessment is made using penetrometer readings taken from each training track (Murrumbidgee Turf Club has 2 sand and 1 grass training tracks and Flemington has 1 dirt, 1 combi and 1 grass training track) both across the width of each track and around the circumference of each track. The penetrometer itself takes readings at nominated intervals (15mm) through the soil profile, thus providing three-dimensional data on the hardness of the soil for each track. Recordings made over the period of study will also produce temporal data. Other track information that is recorded includes rainfall, soil moisture, soil profile and track management procedures. This data will provide information about which factors significantly affect soil hardness on these tracks.

Data Collection and Analyses

Statistically, this is a longitudinal cohort study as it refers to a group of animals being followed over a period of time. The subjects being studied experience disease naturally, without intervention. That is, the horses in this project are in commercial training and not a controlled experiment. Multivariable statistical techniques will be used to assess the relationship between a response variable (shin soreness) and many explanatory variables (horse age, sex, rider, track, season, exercise level) allowing the effect of each risk factor to be determined, while controlling for all others (Thrusfield, 1995).

Analysis of the data will determine the relative risk (the chance of shin soreness being present when a certain factor, such as track type, is present) compared to the odds of shin soreness being present when the factor is absent. The attributable risk is also important in dealing with shin soreness risk factors. This
determines how much of the incidence of shin soreness is due to a certain factor. Attributable risk can then be converted to the attributable fraction, which measures the proportion of shin soreness that can be attributed to the factor being studied. This will indicate what level of shin soreness can be removed by removing the risk factor (the benefit in controlling the factor) (Robertson, 1998). Thus, if the hardness of a track has a high risk factor, then softening the track will significantly reduce the level of shin soreness.

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I would like to thank Charles Sturt University for their continuing support of this project.

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Training Tracks (Non-Turf) Workshop
Morphettville, 1999

“What are the important considerations for non-turf training tracks?”

Issues
- Surface options and their pros and cons
- Maintenance needs of various surfaces
- Maintenance cost comparisons
- Horse capacity comparisons

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<tr>
<th>Surface</th>
<th>Pros</th>
<th>Cons</th>
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<td>- cheapest option</td>
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<td>- all weather</td>
<td>- wind loss</td>
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<td>- susceptible to rain if left open</td>
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Summary

Grass
There is a high demand for grass training tracks with the general opinion that this is the preferred surface for training. With the improvement in synthetic (non turf) surfaces, the demand for grass is likely to be less at some training centers, however, for most training facilities, grass is the only option for fast work.

Grass training tracks require a high level of maintenance because of the intensive use and the damage that occurs, particularly in divot replacement and filling. This work is labour intensive and the cost of manpower is usually the greatest single cost in maintaining a grass training track.

The costs of maintaining a grass training track are high when compared to the income derived from training fees. It would appear that only 50%-60% of the maintenance costs are being recovered. The communication between trainers and the clubs operating the training facility is usually minimal. While some clubs have initiated a formal meeting process to discuss issues related to the tracks, the main method of dealing with trainers is on an ‘as needs’ basis. This is usually in response to specific complaints from particular individuals.

There appears to be no preferred method of constructing grass training tracks. The configuration or geometry of training tracks has been discussed and various options opinionated. The consensus of opinion would seem to be that grass training tracks should at least not have a reverse camber as horses will not run on that.

Synthetic
Synthetic surfaces have continued to be developed in Australia to meet the increasing demands of trainers and the increasing population of horses in training. While most “serious” training is on grass, particularly for fast work, synthetic surfaces have been traditionally used on those days when grass is unavailable. Synthetic surfaces provide a safe and convenient surface for “off days”.

Synthetic surfaces have been developed mainly in the UK, for periods when weather conditions (i.e. snow, ice etc) do not permit the use of grass. This has been extended to incorporate the possibility of conducting race meetings, when otherwise a meeting would be cancelled due to wet weather. There have been a number of different synthetic surfaces introduced into Australia from overseas, however, Australia’s hotter and drier climate has often resulted in the failure of such surfaces.

Synthetic tracks generally have a high capital cost and the maintenance cost for polymer based tracks can also be high when compared to grass tracks. While the cost aspects are still highly speculative, synthetic surfaces have the potential for much greater usage and therefore the annual cost per day of use per square metre is potentially lower than grass tracks.

