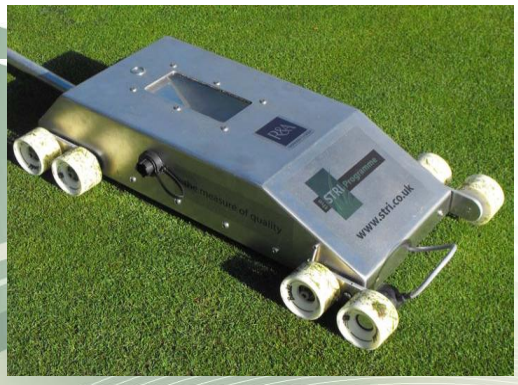
Advisory Report incorporating the STRI Programme

Royal Copenhagen Golf Club

Report Date: 15th May 2012

Consultant: Charles Henderson



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the STRI Programme
the measure of quality

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Report Title	**Advisory Report incorporating the STRI Programme**
Sports Facility Name	**Royal Copenhagen Golf Club**
Date of Visit	**25th April 2012**
Visit Objective	**To assess course maintenance strategy, measure existing performance of greens and make recommendations for on-going improvement**

Executive Summary

- Over the last few years in order to meet ever changing legislation within Denmark and the highly restrictive environment in which the club is based, the club has undergone a high level of strategic change in order to best manage greens in such an environment.

- In general the change has included creating a better growing environment for desirable grasses, introducing desirable species and encouraging these species to become dominant.

- The STRI in general terms supports the strategic direction and management of the greens and this is further detailed in the report.

- From the site assessment and measurements taken on site, the STRI feel that the club has made notable progress in line with key strategic directions.

- Species conversion outlined as a main priority for change has for the most part been achieved to a high level with the majority of fescues and bent grasses contained within the greens. It is apparent that greens can be segregated into three distinct categories which are further discussed within the report, with notably the 18th putting green lagging somewhat behind the other greens. Again these greens are specifically discussed in the report.

Putting greens poor growing environment

- In order to achieve species conversion, a reduction of organic matter and thus average year round moisture content is essential. Organic matter content within the greens averaged 23-26% and is within year round target, taking into consideration 35-30mm rainfall prior to the visit.

- Green speeds during the 2 days of testing were lower than ideal but the foundations to improve this over the forth coming weeks, as growing conditions improve, are in place. Guidelines for greens speeds are further discussed.

- Greens ball roll smoothness and trueness left room for improvement, however given winter conditions experienced in Denmark along with limited restrictions on disease control, these levels can be improved upon as discussed on site through maintenance practices such as rolling through early parts of the season.

- The levels of green firmness were excellent especially given the rainfall experienced during and directly prior to the site visit. This is the tribute to the work done leading into the last few years with regards to organic matter reduction.

- Greens moisture content especially given the rainfall experienced prior to the visit was exceptional and is indicative of an extremely positive growing environment which has been managed extremely well to date. Continued management of organic matter and on-going monitoring of moisture content will be essential in order to retain these moisture contents and encourage desirable species.

- The club and course manager and staff have a continued focus on improving the quality of the course. For the most part management of the greens programme is in place, although we have outlined some additional treatments. However, work on green surrounds should become an on-going focus in order to retain positive progress within the club.

Pictures showing uniformity of appearance in greens surrounds

- Management of fairways is heavily restricted due to the localities and restrictions. Some further guidelines to help improve the worst areas of fairways are outlined in the report along with further long term considerations.

Introduction

Royal Copenhagen Golf Club is a notorious golf club located on the outer perimeters of the city and is highly restricted in its maintenance practices within a sensitive landscape.

The course offers a unique setting upon which the clubs reputation is based.

In order to meet both restrictions from the Danish Legislation and that of the Deer Park itself, the club has undergone a programme of change over the last 4 – 6 years.

The club seeks from the STRI, further opinion on the club's existing strategic direction over maintenance of the greens and an assessment of its existing position in line with this strategic direction.

Consequently, the report includes the above information and further results from the STRI Programme to assist measuring of the course performance moving forward.

Performance and Agronomic Assessment – STRI Programme

During the visit we measured the performance and agronomic condition of the greens. The speed, smoothness/trueness and firmness of selected greens were measured to define how they were performing on the day. Additional testing was also carried out to determine the moisture content,

organic matter content and chemical status of the upper soil profile. Our aim was to conduct a thorough and accurate assessment of the greens to highlight the areas in need of attention. Selected over the 2 days were 4 greens for testing which are represented by a stronger and more development green, 2 x typical green and a green lagging behind.
Maintenance was highly affected by rainfall during the site visit and as such the results, although taken in context, were impacted upon by rainfall.

In addition, the results were collected early on in the season and the club is likely to see on-going improvement over the next 2 – 3 weeks as growth commences.

