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This month, Tracey Maddison, BIGGA's Membership Services Officer, welcomes over 90 new members to the Association, and gives some important renewal information

Renew your membership for increased benefits!

In September, over 90 new members joined BIGGA and became part of the largest greenkeeping association in Europe. Membership has grown in strength and now boasts almost 7,200 members. If your expiry date is 31 December 2000 or 31 January 2001, your renewal pack will be with you this month. Read it! It contains important information on improvements to your benefits.

Watch out for your renewal envelope dropping through your letterbox later this month.

New benefits for members for 2001 include a health care scheme. You can choose a plan that most suits your lifestyle, you elect to pay a weekly or monthly sum to cover you for the cost of minor medical treatments not normally covered by the NHS. In this way you will always have the funds to pay for dental treatment, glasses or contact

lenses, physiotherapy and a whole host of other treatments including consultation by a specialist. By ensuring that you have the funds you can ensure that you have the treatment when you most need it as opposed to when you can afford it.

Be a BIGGA winner!

Also, in your renewal pack will be two yellow application forms, pass them on to your greenkeeping colleagues, who are not already members, and encourage them to become part of BIGGA. Each month, if you introduce one new member, your name will be placed into a draw to win £50 worth of vouchers to spend in a popular high street store.

Watch out for December's Membership Update for details on another exciting new membership benefit.

BIGGA welcomes...

Scottish Region

Steven J Amott, Ayrshire
Craig Davidson, East
Graeme Davidson, East
Logan J Ferguson, East
William Fulton, Ayrshire
Kevin A S Neilson, East
Ian J Williams, East
Steven Wilson, Ayrshire

Northern Region

Richard Allen, N West
Matthew J Bulmer, Northern
Anthony J Carr, N East
Peter L Cotgreave, N West
Grant Dougherty, N West
Stephen Eccles, N West
Andrew D Ellis, Northern
John P T Evans, N West
John Grimes, N West
Ethan Moses, N West
Michael Rogers, Northern
Andrew M Stingsby, Northern
Tony Smith, N West
Richard G Wilson, N West

Midland Region

Andrew Bailey, Midland
Philip Chiverton, BB&O
Peter Hobbs, Mid Anglia

Devlyne Hodgkiss, Midland
Martin Huckle, Mid Anglia
Melwyn L Labram, Mid Anglia
Darren J Reeve, Mid Anglia
Anthony P Rudge, Midland
Adrian Sharratt, Midland
Robert Spikings, Mid Anglia
Graeme W Stevenson, Midland
Stefan J Timworth, E Midland
Christopher J Yeomans, Mid Anglia

South East Region

Paul M W Bacon, Surrey
David S Badham, London
David Beale, Essex
Jason J Bradbury, Surrey
Steve Brennan, London
Peter J Brooker, Surrey
Mark D Couch, Surrey
Tim Daniel, Sussex
Andrew Duffy, Sussex
Meyrick J Field, Surrey
Neil Gibson, London
Chris Guy, E Anglia
Nicholas Guy, E Anglia
Richard P Hare, Essex
Richard J Hayward, London
Robert J Kemp, London
Michael G Kyriacou, London
Gary Leggatt, Sussex
Robert J Newson, Essex
Matthew Short, Surrey

Barry J Smith, Surrey
Rob S Thomson, London
Kevin Westney, London
Michael Wilding, E Anglia

S West & S Wales Region

Andrew J Brown, S Coast
Graham C Burbidge, Dev & C'wall
Ryan J Church, S Coast
Danny P Corson, S Coast
Matthew D Driffiths, S Wales
Patrick Jackman, S Wales

Northern Ireland

Lee M Cartmill
Mark Cassidy
Damien Doherty
Adam Kelly
Scott Otley
Irwin Robinson
Ivan J Ward

Republic of Ireland

Donal Kearney

International Members

Michael Ortegren, Sweden
Dirk Josef Thelen, Madeira
Shawn W Semones, USA

John Berry, Australia

Associate Members

John A Souter, Central
Kevin Kinzer, E Midland
Nigel Kirkup, E England
Dawn Magan, E England
Jonathan T Wood, E Midland
A Atilla Demirsoy, Essex
David Maclaren, London
Terence Welch, London
Paul Burroughes, S Coast
Stephen Clifford, Dev & C'wall
Jeremy A Dunn, S West
Gareth D Jenkins, S Wales

Student Members

Darren Kilby, London
Roxanne E Roberts, S West

Check out December's edition for October's new members!



