GOLF COURSE IRRIGATION
A NEW STUDY

by PAUL HERRINGTON and MARTINA HOSCHATT

This study, undertaken over 1991-3 by
the Department of Economics at the
University of Leicester to assess the
possible implications of climate
change for the demand for water, con-
cerns itself with both the public water supply
(PWS) and direct abstractions (DA's), con-
centrating on those demands thought to be espe-
cially sensitive to climate.

Mr John Shildrick of the BTIA helped in
the compilation and distribution of a question-
naire to a sample of members of BIGGA, and
five NRA regions in the south and east of Eng-
land (Anglian, Southern, South West, Thames
and Wessex) were targeted as the area most
susceptible to water scarcity problems. A ques-
tionnaire was produced, the objectives of
which were:
• to gain a factual picture of present golf
course irrigation in terms of quantities,
sources, uses and timing;
• to assemble information about annual water
costs;
• to ascertain the possible response to a hypo-
theretical doubling of water prices, from both
PWS and DA's;
• to invite comments about the possible impli-
cations of global warming for course water
use.

The questionnaire was sent to 298 BIGGA
members and there were 89 returns (30%),
covering irrigation activities on 114 golf
courses: 95 18-hole (83%) and 19 9-hole
(17%). The consensus estimate is that there
were about 1600 golf courses in England and
Wales in 1992. Assuming that half of these,
800, were located in the five NRA regions,
returns represented 14% of courses in the
south and east. The returns were from 21
counties, from Cornwall across to Lincolnshire;
of these 35% came from Hertfordshire, Kent
and Surrey.

Size of Golf Course Complexes
One of these 89 responses gave information
about a 64-hole complex (14000 yards, in Sur-
ry), one for a 39-hole complex (15000 yards,
in East Sussex), nine for 36-hole complexes,
and twelve for 27 holes. Of the remainder, six
were for 9-hole courses and sixty for 18 holes.
18-hole courses ranged from 5300 to 7100
yards. Numbers of rounds played per year
ranged from 2500 to 80000. The 44 18-hole
courses providing use information revealed an
average of 44250 rounds per year.

Irrigation Systems and Uses
Virtually all courses provided information of
the type of irrigation system used. 76% made
use of automatic systems with pop-ups, 12%
had manual installations (with sprinklers
working from hose-points), and 11% had
mixed automatic and manual systems. Just
one course had no fixed installation at all, and
two reported travelling sprinklers in addition
to an automatic system. As recently as 1987 it
was reported in Turf Management that as
many as 11% of courses had no form of irriga-
tion system. However, the regional breakdown
of that 11% is unknown.

Most courses (56%) irrigated both greens
and tees in a climatically average year; a fur-
ther 27% watered greens only, 7% irrigated
tees and approaches, and the remain-
ing 10% watered fairways in addition.

Sources of Water
We obtained information on sources of irriga-
tion water for 100 'courses', a course some-
times defined as a 27-hole or larger complex.
33 courses reported more than one type of
source, 'types' being defined as • PWS (direct)
• PWS (into storage first) • DA's (direct) • DA's
(onto storage first).
The various possible source combinations are
best summarised in the Venn diagram shown
as Figure 1.

Table 1: Average Water Quantities Used on
Courses

PWS-only courses

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1991</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information for all three years (Q6)</td>
<td>16</td>
<td>3.97</td>
<td>3.77</td>
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<tr>
<td>1992 information only (Q6 &amp; Q7)</td>
<td>30</td>
<td>3.76</td>
<td>2.70</td>
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</table>
| DA's-only courses

<table>
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</thead>
<tbody>
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<td>9</td>
<td>3.32</td>
<td>2.86</td>
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<tr>
<td>1992 information only (Q6 &amp; Q7)</td>
<td>27</td>
<td>5.42</td>
<td>3.64</td>
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</tbody>
</table>
| All courses

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1991</th>
<th>1992</th>
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</thead>
<tbody>
<tr>
<td>Information for all three years (Q6)</td>
<td>40</td>
<td>6.36</td>
<td>5.07</td>
</tr>
<tr>
<td>1992 information only (Q6 &amp; Q7)</td>
<td>84</td>
<td>5.42</td>
<td>3.23</td>
</tr>
</tbody>
</table>

Notes
(1) Strictly speaking data refer to responses
received and therefore to complexes rather
than courses. Virtually nothing is known
about irrigation of separate components of
> 18-hole complexes; we therefore apply
our water use averages to courses,
although average course use will be lower
than the average complex use data listed
in the table.
(2) To convert data to millions of gallons per
year, divide figures by 4.546.
(3) Number of courses providing this informa-
tion < 100% of sample.
(4) As explained in the text, the 1990 estimate
in italics is derived by multiplying 8
Averages for 1992 were lower than earlier data for two reasons: the wetter weather in many parts of the south and east from June onwards, plus some restrictions on watering in earlier months. Without further study it is impossible to establish the extent to which the 1992 averages reflect restrictions-suppressed and therefore less than 'true' demands. We are thus inclined to label the '1992 information only' figures for 1992 as demands relating to a climactically 'average' year, and those for 1990 (in italics) as our best estimates for a 'hot, dry' year. 1990 estimates have been calculated by applying '1992 information only' to 1992 averages, the 1990/1992 relativity factors established from courses providing data for all three years.