The occurrence of horse injury due to training surfaces is still not well understood due to the lack of information. While some Clubs have attempted to survey trainers and to keep records of injuries, there is strong resistance from trainers to provide this information. There has been very little research on the performance characteristics of synthetic surfaces and their relationship to injuries. This lack of quantitative data makes it difficult to assess the merits of the options available.
6. Devices For Assessing Racetrack Conditions

by John Neylan, AGCSATech (formerly Turfgrass Technology), and Arthur Stubbs, Primary Tasks.
Doomben, 1998

Background Studies

The horse racing industry in Australia, is a multi-million dollar business that relies on high quality turf surfaces on which to conduct its race meetings. In a previous industry survey and workshop (RIRDC report TGT.1A) it was determined that a reliable method for evaluating turf racing surfaces was required. Track ratings influence the decisions of trainers, jockeys, owners and the gambling public on the winning potential of particular horses on a particular day. When race times and horse performance indicate that the track rating is not a true reflection of the track condition, then there is widespread criticism and controversy. The industry survey showed that only 7 out of 48 race clubs used a mechanical device to determine track conditions. The remaining clubs rely on experience to subjectively judge the track ratings. This is how the majority of race clubs in Australia rate their tracks and in this context, a multi-million dollar industry is using estimates to identify racing conditions.

At the industry workshop (RIRDC report TGT.1A) one of the three highest priorities for further research and development rated by attendees was the investigation of available equipment and techniques for evaluating grass racing surfaces. This project has involved a comprehensive review of world literature pertaining to the development and utilisation of various mechanical and other devices for the measurement of parameters of grass racetrack quality and "going". A detailed analysis of available data for the penetrometer and the Clegg Impact Soil Tester used at four racetracks was also undertaken.

Horse and Track Interaction

There have been numbers of research studies investigating horse injury as related to the racing surface. However, only a few of these have quantified the surface properties. The measurement of risk of horse injury or horse performance involves several interacting factors of which track condition is one. These include; the type of surface, surface conditions, track configuration, season, location on the racecourse, racing speed, the jockey and pre-existing injuries. Track conditions are influenced by soil type, bulk density, porosity, compaction and moisture content. The interaction of the horse with the track can be described in terms of impact force when the hoof strikes the surface and shear force as the hoof grips and pushes off the surface. Impact forces have been quantified using accelerometers and penetrometers, and shear forces with the use of shear vanes. The dynamic properties of the racing surface affect the gait pattern of the horse and affect the shock absorbing mechanisms in the limbs of the horse. Any reasonable measure of track conditions or "going" must be defined in terms of how it affects the horse.

In measuring the “going”, an understanding of the relationship between the horse and the surface is required. A galloping horse imposes vertical and horizontal forces on the track surface and the horse responds to how much energy is returned to it via its limbs. That is, a good track provides the horse with good traction, with high shock absorbency and minimal surface deformation. There is a relationship between increasing firmness of the surface and winning race times in that the firmer the surface, the quicker the horse can run. However, on very hard surfaces, the energy returned to the horse is such that the horse will slow down in order to minimise the stress and risk of injury.

Strain gauges have been fitted to horses to measure the impact forces experienced by the horse and will be a necessary device in relating what the horse "feels" to track conditions.
Penetrometer & Clegg Impact Soil Tester

The penetrometer and the Clegg Impact Soil Tester are the only devices in regular use for defining track surfaces, however, their usefulness is still in debate. The penetrometer was developed in France and measures surface hardness being related to the depth that the horse’s hoof penetrates into the track surface. Penetrometer readings have shown a good relationship with winning race times in New Zealand and France, however, it has still failed to achieve universal acceptance.
The Clegg Soil Impact Tester (CIT) is an accelerometer type device that measures the hardness of the surface which is related to the deceleration of a failing weight on impact. The CIT has been adopted for measuring other sporting surfaces, however, the current device is unsuitable for racetracks. The CIT is a light weight device and on racetracks is disrupted by surface irregularities that may not be experienced by the horse. The use of other accelerometer devices, using heavier weights and dropped from a greater height, have shown good relationships between what the horse experiences, horse injury and race times. The CIT would appear to have a potential use by incorporating a heavier weight (about 2.5kg) dropped from a greater height (about 1 metre). The Jockey Club (England) has researched the use of several devices, including accelerometers and load transducers worn by the person rating the track, but as yet has not succeeded in developing a device with sufficient sensitivity over all track ratings.