BIGGA's Education and Training Manager, Ken Richardson reports on the latest education and training developments

INDIVIDUAL LEARNING ACCOUNTS

What are they?

To enable all of you to help pay for education and training, the Government have introduced a scheme called Individual Learning Accounts. Supported by a range of Training Providers, the Accounts are designed to make it easier for you to start and continue learning.

Who can have an account?

Accounts can be opened by anyone aged 19 or over.

How do I open an account?

You need to obtain an application form by phoning 0800 0725678 in England or 0800 100900 in Scotland or 01792 354126 in Wales or ask your college or other training provider. You should return the completed form to the Individual Learning Account Centre which handles your account. The form asks if you have opened an account before, asks for information on citizenship, asks for your date of birth, personal information and information on your own learning.

What do I get from an account?

Once you have opened an account you will be able to claim discounts on a range of learning, eg. If you are one of the first million to open an account, you will get a £150 contribution

towards the cost of your course if you contribute £25. If you are not in the first million account holders, you can claim a 20% discount on a wide range of work related learning up to a maximum of £100 in any one year. You may even be eligible for an 80% discount, up to a maximum of £200, on some types of learning eg. computer training courses and key skills in maths.

How will the scheme work for me?

Many of BIGGA's Regional Training Courses could, in the future, be eligible for ILA discounts, which together with BIGGA's Education and Development Fund subsidies to BIGGA members, will ensure quality training provision at even lower costs.

Are there any courses that are not eligible for discounts?

You will not be able to claim discounts on:

Graduate or post graduate courses.
Courses that you have started already.
Learning for which you have already received government help.
Leisure or sports courses.

How can I find out whether the course that I want is eligible for discounts?

You can find out by asking the training provider eg college, BIGGA etc. or

by phoning the Individual Learning Account Centre on 08000 725678

How do I claim discounts?

Once you have opened your account, you will then need to contact your chosen learning provider. The learning provider will then:

Check your account details with the Individual Learning Account Centre.
Confirm your enrolment and eligibility for a discount.
Take the payment for your own contribution.
Claim your discount entitlement from the Individual Learning Account Centre.

Don't delay, contact your Individual Learning Account Centre, request an application form and look for discounts on your learning courses.

BIGGA HOUSE and Regional Training Courses

Following a very poor response for this year's BIGGA HOUSE Courses, we have been forced to cancel all advertised courses except the Making Budgets Work week which runs from 16 to 19 October.

Regional Courses cancelled are Making Meetings Work on 22/23 November at Stirling. Interviews and Appraisals on 11/12 December at Huntingdon and Ornamental Horticulture on 29 November at Ham Manor.

Making Budgets Count at the East

Cliff Hotel, Bournemouth will now be held on 15/16 February 2001 and not on 19/20 February 2001

The Learning Experience 2001

Bookings have started to arrive at BIGGA HOUSE for the Learning Experience 2001, which, once again, will be held with the support of Textron Turf Care and Specialty Products, in Harrogate, North Yorkshire.

Starting with the National Education Conference and Workshop Programmes which are being held in the Majestic Hotel on Monday 22 and Tuesday 23 January 2001, the Learning Experience continues with the joint BIGGA/SRTI Course, Running Golf Courses in the 21st Century, held in the Crown Hotel, followed by the BTME Seminar Programme, which starts in the Royal Hall on Wednesday 24 January.