By taking measurements of the playing qualities we can accurately describe the standards being set and also compare the results against our target performance levels. Essentially, our aim is to produce a set of greens that receive approach shots correctly then provide smooth/true and well-paced surfaces for putting. It is important that the greens are performing consistently on any given day and as well as possible throughout the year. At this time of year our target ranges for the various playing qualities are as follows:

- Speeds of 7 and 8ft early in the season and 8 ft 0 in – 9 ft 5 in during the season using the Stimpmeter
- Smoothness readings of 16 – 23 mm/m using the STRI Trueness Meter™
- Trueness readings of 6 – 10 mm/m using the STRI Trueness Meter™
- Firmness readings of 90 – 110 gravities using the Clegg Impact Hammer

It is understood that if we achieve all these target figures then the greens will be performing as desired for this time of year and indeed providing excellent surfaces for play. If we are failing to hit the desired target range then recommendations will be made to help rectify the situation.

The results obtained on the day are outlined in the following table.

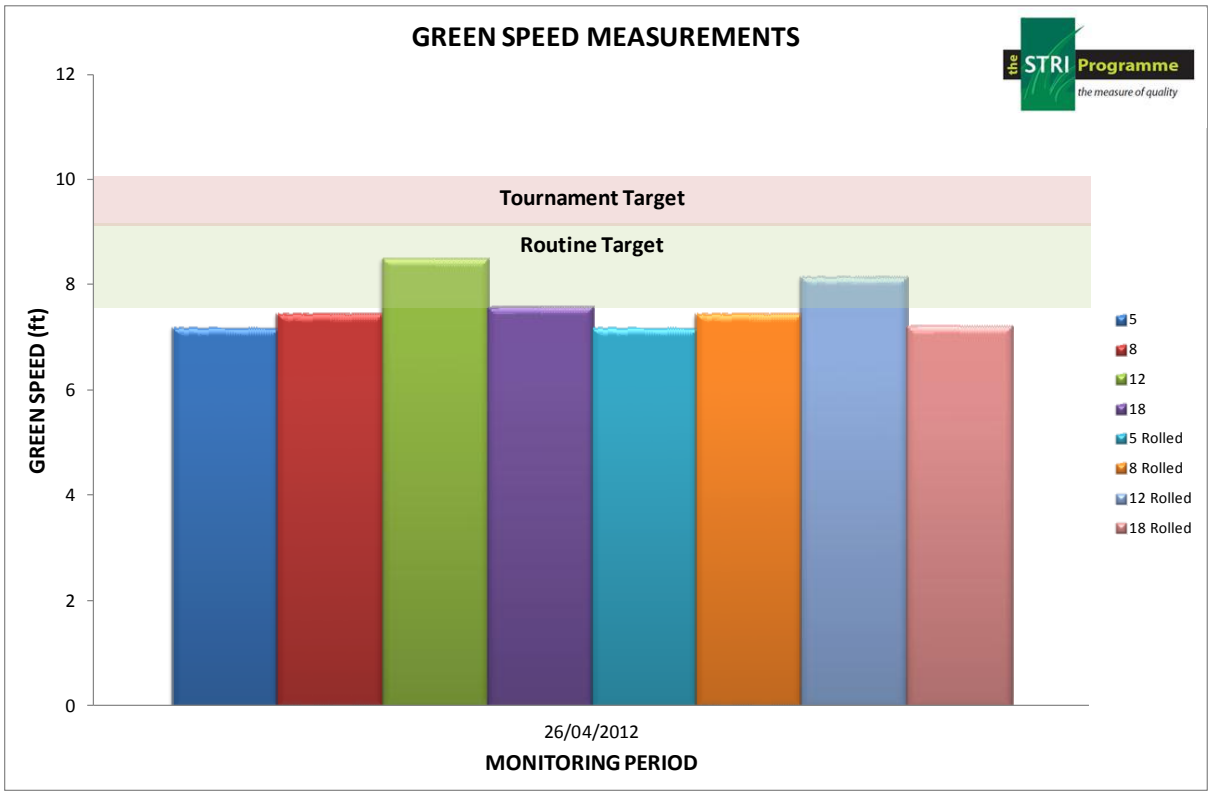
Performance Measurement Results							
Green No.	**Speed (distance)**	**Smoothness (mm/m)**	**Trueness (mm/m)**	**Firmness Mean (gravities)**	**Firmness SEM (±)**	**Moisture Content (%)**	**Moisture Content SEM (±)**
5	7 ft 2 in	25.9	9.3	84	2	25.4	0.8
8	7 ft 5 in	26.1	9.3	81	1	26.1	1.0
12	8 ft 6 in	23.9	8.1	90	2	23.1	0.6
18	7 ft 7 in	27.4	10.8	83	2	24.1	0.4
5 Rolled	7 ft 2 in	22.2	6.3				
8 Rolled	7 ft 5 in	22.4	8.4				
12 Rolled	8 ft 2 in	18.3	7.9				
18 Rolled	7 ft 2 in	22.8	9.5				

Green Speed

The speed of the greens was measured using a Stimpmeter. The speed is expressed as the average distance rolled by 3 golf balls that are delivered from the Stimpmeter ramp on a flat area of the

green and repeated in the opposite direction. The greater the distance the faster the surface is deemed to be. At least two readings were taken from each green then the results were calculated using the Brede equation to take out any slope effects.

Our target range for the speed of the greens at this time of year is 7 ft 6 in – 8 ft 6 in**.** Moving into the season this will be increased to suitable levels by the club.