Track rating data was collected from Moonee Valley, Rosehill, Canterbury and Doomben racetracks where the penetrometer and CIT have been used to provide a quantitative measure of track conditions. The data was compared with winning race times and there exists a moderate to good correlation, i.e. as the track became firmer, race times were faster. Where all the raw penetrometer data was available, the first shock value was compared to winning race times and the correlation was considerably higher than when all three shocks are combined and averaged as is the current Australian technique. This would confirm that the penetrometer has not been used in Australia as it was intended compared to the methods used by the French and New Zealanders. The inclusion of the 2nd and 3rd shocks was originally intended to provide a correction factor for the first shock which is supposed to represent what the horse experiences. With each shock the variation increases and therefore introduces greater error into the final value.

The penetrometer would appear to be a useful tool for determining the variability of the racing surface and the underlying soil profile. Monitoring this variation would provide track managers with useful information on changing track conditions in relation to track bias and scheduling renovation procedures. The level of acceptable variation still needs to be determined and could be done by relating the variation to what a horse fitted with strain gauges experiences.

The data from the CIT was evaluated and found to be highly variable. The combination of a light (0.5kg) hammer weight and short drop height resulted in minor surface irregularities having too great an influence on the results. The CIT is still worth investigating with the use of a 2.25 - 2.5kg weight dropped from a height of one metre.

It would appear that it may not be possible to develop a simple device, meeting all the criteria for rating tracks, when dealing with such a large number of variables. There is scope to undertake further work with the penetrometer and CIT, however, the inclusion of soil physical characteristics may also be necessary. Any future work must incorporate what the horse is experiencing when racing under a range of track conditions.
BHM Machinery is the Australian and New Zealand distributor for the *Soil Reliever Deep Tyne Aerator*.

The *Soil Reliever Deep Tyne Aerator* is the only specially designed aerator on the market and is well accepted in the racing industry.

With features such as, on the go depth adjustment, straight tyne arms and split driven crank, it makes the *Soil Reliever* fast, efficient and effective, with very low maintenance.

There are five models of *Soil Relievers* to choose from:

The **SR48** is ideal for golf courses to aerate greens, tees, surrounds and fairways.

The **SR60, SR72** and **SR80** models are all designed for heavy duty aeration on race tracks, playing fields and fairways, yet are delicate enough to aerate greens.

Then there is the **Rhino 54 Aerator**, which is designed specifically for the aeration of greens and tees.

All **Soil Relievers** have the ability to fit both solid and coring tynes.
7. Racecourse Machinery & Maintenance Requirements

by Bill Heraghty, Bill Heraghty Machinery, Brisbane. Doomben, 1998

Ideal Machinery List for the Industry

1. Tractors
   Specifications:
   Modern MFWD with low pressure turf tyres.
   Attachments
   Air-conditioned cab and quick hitch loader.
   1 x 70-80 hp.
   1 x 50-60 hp.
   3 x 35hp.

2. Hydraulic Tip Trailers
3. Deep Tyne Aerator
4. Grader Blade
   Harrows –for trainingtrack

5. Aerator
6. Roller
7. 3PL Mower
8. Mowers
   Front Mower - for the track
   HD Ride-ons - for spectator areas and gardens
   Front Mower and HD Ride on - for training track
   W B Cylinder - for saddle enclosure and pristine areas
   Walk behind Mowers
   Wide Area Cylinder Mower.

9. Vehicles
   6 x 4 gators
   Cleaners
   Gardeners
   Locating from site to site
   Track maintenance men
   Utilities
   Water Truck
   Tip Truck

10. Hand Held
    Back Blowers
    Multi purpose Saw
    Chain Saws
    Hedge Trimmers

11. Sprayers
    Rogers 6 m Boom Tank 600 litre

12. Blowers
Criteria for Buying and Selling Machinery:

1. It must work
   It should not be a case of, "it will work if... or "Maybe if we do this, it might work".
   Too often, people buy a product because it is cheaper. They try to convince themselves the
   product is better than it really is, only to face reality and disillusionment some time later.

2. It must be safe
   I have employed a lot of operators and I know from experience that they all know "Murphy's
   Law" backwards.

3. It must be cost-effective
   We would all like everything at once - but we need to stick to priorities.

4. It must be reliable
   Reliability should be measured by in-built design - not by compulsory day-to-day upkeep and
   maintenance!