Full information on all of the Harrogate Learning Opportunities can be found in the Learning Experience brochure which can be obtained from BIGGA HOUSE.

Please note that due to a production problem there is an error on the Bed and Breakfast section of the Learning Experience booking form. The dates should read: Sunday 21, Monday 22, Tuesday 23, Wednesday 24 and Thursday 25 January.



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With the recent fuel crisis now behind us, but only perhaps for the time being, Richard Comely, Product Manager at Textron's Specialty Products division, looks at the case for alternative fuels for golf course applications

Fueling the economy?

Legislation, pressure groups and technology, not to mention the recent fuel crisis that affected the UK and some parts of mainland Europe, are just some of the factors driving research and development into the use of alternative fuels. Before looking at how alternative fuels will impact upon the golf course, it is perhaps pertinent to look at some of the influences that will affect their use over the next decade.

A recent report by Dr. Peter Harrap, entitled 'Electric Vehicle Markets, Players and Forecasts', provides a fascinating insight into the predicted growth of various markets up to the year 2010.

This report and other factors, such as the commitments from the authorities in Paris to have low or zero emissions for many new delivery vehicles in the French capital by the end of 2001 and London's mayor, Ken Livingstone, pressing for a fleet of electrically-powered buses as soon as possible, all help fuel the argument that alternative sources for vehicle

power will gather momentum in the coming years.

Dr. Harrap's report states that the global market for electric vehicles was US\$14.02 billion in 1999 and will grow by 11% by the end of 2000 to US\$15.5 billion, representing a total of 7 million electric vehicles in use worldwide. In the next decade he predicts that the global market for electric vehicles, including manufacture and after-sales, is expected to exceed US\$48.3 billion.

So, from these brief statistics and the undoubted pressure that will come from governments to reduce emissions, together with advances in battery technology, we can see that one of the major sources of alternative fuel for vehicles will be electric power.

How will this affect golf course operations here in the UK?

At present the main use of electric vehicles is restricted to golf cars and utility vehicles and here in the UK the split between petrol and electric is

60% and 40% respectively. However, in Europe, the trend is very much the other way with 76% electric and 24% petrol. In America they have embraced the use of electric power and there we see a 62%-38% split in favour of the electric buggy over its petrol driven cousin.

So why is there this disparity as we cross the English Channel and the Atlantic?

In the United States, they believe that the electric golf car offers better efficiency and more flexibility than the petrol-driven version. For example, the electric-powered E-Z-GO TXT golf car with Precision Drive System (PDS) allows course operators to specify a golf car with very specific performance characteristics, optimised to suit the topography of their individual courses. This golf car is now available with three options - All Terrain, Mild Hill and Steep Hill, and can be programmed to ensure optimum efficiency relative to the design of the course.

From an economic standpoint, the electric golf car has added benefits. The solid-state technology of the drive system and high efficiency of the electric drive motor reduces maintenance costs over the lifespan of the vehicle. Improved battery technology means that batteries now have a minimum lifespan of at least three years. And then there's the fuel storage problem. Ideally, petrol should be stored in underground tanks and although at present some clubs turn a blind eye to this HSE requirement, the laws governing storage are bound to be strengthened and enforced more enthusiastically in the future. In terms of security, petrol can be stolen, whereas electricity is pilfer-proof.

Looking at the comparative running costs of petrol versus electricity for golf cars, it makes interesting reading. The figures given below have taken into consideration that overnight electricity charges can vary between £0.50p and £0.70p depending on the tariff and that a golf car requires an average of 6kW hours of electricity. The petrol figures are based on a golf car using between 0.5 and 1 litre per round. However, it is pertinent to recall that charging facilities have to be installed, but this could be offset by the reduced maintenance requirement of the electric buggy.

Electricity

£0.70p per night for 7 nights a week =
£4.90 per week.

Petrol

14 litres per week at £0.81 per litre =
£11.34 per week.