Speeds for the time of year were okay and ultimately the club should decide moving forward a sensible target range for green speeds which is allocated to the seasonal variations in growth and recovery.

The club have already commenced measuring on a 2 x weekly basis which will help with management and preparation techniques moving forward.

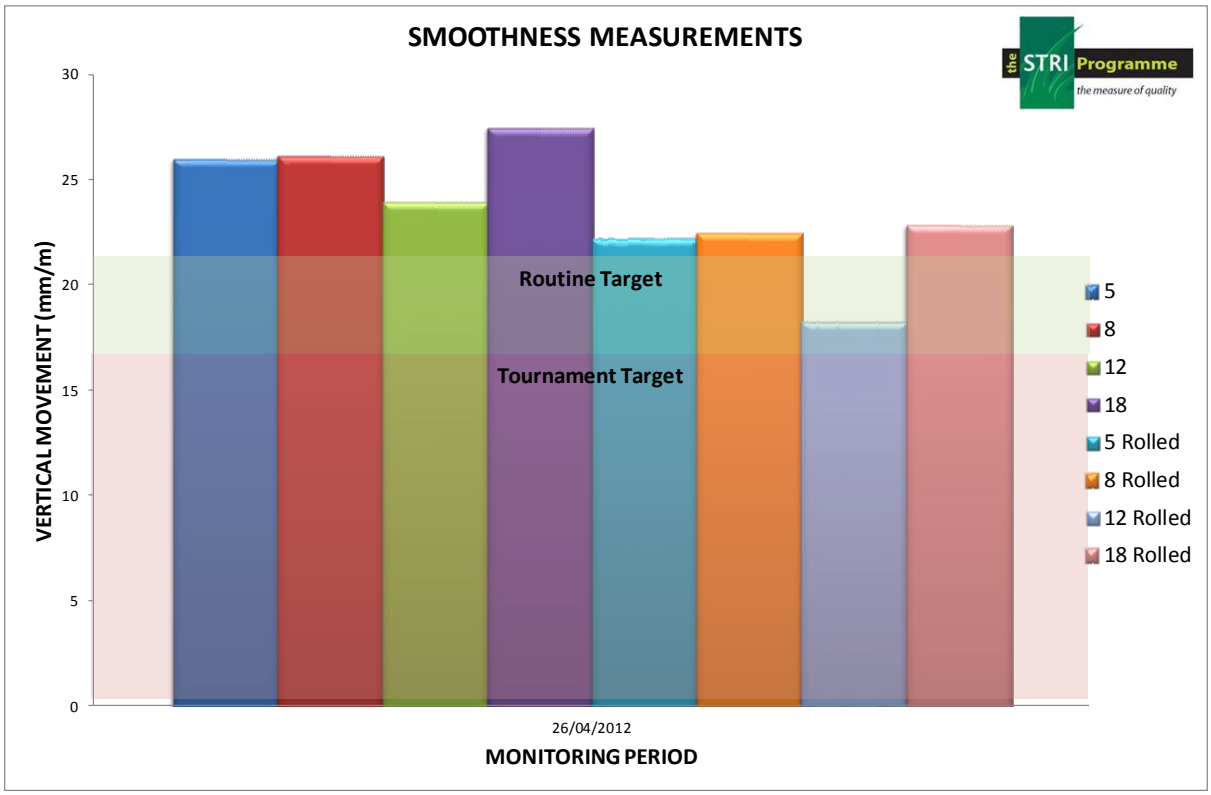
It is likely moving forward that rolling will be the most appropriate means used to ensure the best possible standards of ball roll smoothness are achieved with minimal impact upon green speeds.