Using our four criteria on machinery - it must work, it must be safe, it must be cost-effective, it must be
reliable - the following outlines a life cycle for the equipment.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Min Time (years)</th>
<th>Max Time (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractors</td>
<td>4-5</td>
<td>8-9</td>
</tr>
<tr>
<td>Trailers</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Deep Tyne Aerator</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Blower</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Grader blade</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Harrow</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Aerator</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Front Mower</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>HD Diesel Ride Ons</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>WB Cylinder Mower</td>
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<td>4</td>
</tr>
<tr>
<td>Gators</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Water Truck</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Tip Truck</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Hand Held</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Some of you probably haven't ever owned a new tractor. Therefore, you may query a suggestion to sell a
tractor after 4 years, when you currently own one at least 20-30 years old! The reasons for upgrading are
technology, which now changes every 4-5 years, and opportunity.

The Race Clubs here today who are Sales Tax exempt have a 22% discount on all other Sports Turf
Industries, Golf Clubs, etc., and a growing industry of mowing contractors who contract to Councils and
Government. High activity equipment with low hours in good mechanical order is worth good dollars,
either by trade-in or direct sale. This enables the seller to minimise maintenance costs, to always have the
latest technology and to generally have equipment that is still under warranty.

Ideal candidates are:
   30-60 hp. Tractors on wide turf tyres and cab
   Front Mowers, 1000-1500 hours, 4WD
   HD diesel ride-ons, 500 hours
   Deep tyne Aerators
Where there is not a demand for low-hour equipment, you're better off maximising the life of the machine until reliability and cost effectiveness are no longer valid. Products under this banner are:

Gators - demand is growing as people decide what to do with them.

Hand-held products - there is no value in keeping in service a hand-held product that is worth an operator's daily or weekly pay, resulting in poor productivity.

**Main Challenge facing the Racecourse Manager**

There's no doubt the greatest challenge facing you is *compaction*. While Golf Course Superintendents worry about golfers walking on golf greens, compaction on racetracks comes from three sources – Horses; People; and Machinery

<table>
<thead>
<tr>
<th>Source</th>
<th>Effect</th>
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<tbody>
<tr>
<td>Horses</td>
<td>From 18.5 psi to 1.5 tonnes</td>
</tr>
<tr>
<td>People</td>
<td>8.5 psi (Constant)</td>
</tr>
<tr>
<td>Machinery (Tractors)</td>
<td>Refer MF 135</td>
</tr>
</tbody>
</table>

**The Racecourse "Special", the MF 135**

I'm not singling it out, but I've yet to visit a racetrack that doesn't own one! The MF135 started life as an MF35 TE 20 and is still with us today as an MF240. It weighs approx. 2000 kg. (4409 lbs) fuel, operator etc.

The MF135 was designed in an age when its purpose was to work in an agricultural environment, pull ploughs, harrows, etc. To maximise performance in those days, manufacturers designed the weight around the rear on the tractor area, the drive wheels. The desired ratio was 90% rear, 10% front wheel. Some failed and only got 80 R / 20F. Massey, however, designed the weight around a light front axle.

The basic wheel equipment consists of: 6.00 x 16 front tyres and 12.4 x 28 Rears (on either worn agricultural tyres or turf tyres).

A 12.4 x 28 agricultural tyre has a contact area of 119 square inches. (Contact area divided by weight = ground psi). MF 135 weighs 4409 lb. Total contact area is 119 x 2 = 238 squ. ins.  

\[ \text{Ground PSI} = \frac{4409 \times 90\%}{238} = 18.5 \text{ PSI} \]

With 12.4 x 28 turf tyres the contact area is 125 squ. ins. Total contact area is 125 x 2 = 250 squ. ins.  

\[ \text{Ground PSI} = \frac{4409 \times 90\%}{250} = 17.6 \text{ PSI} \]

With a Howard 6 foot Rollamower weighing 903 lb, and a 50% weight transfer of 451 lb, total weight becomes 5763 lb.  

\[ \text{Ground PSI} = \frac{5763 \times 90\%}{250} = 23.05 \text{ PSI} \]
Alternatively, with Ford tractors, say the FW Ford 60-70 hp at Ford 5610. Ford Tractor chassis design has remained constant up until the recent New Holland/Fiat release. Therefore, Ford from the 4000, 5000 were basically the same up to the 6640 series.