Results: courses using only mains water reported using an average of 2.70 Ml (about 600,000 gallons) in 1992; we estimate the corresponding average for 1990 to be 3.76 Ml, 39% higher. Courses using only direct abstractions (from borehole, river or lake) irrigated an average of 3.64 Ml (850,000 gallons) per course in 1992, and 49% more than this in 1990. For all courses for which we have information, however, the estimated averages were 3.23 Ml (710,000 gallons) in 1992, and 68% more than this in 1990. For courses using both mains water and direct abstractions, the average quantity irrigated was higher: 5.50 Ml (1,210,000 gallons) in 1992. Based on the responses of only eight courses providing the relevant information, 53% of this was from the PWS and 47% from direct abstractions.

These average figures hide very skewed distributions; for all categories of courses the most frequently reported irrigation use was in August and only 16 in September. The most frequent use timing. Only ten clubs claimed to use water in April, and even then it was generally only 5% of annual use. 44 clubs used water in May (mostly 10% of annual use), but 80 watered in June and 87 in July. 68 irrigated in August and only 16 in September. The most common pattern was to use 10% of water in May, followed by 30% in June, 40% in July and 20% in August.

What if the Price of Water Were to Double?

It is likely, whether or not global warming occurs as predicted, that the real price of water will continue to increase significantly over the next decade. For PWS's this trend is already very clear, while for DA's incentive-based charging schemes are now the subject of public debate. We wished to sound out those responsible for course irrigation management as to their responses to a large increase in the price of water, and so we hypothesised a doubling of real price and presented various possible reactions for checking.

- Two respondents complained about recent trends towards sandy top dressings of greens and tees, with one complaining this had probably doubled water use on a particular course in the last seven years.

The first question, about application (would a doubling in price affect the amount of water you apply with existing techniques and sources?), is essentially about a short-run decision, implicitly assuming irrigation technique and equipment to remain unchanged. Only a quarter said they would cut back water use. Another quarter might, but half thought they definitely would not. These results are unsurprising; when courses are locked into a certain irrigation system, there may well be only limited scope for economies in use. There were no significant differences in the average annual water costs of courses answering yes, maybe and no.

On the question of more storage, involving a once-and-for-all investment (and therefore a longer-term) decision, there was more interest. Overall, nearly 40% of the 81 courses responding thought they would be induced to construct more storage by a doubling of water prices and only one third thought they would not. Significantly, the present average annual water costs of 15 courses saying 'yes; more storage' were nearly double those of the 14 courses responding negatively. This accords with what economic analysis would predict. On the other hand, it was surprising that courses with no storage at present seemed no more interested in additional future storage than those already having storage facilities. Courses with mixed supplies, perhaps already alive to the dangers of water scarcity, were particularly interested in adding storage in the event of a large price increase.

Even more interest was expressed in changing irrigation techniques and technology if the price was to double in real terms. Nearly half of all courses registered a definite 'yes', and...
less than a quarter ruled this out. Again, economic factors seem to be at work here: the courses answering 'yes' or 'maybe' have at present average water costs more than twice as large as those registering a firm 'no'.

Further Information about Water Use
We invited greenkeepers to offer other relevant comments or information about course water use, especially in relation to the possibility of global warming, and 34 (38%) responded to this request.

Reactions covered a wide variety of aspects of course irrigation, with most frequent mention being made of the need to produce and encourage more drought-resistant grasses for a warmer climate and of current and future plans to construct reservoirs for on-course storage. Typically these provide storage of between 1.5–2.5 million gallons (7 to 11 megalitres), and one current application was described for a licence for two borehole abstractions, to fill two large course water hazards which would also serve as reservoirs for use when mains water was restricted or became too expensive.

Two respondents complained about recent trends towards sandy top dressings on greens and tees, with one complaining this had probably doubled water use on a particular course in the last seven years. Two more drew attention to greater use of courses leading to compaction and hence greater run-off and therefore even more water being needed. As though in response, another two reactions drew attention to the usefulness of tining turf regularly in the peak summer season to assist water penetration.

Two clubs pointed out the usefulness of misting irrigation in very hot weather and two more saw great virtue in the use of wetting agents (one recorded a 'dramatic reduction' in water use after using a 'hand hose with wetting agent gun plus a monthly blanket wetting agent').

The influx of U.S. irrigation technology was criticised ('different conditions and different budgets there'), but another respondent was pursuing US style plans to treat the effluent from the clubhouse and an associated hotel, hopefully to supply up to 4000 gallons (18000 litres) per day for course watering.

Other comments covered supply restrictions and the need to modify the game itself as well as balls and clubs for warmer conditions. Finally, three East Anglian greenkeepers claimed they would be unlikely to lose sleep over future water shortages induced by climate change since the same phenomenon would most likely ensure their courses were completely submerged by rising sea water!

This is an abridged version of the document 'Golf Course Water Use', a 16 page study document by Paul Herrington and Martina Hoschatt. Copies are available from the University of Leicester, Economics Department, Leicester LE1 7RH, price £1.50 including postage - cheques, made payable to The University of Leicester, should be sent with order.