That's a saving of £6.44 per week per car. Using the above figures and looking at a fleet of 10 golf cars we see an initial annual saving of £3,348.80 (£64.40 x 52).

It's not only the golf car market where growth is foreseen. Electric power is now being introduced on course maintenance equipment, especially mowers. Again America is leading the way with stricter laws on noise pollution being implemented and existing laws being enforced more diligently. In the UK, with increased pressure on our green areas for housing development, more and more golf courses will have residential properties adjacent to their borders.

California, one of the most environmentally aware states in America, is introducing legislation restricting the use of petrol-powered equipment within 250 feet of residential property between 9 a.m. and 5 p.m., Monday to Saturday and banning all use on Sundays and holidays. This will have major implications for course operators who are aware that homeowners will not tolerate being woken at dawn or have their weekends polluted with the noise of greenkeeping teams going about their business.

All the major turf equipment manufacturers are looking at producing mowers that are quieter and cleaner. Some are investigating the use of dual fuel, using lean-burn, highly efficient petrol engines for moving between greens and using electric power for cutting. Here in the UK, Textron Turf Care is the only company currently marketing an electric ride-on greens mower.

Sales of the Jacobsen E-Plex II have seen a steady increase in the past two years and one of the major advocates of the electric-powered mower is the course management company, American Golf (UK) Ltd, which has recently included three units in a major order for new equipment.

Commenting on the inclusion of the E-Plex II's in their latest round of orders, Laurence Pithie, Director of Maintenance, said, 'We have been impressed with the two E-Plex

Below: The ST350 Workhorse proves that LPG can now be used successfully to power smaller, air-cooled engines, ideal for golf course utility vehicles





Above: Advanced technology allows course operators to specify a golf car with very specific performance characteristics, optimised to suit the topography of their individual courses

machines that we currently operate and these three additional units will be deployed at The Hertfordshire, Addington Court and Sunbury which all have residential properties close by. I must admit that I had reservations initially, but they have exceeded all our expectations. Battery life is good, giving us a very acceptable operational range, and when it comes to maintenance there's no oil filters, oil changes and absolutely no question of accidental hydraulic oil leaks onto the greens.

Having looked at golf cars and mowers, lend themselves to electric power? Textron have recently adapted their

E-Z-GO Industrial 875 platform to take a series of alternative body derivatives. The platform model now offers the option of a Chelsea refuse collection tipping body, a tipping litter cage for the collection of refuse sacks or a water bowser complete with lance and 12 volt pumps for watering hanging baskets - all could be adapted for use on tomorrow's golf course.

However, it's not just electric power that provides an alternative to petrol and diesel. LPG technology has been around for many years mostly for use in industrial applications, i.e. powering forklift trucks in warehousing and logistic operations. Also, car manufacturers such as Volvo have introduced bi-fuel powered vehicles that can run on LPG, then switch to conventional fuel if the need arises.

At Saltex this September, Textron introduced an LPG conversion kit for their popular ST350 utility vehicle, which is powered by an 11hp, 350cc twin cylinder, four-stroke petrol engine.

For many years LPG has not proved popular when used on small, air-cooled engines, the cost of the installation often outweighing the savings to be made in fuel. As petrol prices continue to rise LPG is becoming a viable alternative even in relatively low cost vehicles such as golf cars.

Using LPG results in greatly reduced emissions, the fuel is cleaner and safer to use, the period between oil changes can be increased as less carbon is produced in the combustion cycle and the fuel can be stored in bulk tanks above ground, unlike petrol, and it is unlikely to be a target of pilfering.

LPG will appeal to many golf courses that are not on mains gas and already use this fuel for heating and cooking. When purchased in bulk it can be very cost effective and, like red diesel, taxation is lower for off road use offering further significant savings.

These LPG conversion kits are also available for E-Z-GO Workhorse utility vehicles and the petrol-driven TXT golf cars.