Smoothness/Trueness

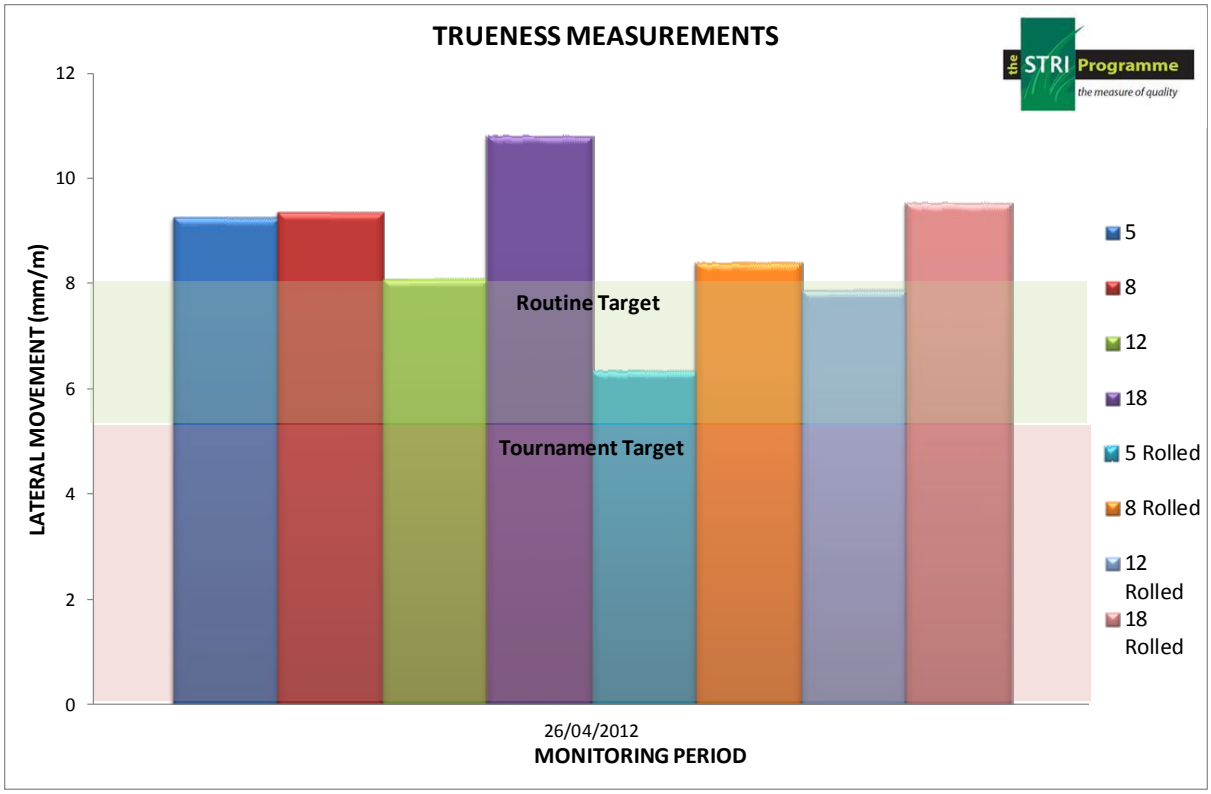
The smoothness and trueness of the selected greens was measured using the Trueness Meter™. This device measures the smoothness (vertical deviation) and trueness (lateral deviation) of the putting surfaces with the level of deviation being expressed in millimeters per meter (mm/m). With these results, lower readings indicate a smoother or truer surface.

Our aim when maintaining the greens is to produce surfaces that are smooth and true for putting for as long as possible throughout the year. We are aiming to create smooth and true surfaces for putting that do not deflect the ball from its intended path ("snaking") or kill its momentum ("bobbling" and "chattering"). During the main playing season, our target range for smoothness is 16 - 23 mm/m of vertical deviation and for trueness 6 - 10 mm/m of lateral deflection. The lower end of these target ranges represents fantastic putting surfaces (worthy of international tournament standard) with the higher end providing really good standards for routine play. These target ranges are very challenging but we are striving to achieve the highest standards for play.

The results for smoothness and trueness are outlined in the two graphs below and they are compared against our target ranges.



Ball roll smoothness scores were just outside ideal target ranges, this is normal given the time of the year. Scores were reduced by differential growth rates especially over fescue/bent areas and on-going disease scars. This will be a common occurrence at this time of the year. Scores improved after rolling to fall within minimum acceptable levels.



The results at this point were impacted upon by disease scars and footprinting (deer) where applicable. Again this will improve over the forthcoming weeks. It is likely that sand dressing will be a vital tool for improving both smoothness and trueness on an on-going basis moving forward. Again scored improved to (almost) within desirable ranges.

Ball roll smoothness and trueness can be measured using the following table moving forward:

STRI Smoothness Scale	
Score	**Description of smoothness/trueness**
10	No chatter or snaking. Perfect roll.
9	
8	Predominantly smooth, but with a single isolated chatter event and minimal snaking
7	
6	Chatter dominates with possibly single bobble events and some snaking.
5	
4	Bobbling, snaking and chatter throughout the roll
3	
2	Bobbling and snaking (ball bouncing around). Ball stops abruptly.
1	

Chatter = Distinct vertical vibrations discernable but ball does not leave ground
Snaking = Lateral deflection from intended path.
Bobble = Distinct vertical movement where ball leaves the ground.

Please contact me for a copy of the smoothness scores on video.