The Ford 5610 2WD fitted with 16.9 x 28 Rear Turf Tyres has a weight distribution of 80% rear / 20 % front. Tractor weighs 6922 lbs. Tyre contact area is 190 squ. ins.

\[
\text{Ground PSI} = \frac{6922 \times 80\%}{190 \times 2} = 14.5 \text{ PSI}
\]

Compaction is the No. 1 Enemy

- Horses don't like hard tracks - bad for their health; the result is foot damage.
- We are trying to promote a manicured, inviting new place to be - an environment with lush pastures.
- Compacted areas result in poor drainage, poor root growth, weed proliferation, etc

Technological Answers

John Deere produced a line of tractors that were primarily for non farm use (NFU’s). The weight distribution was altered on a 45:55 ratio. Reverser transmissions, new tractor speeds and hydraulics were designed for loaders.

Tyre manufacturers were commissioned to redesign tyres that could support a 60-85 hp tractor with Ground PSI of a maximum of 8 PSI, but down to 3.8 PSI. Galaxy tyres are an example, using Truck Rubber Compound instead of Ag Tyre Compound, with a 6-ply construction and strengthened side walls to take low pressure.

Air Cabs were introduced into compact and compact utility tractors for greater operator comfort and safety.

Front Mowers

A little over 10 years ago, the only manufacturers of Front Mowers were Toro, Jacobsen and the Yazoo. Their only use was as a trim mower. John Deere entered the market with the 935 and for the first time added things like power steering and operator comfort.

When Front Mowers became more operator-friendly, people started using them in areas they weren't designed for, so manufacturers had to respond. Kubota entered the market with 4WD and changed Front Mowers for good. To stay in the business, John Deere produced the JD1145, with a mow speed of 8.5 mph.

Deep Tyne Aerators

In the late 80's, Redixim in Holland released the Verti-Drain. Many of you here have used or own one. They took an Italian mechanical Spade, the Tortelli, and adapted tynes, to replicate the operation of a garden fork on turf. This introduced a new way to aerate large areas with a minimum surface disturbance.

In 1996, I saw the Soil Reliever for the first time. The two gentlemen who designed and built the Soil Reliever had been in the Turf Aeration business for 15 years and were among the first to buy Verti-Drain as contractors. They began to sell them. They decided to build a purpose-built Aerator - one that would:

- Operate behind a Standard transmission tractor
- Not vibrate as much in hard conditions
- Have lowered maintenance
- Operate faster
- Operate with a hydraulic top link
A contractor with a 1.2m Soil Reliever and 30hp Kubota Tractor, aerating the first 8 metres to depths from 6" to 8", lapped the Doomben track in approximately 1 hour 15 minutes on average and completed 1.5 hectares in approximately 10 hours of operation.

**Transporter**
John Deere has evolved the Gator over the past 10 years to an efficient cheap workhorse “people mover”. They are simple to operate and maintain and replace heavier, more expensive vehicles and of course have low ground pressure.

**Sprayers**
Doomben has just taken delivery of a Rogers 6M covered boom. This spray boom will spray in winds up to 40 mph without risk of drift to the close housing community around the racetrack.

The Sports Turf Equipment Industry is very competitive and to stay in front of each other, manufacturers are now introducing new technology changes every 4 years compared to 8-10 years. CAD Computers and World Wide Communications have played their part.

John Deere has a “Team” Manufacturing system and I am sure their competition does as well. A team has the responsibility to design, bring to manufacture one product, and then to monitor its performance and design its replacement.

We have a computer system with John Deere called DTAC. Dealers worldwide log in with a problem looking for solutions. John Deere download their inquiries weekly and monitor these for constant product improvement.

This results in new ideas and new technology, eg, Tractor Mounted Blowers; Rogers Covered Boom (for protection of neighbours); Electric Gators (for use around horses)

**Financing Machinery**

*There is the traditional method of paying cash.*
This system works well until the building manager puts up a case that a refurbished bar or new TV’s and antennas or toilets would be better than a new aerator or tractor or sprayer ... Then ... you resubmit for next year!

*Then there is the begging bowl system*
This appears unique to the racing industry. This is where a Race Course Manager submits a case to a Racing Board (in the capital city, I presume). The Board will decide to gift to you above every other race club in the State - the same request for the same equipment.