Calor Gas has produced some interesting comparative figures for petrol and LPG powered golf carts. In order to provide an accurate comparison the calorific value of LPG has to be taken into account and 10% extra LPG consumption is included in these figures to account for this factor. Also the costs exclude VAT, as most clubs will be VAT registered and claim the tax back.

Petrol
20 litres per week at £0.70p per litre =
£14.00 per week

LPG
22 litres per week at £0.22p per litre =
£4.84 per week

That's a saving of £9.16 per week per car. Using the above figures and looking at a fleet of 10 golf cars we see an initial annual saving of £4,763.20 (£91.60 x 52). Even allowing for the rental of a 2000 litre tank and electric pump at £283.92 (£5.46 x 52), the annual saving is still £4,479.28. Definitely fuel for thought for golf course operators!

Although the recent fuel crisis has highlighted our dependence on petrol-powered products, Textron has been researching and developing turf maintenance equipment that runs successfully on alternative fuels. High levels of excise duty, tougher regulations on emissions, stricter environmental laws and greener purchasing policies by multi-national organisations will all ensure that the quest for alternative fuels remains on the political agenda. It is an issue that golf course management will ignore at their peril and, most probably, to their cost.

*Electric Vehicle Markets, Players and Forecasts is written by Dr Peter Harrap and published by Footnote Publications. Tel: 01256 862163

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Web-tastic!

The December edition of Greenkeeper International will be introducing a new-look Web page. Included will be editorial on new and interesting web sites to browse within the industry. There will also be a classified Web listing where you can advertise your product, service or golf club.

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Diane, Cheryl or Meredith on: 01347
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Terry Crawford manages the only inland 36 hole development in Northern Ireland and, as Scott MacCallum found out, he has some interesting views on greenkeeping...

MR BIG



Above: Terry Crawford aboard his new Millennium Putting Green

Terry Crawford stands on the balcony of Clondeboye's imposing modern clubhouse surveying his latest project - the Millennium Putting Green which was due to be opened officially on the upcoming Captain's Day.

"I suggested a putting green for the area in front of the clubhouse and the Council agreed that I should put a small one in... but everything has to be big with me," said Terry, with a smile.

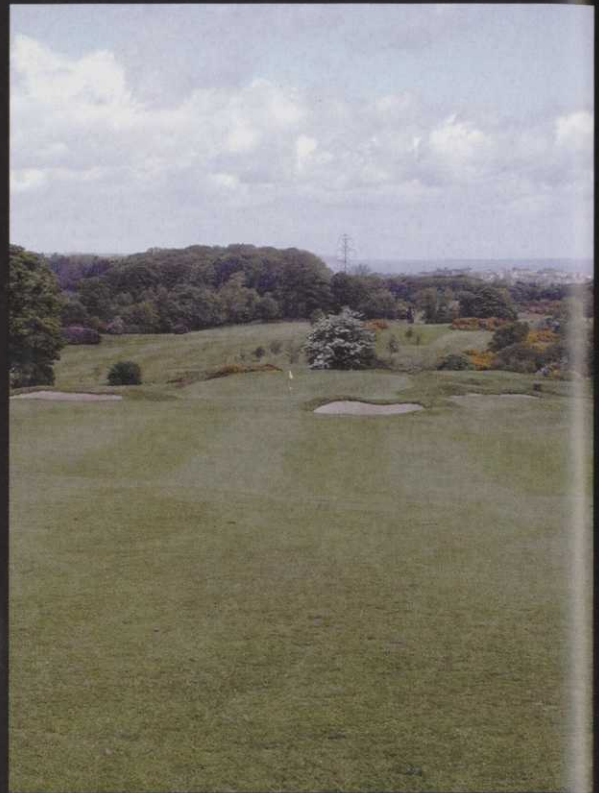
"I've given them three different characteristics. A links area so you can practice breaking putts, another which is typical Clondeboye with a lot of subtle borrows and then an area which is completely flat," he explained, at once showing that a greenkeeper who possesses golfing knowledge can be a real asset in so many ways.