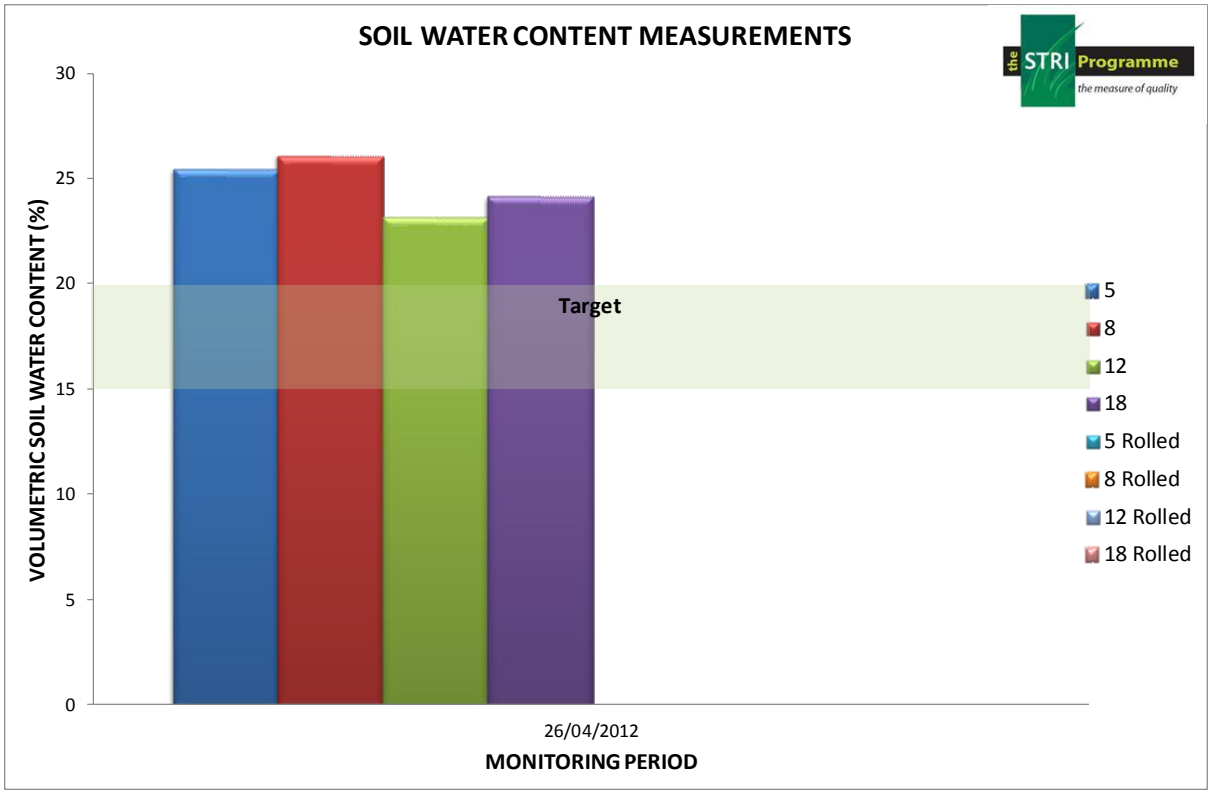
Soil Moisture Content

The soil moisture content was measured using a Theta Probe moisture meter. Nine points were sampled on each green and the average was calculated.

The moisture content of the soil profile has a significant impact on the playing qualities of the greens and also the health of the turf. When the soil moisture content is too high, the surfaces can become soft and the turf health can also suffer. When the soil moisture content is too low the consistency and uniformity of the turf can become compromised. For these reasons, we aim to keep moisture content within an ideal range of 15 – 25 % (15-20% once into the growing season). At these moisture levels the turf health and surface firmness will be optimal. Careful monitoring of moisture

content and the regulation of irrigation inputs (as well as organic matter management) will help ensure that we are able to hold the moisture levels within our desired range.

The results of the moisture content testing are contained within the bar chart below and compared against our target ranges.



Given the weather experienced prior to the visit, the results achieved were exceptional. This is a credit to the foundation works that have been carried out with regards to reduction of organic matter this is extremely positive.

Regular monitoring of organic matter will be vital to assist the club in ensuring that rapid moisture contents are retained throughout the year to encourage desirable species content.

A moisture probe can be obtained at the following link – http://www.delta-t.co.uk/product-display.asp?id=ML2x%20Product&div=Soil%20Science

The club will have to be careful as it progresses through the year to monitor high areas and high points of greens as these will be prone to drying out notably quicker than other areas. The only way round this will be to keep hand watering as much as possible.