**Leasing**
What we have found over the past couple of years is that Clubs are turning to leasing. In the U.S. John Deere Credit has developed a package where a club will lease a machine for a sum of money, for a set period, and at the end of the period the machine is returned and a new one taken for similar money. The advantage is that the club knows exactly what its costs are.

Let’s do some sums on some essential equipment and some other line ball equipment:

<table>
<thead>
<tr>
<th>Model</th>
<th>Term</th>
<th>Payment</th>
<th>Residual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Deere 1070M</td>
<td>48 mths.</td>
<td>$492.00</td>
<td>$11,600</td>
</tr>
<tr>
<td>John Deere 5510M Cab/H R Trans/ Galaxy tyres</td>
<td>60</td>
<td>$460.00</td>
<td>$8,700</td>
</tr>
<tr>
<td>Rogers Covered Boom</td>
<td>48</td>
<td>$942.25</td>
<td>$22,200</td>
</tr>
<tr>
<td>Electric Gators</td>
<td>60</td>
<td>$880.00</td>
<td>$16,500</td>
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</table>
(Structured - 1,2,3 Payments per year)

2. John Deere 1145 Front Mower $26,000

<table>
<thead>
<tr>
<th>Model</th>
<th>Term</th>
<th>Payment</th>
<th>Residual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1145</td>
<td>48</td>
<td>$509.89</td>
<td>$7,800</td>
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</table>

3. Agrimetal BW 360 Blower $8,500

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</tr>
</thead>
<tbody>
<tr>
<td>BW360</td>
<td>60</td>
<td>$160.37</td>
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<tr>
<td>BW360</td>
<td>48</td>
<td>$173.92</td>
<td>$2,550</td>
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</table>

4. Agrimetal Tuff Vac 5000 $37,000

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<th>Term</th>
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<th>Residual Value</th>
</tr>
</thead>
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<tr>
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<tr>
<td>5000</td>
<td>60</td>
<td>$651.00</td>
<td>$11,100</td>
</tr>
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</table>

5. John Deere 6 x 4 Gator $10,900

<table>
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<th>Model</th>
<th>Term</th>
<th>Payment</th>
<th>Residual Value</th>
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</thead>
<tbody>
<tr>
<td>6X4</td>
<td>148</td>
<td>$213.77</td>
<td>$3,270</td>
</tr>
</tbody>
</table>

6. Soil Reliever SG 48 $26,000

Soil Reliever SG 60 $37,400
Soil Reliever SG 72 $38,800
Soil Reliever SG 80 $44,000

<table>
<thead>
<tr>
<th>Model</th>
<th>Term</th>
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<th>Residual Value</th>
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<tbody>
<tr>
<td>SG 48</td>
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<td>$457.53</td>
<td>$7,800</td>
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<td>SG 60</td>
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<tr>
<td>SG 72</td>
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<tr>
<td>SG 80</td>
<td>60</td>
<td>$774.28</td>
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7. Rogers Boom $10,500

<table>
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<tr>
<th>Model</th>
<th>Term</th>
<th>Payment</th>
<th>Residual Value</th>
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<tbody>
<tr>
<td>6 METRE</td>
<td>60</td>
<td>$184.77</td>
<td>$3,151</td>
</tr>
</tbody>
</table>

**Cost Effectiveness of Leasing**

*Labour*

Monthly Cost = $3,040 + Super @ 6% ($182.40) + On Cost @ 25% ($760) = $3,982 for 160 hours
Hourly Rate = $24.87

*Gator*

Lease Rate @ $213.77 / 160 hours = $1.34 + Maintenance Cost @ $2.11 per hour
Hourly Cost = $3.44

*3PL 360 Blower removing grass clippings compared to labour*

To rake this track takes one day with 5 people. Total Labour Cost = 8 Hours x (5 x $24.80) = $620 per day
A Blower on the back of an MF 135 taking the same time (blowing time would probably equal mowing time). Cleaned once a month. 
One operator $24.80 \times 8 = $198 + MF135 @ $10.00 per hour = $80 + Blower (Monthly Lease) = $160
Total Cost = $438

Aerator
On Monday and Tuesday morning a contractor aerates approximately the first 8m of the track. Aerates from 4” to 1 0” with 1/4” Tynes.
Time = 10 Hours. Average of 1.25 hours per lap. Total Area covered is 1.5 hectares. Rate 15c to 20c per sq. metre.
Total Cost = $2,250 - $3,000