Now a 36 hole development, just a few miles from Belfast, the Duffern and Ava courses offer differing chal-

lenges to member and visitor alike but Clondeboye was originally an 18 holer with nine coming for each of the present two 18s and was built 20 years ago for the princely sum of £33,000.

The Duffern is more manicured and takes up a greater expanse of ground while the Ava is more heathland and much more rugged.

"We've been ranked highly in inland course categories but with so many multi-million pound developments in Ireland we have had to work hard to



Above: The results of some of the alterations made to the course recently

Far right: One of Clandeboye's excellent greens and aprons

Below: The team



maintain our standing," explained Terry, who is a former Chairman of the Northern Ireland Golf Greenkeepers Association, and now an active BIGGA member.

To fulfil this ambition £1.8 million has been spent on the new clubhouse for the 1500 members, £180,000 has been allocated for new maintenance facilities and Howard Swan was commissioned to make alterations to the Duffern course.

"I met Howard, along with Simon Gidman, on one of BIGGA's training courses and liked him very much. I brought him over to do a critical analysis of the golf course but it kind of just went mad," chuckled Terry, as he recalled the occasion.

"The reason I got Howard in was to bring the golf course up to a higher standard by lifting and levelling tees to give better sightings to the fairways and to introduce new bunkering."

Having done some work on the course, including tightening up the entrance to the 8th hole Howard met with the Council members and his potential brief grew enormously.

"The Council members met him in this very room and before he left he was bringing the 9th hole back to the clubhouse, building new practice facilities and all but designing new golf courses."

The meeting ended with Howard drawing up five different options which the members will decide upon in due course.

Terry has been at the club for 10 years and in that time has also used his own methods of improving the courses.

"Golf is becoming easier with the modern day equipment so the cheapest way to improve the course and to make it more difficult is to grow in the rough. The next cheapest option is to put in bunkers and the most expensive way is to redesign and rebuild the greens. We've gone down the cheapest route first to try and make the course more difficult," explained Terry who has also spent around £30,000 on mature trees for the course.

Terry admits he is extremely fortunate to be at a golf club which is so forward thinking.

"I can put my hand on heart and say that in my ten years here they have not refused me one thing. Not too many Head Greenkeepers could say that after 10 years."

"I feel that I'm probably a very lucky greenkeeper but you must work hard to keep yourself in that position."

"The one word that I use about management philosophy, and when I'm talking to younger greenkeepers, is consistency. That's the name of the game."

"If a golfer is on a green and it's not in peak condition there is no use me saying to him 'If you were here last week when we had the Irish Amateur they were brilliant.' He'd say 'But, Terry, I'm here today and I have guests with me.' You must be consistent

and have no ups and downs."

With that in mind everything is done seven days a week at Clandeboye. Bunkers are done seven days a week, greens are cut seven days a week while fairways and tees are cut three times a week.

"We have two teams but with so much golf is is sometimes difficult so sometimes we'll go out and blitz one course and then blitz the other," said Terry.

He has noticed that disease has become more apparent in recent years.

"We're getting more traffic and the climatic conditions are changing. We're not getting season now or rather we can get all four seasons in one day. We're not getting frost to kill off disease. In fact, although we're high up, we've had no frost at all this year and we've only closed the course perhaps three times this year. It is golf 365 days a year and people will play more competitively for a turkey than they will for an Open strokeplay event."

"I'm using much less fungicide than I was five years ago and 50 times less than when I started - aeration is the name of the game. The preventative approach is better than having to find a cure," said Terry, who was the youngest Head Greenkeeper in Northern Ireland and the first to go to Elmwood College.

"I never thought I'd be here at Clandeboye. In fact I never thought I'd get out of Newton Stewart (his first job) because in the past people would go to a golf club and stay there but I could see the challenge of a 36 hole club and this is the only 36 hole parkland club in Northern Ireland."

He is proud of the fact that he has turned out four Head Greenkeepers and is keen to promote the young greenkeeper.