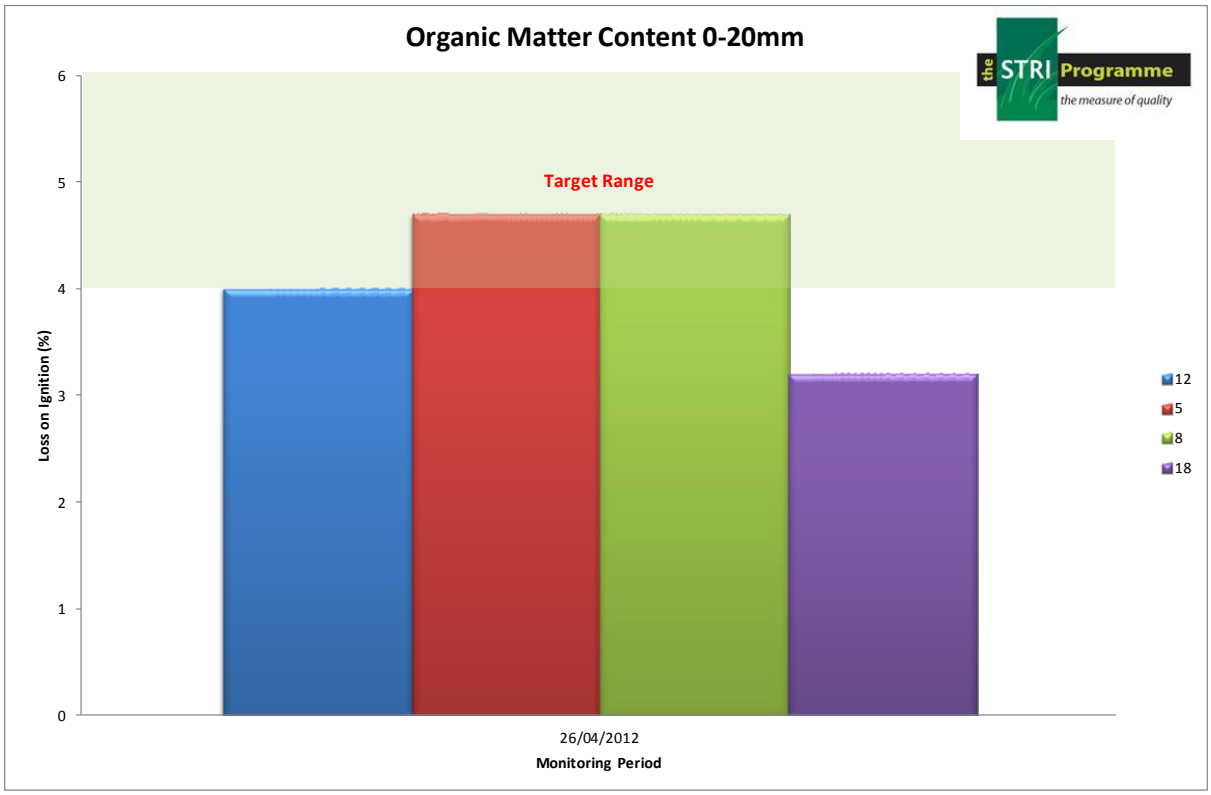
Organic Matter Content

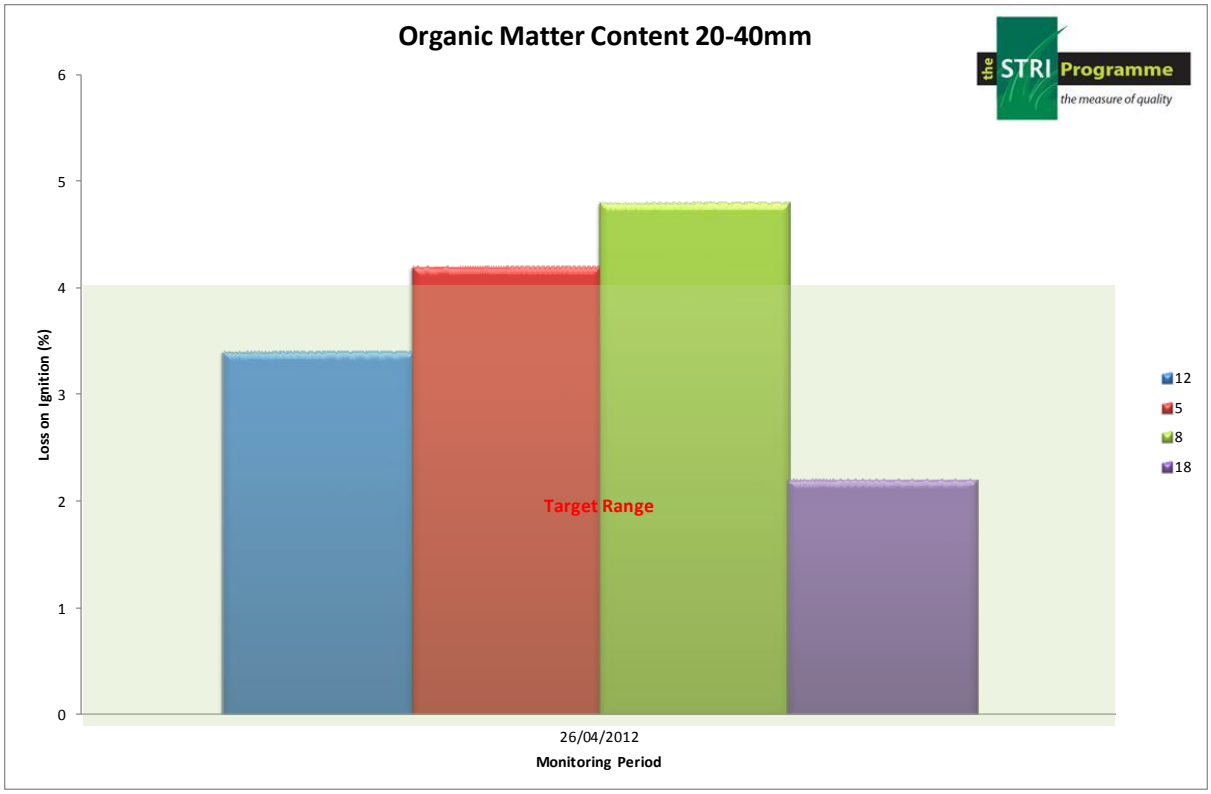
Samples were taken and submitted to our laboratory to assess the organic matter content of the upper soil profile beneath the selected greens. Organic matter content is important because high levels can adversely affect playing quality (soft surfaces) and also increase the risk of potentially

damaging conditions such as disease and dry patch developing. Our target range for organic matter content is 4 – 6 % in the top 20 mm moving down to < 4 % lower down. An accurate measure of the organic matter content helps us determine the intensity of work required to hit our target levels. The results of the organic matter content testing are contained in the table below.