Cost of leasing and operating machine (based on 10 hours):
Labour $248.00 (10 hours x $24.80) + MF135 @ $100.00 + SG48 (Monthly Lease figure) @ $457.00
Total Cost = $805.00

Aerating entire track in 3 days once a month:
Labour 25 x $24.80 = $620.00 + MF1 35 @ 25 x $10.00 = $250.00 + SG48 @ $457.00 + Tynes - 1 Set @ $116.00
Total Cost = $1,343.00

I don't know the area of a racetrack but I'll guess at say 4-5 hectares. To control aeration of 4 hectares @ 0.15c per sq metre, an application basis is $6,000.00 per application. 5 hectares is $7,500.00. That's folding money out the door.

Let's go back to the SG 48 and look at costs out the door. We are employing someone to do something, sometime. So we are up for salaries. We own the MF 135 so we have to pay for fuel and when it breaks down.
Our cost out the door is x $457 = $5,484.00 + 116 = $5,600.00

If you only used it once a year and at the end of the day you still own it you have the unit available to do aeration when you want to and can do it.

Gentlemen, what I have tried to do this morning is to present some alternatives and try and look at machinery from outside the circle. I'm sure all of you have a special unique set of circumstances. You don't own a MF135, but you have a MF165. Your contractor does a special and 10 cents or 12 cents per sq. metre. All I ask is you look at your situation from a different perspective from time to time.
Appendix I

Data collection forms

Monitoring, measuring, recording and analysing all factors affecting racetrack maintenance and performance, including user assessment, are fundamental to sound racetrack management practices.

A sample of data collection forms currently in use at Doomben, Elwick and Santa Anita racecourses are provided as an example.
## Irrigation and Weather Data

<table>
<thead>
<tr>
<th>DATE</th>
<th>Evaporation (E-mm)</th>
<th>Rain (R-mm)</th>
<th>E - R (mm)</th>
<th>ET (mm)</th>
<th>Irrigation (I-mm)</th>
<th>Max Temp</th>
<th>ET To Date</th>
<th>Irrigation To Date</th>
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</thead>
<tbody>
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<td>1</td>
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| CHEMICAL application date | PRODUCT |
| RATE                     |         |
| Comments                 |         |

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# TRACK PERFORMANCE REPORT

**TRACK**

**COURSE PROPER**

**TRACK REPORT ISSUED**

TIME: 

DATE: 

**RACE MEETING DATE**

---

**TRACK RATINGS**

<table>
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<tr>
<th>Rating</th>
<th>Description</th>
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<tr>
<td>3.0 - 4.0</td>
<td>GOOD</td>
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<tr>
<td>4.0 - 4.5</td>
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<tr>
<td>4.5 - 5.0</td>
<td>SLOW</td>
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<tr>
<td>&gt; 5.0</td>
<td>HEAVY</td>
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**PENETROMETER READING**

Average: 

**TRACK RATED**

---

**RAINFALL**

Overnight: 

2 Weeks: 

**IRRIGATION**

1 Week: 

**RAIL POSITION**

---

**LAST TIME IN THIS POSITION**

---

### PREVIOUS MEETINGS

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<th>Track Rating</th>
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<td>Burners / Signs / Flags Up</td>
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# Raceday Assessment Form

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<td>Total amount up to raceday for week:</td>
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<td>OR mm</td>
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<th>Soil Type:</th>
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<th>Soil Amendments (eg. nation, fibres, matt):</th>
<th>Drainage: Sub Surface Laterals:</th>
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<td>Heavy</td>
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| Jockey Assessment: | |
|--------------------| |

| Course Manager Assessment: | |
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| Veterinary Assessment: | |
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<th>Cause?</th>
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<th>Cause?</th>
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Signed: ___________________________  Date: ___________________
Appendix II

References

Proceedings of the 1996 Australian Racecourse Managers’ Conference at Rosehill

Proceedings of the 1997 Australian Racecourse Managers’ Conference at Moonee Valley

Proceedings of the 1998 Australian Racecourse Managers’ Conference at Doomben

Proceedings of the 1999 Australian Racecourse Managers’ Conference at Morphettville

Proceedings of the 2000 Millennium Turfgrass Conference at Melbourne