"I've only got a couple of guys over



30. I'd rather they came to me without experience so that I can train them in the way I want them to do a job and they don't have bad habits."

Terry is very much an inland greenkeeper and enjoys a bit of banter with his links land colleagues.

"I think there is more of a challenge working on a parkland course whereas links courses look after themselves really. Alan Strachan (Royal County

Down) wouldn't come and work this because he'd think it was too hard," laughed Terry.

"Greenkeeping to me is very basic and the more basic you can think about greenkeeping the better you will get on. This high tech greenkeeping that you hear about will never last. It gets too advanced and you can't control what is happening."

Terry, who advises at four other

clubs has strong views on what is expected of the modern day greenkeeper.

"Committees and councils used to be full of older guys but now it is the younger members who sit on these and they demand that the course is at its best every day. If it isn't they look to make changes. If you are at the top and you're not producing what they are demanding the next

step is out the door. The first person to be targeted is the Head Greenkeeper.

"Golfers used to expect. They don't expect any more. Golfers demand. That is the difference nowadays."

In Terry's case he delivers more than is demanded as with the case of his state-of-the-art putting green in front of the clubhouse.

Another wet September/October and once again drainage is foremost in Head Greenkeepers'/Course Managers' minds. A fact borne out by the number of enquiries for the installation of land drainage systems to golf course fairways says Nigel Wyatt, Director of M J Abbott Ltd.

THE DRAIN GAME

Any golf course which is excessively wet will impose limits on the availability and quality of play. In addition a wet golf course will affect grass growth and development restricting maintenance operations.

The benefits of good drainage include the following:

Removal of excessive moisture and the lowering of the water table.

Improvements to the quality, firmness and durability of the turf increasing wear tolerance.

Quicker drying of the ground surface, extending possible playing and maintenance time.

Subsequent prevention of damage to the soil structure through machinery and pedestrian traffic.

Prevention of erosion and collection of surface water run off.

Improvements to the soil structure and air movement within the soil preventing restriction of plant root development.

Increased root development and improved bacterial action.

Increased capillary moisture in dry weather promoting improved drought resistance.

Higher soil temperature earlier and later in the year giving a longer growing season.

The need for good drainage on golf courses cannot be disputed.

Courses built upon naturally free draining soils may only require basic drainage systems to carry water from features within the golf course, i.e. golf greens, tees, bunkers and hollows within fairways.

Courses built on heavier soils will require much more work and expenditure to provide satisfactory drainage.

A primary piped system is the basis for all golf course drainage. The introduction of drainage systems incorporating perforated plastic pipe will play an essential role in the part of removal of excess water quickly.

The piped systems usually consists



of a main drain installed at the edge of a fairway within the semi rough/rough with lateral drains connecting into the main drain at 5-10m spacings in a grid formation depending on the slope of the land. Lateral drains should always cross the natural slope of the land in order to intercept ground water moving naturally through the soil. If ground levels demand it the main drain may be installed within a fairway with lateral drains connecting into the main in a herringbone formation.

Main drains - typically 200mm-100mm diameter depending upon the catchment area should be laid within trenches excavated cleanly to a depth of 900mm-600mm generally. Pipes are laid on a formed trench bed. The pipe is then surrounded and the trench filled to within 150mm of the surface with an approved clean stone. The stone is generally blinded with grit and the trench filled to the surface with an approved coarse sand, ensuring no migration of fines through the gravel. It is common to use a capping mix of rootzone to dress the trenchlines, providing a medium in which grass seed can grow enabling quick establishment.

Lateral drains typically 100mm-60mm diameter depending upon the spacings should be laid within trenches excavated cleanly to a minimum depth of 750mm-450mm generally and backfilled in the same manner as main drains. It is a fact that natural settlement may occur over the trenchlines, therefore continued work may be necessary in order to maintain surface levels.

There is no doubt that a piped drainage system alone can dramati-