Organic Matter Content				
Loss on Ignition (%)				
	Green 5	Green 8	Green 12	Green 18
0-20 mm	4.7	4.7	4.0	3.2
20-40 mm	4.2	4.8	3.4	2.2
40-60 mm	4.3	4.5	5.0	3.1
60-80 mm	3.6	3.6	3.3	2.9

The following bar charts serve to compare these results against our target ranges.





Organic matter at present is extremely low and amongst some of the lowest rates tested to date. It is a credit to the hard work done through renovations such as hollow coring/sand dressing throughout the last 6 years.

From the results obtained, it is the STRI's recommendation that on-going reduction of organic matter can cease and the key objective moving forward now will be to sustain organic matter at existing levels.

Soil Chemical Analysis

Samples were taken from each green for routine chemical analysis of soil pH, phosphate (P_2O_5) and potassium (K_2O). The results of the testing are outlined in the table below.

Soil Chemical Analysis			
	pH	**P_2O_5 (mg/l)**	**K_2O (mg/l)**
5	6.1	133	55
8	6.0	97	65
12	7.0	107	52
18	6.2	162	30

pH levels although not critical for species conversion but would be ideally at the neutral level to encourage fescues. Cease using acidic based products such as Ammonium Sulphate and use Urea based products. Lime applications at renovations can also be considered.

Phosphorus levels are high. It is recommended we cease phosphorus applications for a year and review levels in 2013.

Potassium levels a medium to low. These will have to be monitored closely and increased above existing applications levels should they drop through 2012.

Discussion & Recommendations

Course maintenance strategy and background

Denmark, due to leading legislative constraints is having to adjust its maintenance strategies in order to deal with such restrictions.

Through its extensive experience of managing under limited pesticide environment has developed a strategic four stage strategy to assist in achieving sustainable standards in amongst such environments.

The key objectives in order to achieve this strategy include:

- Create and develop the correct growing environment by reducing organic matter down to suitably low levels, reducing average soil moisture contents. Achieve adequate levels of drainage and light levels on greens. It is apparent the Copenhagen Golf Club has achieved the majority of these with the exception of isolated greens.

- Commence introduction of desirable species which are less impacted by disease such as fine fescues and in cases browntop bent grasses. It is apparent that Royal Copenhagen Golf Club has achieved this over most of the greens. Continued advice to help completion of stage 2 is further discussed in the report.

- Start to implement periods of controlled management and stress in order to favour the growing environment towards desirable grasses once they have been successfully introduced. Royal Copenhagen have been doing this over periods of time through controlled moisture management and low nitrogen applications. The STRI provides further guidance to enable the club to apply periods of moisture stress with heavier levels of management and control.

- Minimise disturbance and produce suitable surfaces. Once desirable species have been mainly introduced we minimise stressful activities such as aggressive verticutting, scarification and focus purely on dilution of organic matter (sand topdressing) and management of sensible moisture contents.

In summary, the vast majority of greens have progressed well through stage 1 and stage 2 with parts of stage 2, 3 & 4 on-going.

This is notably further ahead than the vast majority of courses throughout Europe.

Producing Suitable Surfaces

Producing quality surfaces throughout certain periods of the year must now be the key focus for the course management team.

In addition, the club must achieve this without excessive agronomic damage or deficit to the greens that harm the long term condition and capacity to manage them.

In order to achieve this it requires regular and on-going monitoring using a range of resources and less stressful surface preparation techniques in order to achieve better standards of playing quality.

STRI View

The general direction under which the greens have been managed for the last 6 years is positive and the foundations of quality have now been put in place to be achieved on a regular and day to day basis.

The strategic direction is in fitting with the local surroundings, the local climate and diseases present along with legislative changes experienced at the club.

The club needs to continue along this strategic direction, however much of the hard work has been carried out to date.

There are isolated areas within some greens and indeed some isolated greens which are further back in the strategic process mainly due to limiting environmental practice. For example on some greens individual low areas are prone to sitting wetter and as such contain higher levels of bent grass. Or for example the putting greens and 18th green has extremely low light levels and fescue grasses cannot be successfully developed.

Grass Species Content on Greens

In general terms, greens can be split into three main groups in which the groups are either advanced in species conversion, moderately developed or are lagging behind other greens.

Advanced – includes 4th, 8th & 12th greens.
Moderate – includes 2nd, 7th & 16$^{th.}$
Behind – includes 1st, 18th & putting green.

However, the majority of greens have achieved a moderate to advanced status in terms of species conversion where the medium level generally speaking species conversion is only required on a localised basis.

In order to address this issue, it is recommended that general aggressive renovations can be reduced in severity and focus on sustaining the present levels of organic matter continued. Focus on site specific and location specific seeding over and above the renovations already carried out should be considered.

- **March -** Renovations carried out plus fescue seeding (this has already been carried out).

- **June, July & August** – The greens (islolated low points only) can be solid tined using approximately 14-16mm tines heavily seeded and brushed so the seed works its way into the holes and lightly sand dressed to fill holes. Solid tine holes should only be 30mm deep maximum.

- **September** - Renovations should be continued as normal including fescue and bentgrass seed.

On-going Performance Monitoring

In order for the club to sustain quality greens throughout specific parts of the year, on-going measuring in order to input into maintenance decisions will be required.

Methodologies for measuring performance of greens were demonstrated during the site visit and included is some further information to assist with help with measuring greens ball roll smoothness visually.

Measuring greens moisture content can be achieved using a Theta Moisture Probe which can be obtained at the following link:
http://www.delta-t.co.uk/productdisplay.asp?id=ML2x%20Product&div=Soil%20Science .
Initially this should be carried out over 3 – 4 holes which were selected during the site visit carried out on a 2 x weekly basis.

An efficient system for entering data into the computer should be implemented in order to produce this information quickly and effectively.

Green Surrounds

The green surrounds were re-turfed some 6 – 7 years ago.

From this point, the club has sustained reasonable standards especially given the limitations of the site. However, at this point weed ingression, especially clover and invariable species content is leading to declines in uniformity of appearance and playing quality within the surrounds.

Further to this as is commonly experienced organic matter (thatch) was imported with the turf. This is resulting in some softening which is of notable significance on the immediate approaches.

The approaches can be divided into 2 notable areas of maintenance:

- The sides and rears of the approaches.
- The immediate front approach.

For the immediate front approach it is important that the club continues to encourage firm surfaces that encourage balls that land on them to evenly run up onto the surface of the green. It was experienced after rain prior to the visit that some softening was occurring. Recommendations for these areas are further discussed in the report.

The sides and the rear focus problems around inherently uneven ground which is subject to some levels of scalping and high levels of weed invasion.

The objectives for improving the green surrounds and approaches include:-

- To firm the immediate approaches and reduce softening during rainfall periods.
- To smooth out surrounds to reduce proneness to scalping at lower mowing heights.
- Sustain uniform bent/fescue turf cover throughout the surrounds as practically possible.
- Reduce both grass weed and broad leave weed invasion where possible.

In order to achieve this, the following points are recommended as a guideline:-

- **April – May**

It is recommended that the immediate approaches are hollow tined using large 16mm tines (40mm deep only) and sand dressed using the following process.

Continue to fescue overseed green surrounds with fescue during the above renovation processes plus 2 additional occasions throughout the year where practical using either slice seeder or using verticutting and seeding process/solid tining process, as discussed onsite)

On-going plugging will involve careful consideration as to what can practically be resourced. In the first instance, consideration will have to be given to:

- An external nursery or extension of the internal nursery to allow for sufficient amount of plugs to be taken to be reused within the green surrounds.

- Introduction of additional project specific labour in order to carry the works out if applicable.

- Focus on approximately 4 – 6 of the worst holes each year and thoroughly plug out weed content on these specific holes.

August – September

Carryout a second renovation on approaches and sand dressing on the surrounds.

Fairway Quality & Worm Control

Primarily the club accepts its restricted environment and as such the limitations and control of earthworms and deer footprints.

A combination of worm activity and also deer's throughout the winter months do project a significant challenge for the club.

Worms tend to like heavy clay alkaline soils and as such will tend to be active on fairways at the club.

The most feasible option for reducing worm activity which can only be resourced within specific areas is regular applications of iron sulphate moving into the autumn and early winter period. This temporarily acidifies the upper part of the profile and can in cases reduce worm activity.

This is likely only to be feasible over approximately at 1 hectare and will require repeat applications on at least a 2 – 3 weekly basis in order to continually acidify the upper part of the profile. This may have to be considered by the estate owners.

In addition to this, it was deemed during conversations that collection of clippings from fairways which in theory would reduce food sources for worm activity is primarily unfeasible for the club due to a combination of additional time and lack of space in order to deal with necessary clippings.

Sand dressing of fairways due to the environment would be considered unfeasible at this point. Collection of grass clippings on fairways would create issues with clipping storage and disposal. This can be overcome but at notable cost.

Iron applications should be focussed at approximately 20-25kg per hectare in approximately 450 – 500 litres of water (Ferasulphate). Care should be taken not to apply during hot weather.

Putting Green

The existing putting green due to combination of restrictions and its locations will prove very difficult to grow grass successfully.

Surface produced on this green will be short lived and subject to heavy damage through winter periods.

It is recommended the club remove this green from an official title of putting green and focus use on the green located by the driving range.

The driving range putting green will require increasing in size from its existing location in order to allow a greater level of wear spread over the green.

Summary of Visit

The STRI confirms the strategic direction, having taken into consideration limitations present within Denmark, is correct and the club has progressed significantly along this line and feels it has reached mile stones thanks to the work carried out to date.

The infrastructure required and correct growing environments on greens has been achieved and now enables for continued development with species ingression on greens.

The club can expect due to limitations, standards throughout early parts of the year to be challenging and as such must set modest and achievable targets without the deterioration of the agronomic qualities achieved to date. Moving into the season on-going measuring and monitoring of surfaces which input into maintenance and preparation decisions will be required in order to ensure a sustained and positive standard is achieved throughout the year.

Further recommendations are outlined with regards to proposal on green surrounds and immediate approaches which will assist the club in continuing to develop progress.

Thank you very much for your hospitality during the site visit and I look forward to seeing you again in the future.

Signed

Charles Henderson *(H.N.D, B.Arts*)
Turfgrass Agronomist - South East
Office Tel: +44 (0) 1273 628 576
Mobile Tel: +44 (0) 7545439908
charles.henderson@stri.co.uk