Pooling Resources

There seems to intelligent argument to counter the accepted believe that water is going to become an ever more valuable commodity and as it is a resource that is relied upon by golf courses using it wisely, is going to become ever more important.

One way to lessen the impact of water restrictions is to harvest and save the water that we do have access to, namely rainwater and this month Greenkeeper International looks at the building of reservoirs. Irritec look at the project from the early stages while Maureen Keepin adds further input and chats with Course Managers who have already taken the plunge, as it were.

Controlling your own water supply - building a golf course reservoir

Approximately 250 thousand million cubic metres of water falls onto Britain each year, with around 60% of it running into the sea. Much of that 60% is required by the environment, for hydrological processes, navigation and other purposes but saving just a tiny fraction of the excess of this quantity, would provide all the country's irrigation water requirements. Water can be intercepted as it falls to the ground via rainwater harvesting and drainage collection techniques, or it can be taken from the rivers under abstraction licences. Generally, for abstractions of less than 20m³ per day and up to 7,300m³ a year, a licence is not required but whether a licence is or isn't needed, often the best way of ensuring your summer water supply is to store water in your own dedicated reservoir. Any water stored in a reservoir has been temporarily taken out of the hydrological cycle and is 100% yours - to do with as you will, when you will.

Once a club has decided to investigate a reservoir for the course, the first question to address is where might one be sited? Often the club's first conjecture is, 'We have a low part of the course that is wettish in any case, how about there?'

42,000m³ synthetically lined reservoir

RESERVOIR SITING

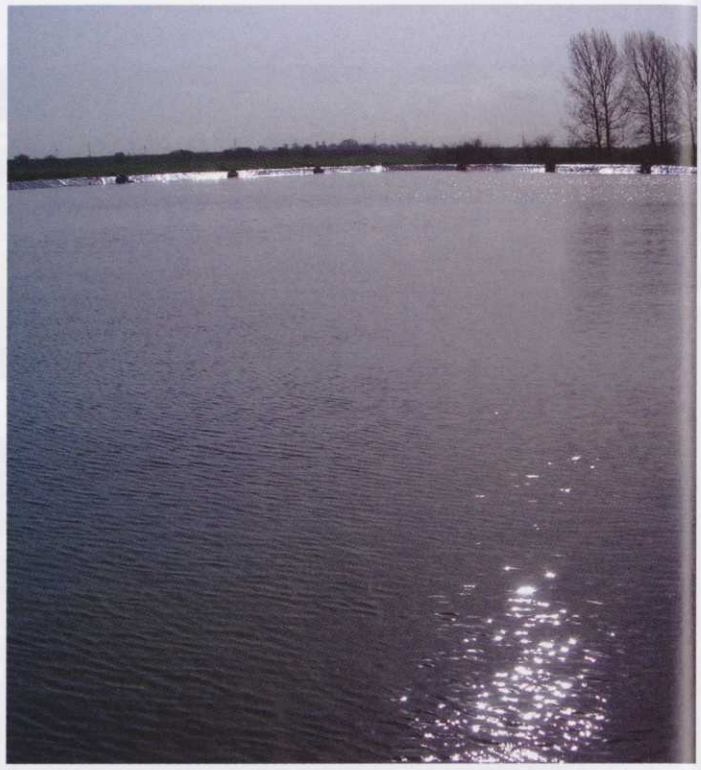
If the club has negotiated an abstraction licence for winter storage, then they must show the water that comes out of the reservoir in the summer is the same that went in to it in the winter. If this were not the case, the club would scratch out a hole at the lowest part of the course, deep into the water table and keep abstracting from this all summer - the water actually flowing in from the sides and the bottom! A reservoir must therefore be lined to prevent not only water escaping but also water entering.

Most small reservoirs (being less than 50,000m³) are lined with a synthetic polymer liner. Any reservoir which is synthetically lined and empty in the autumn when the water tables start to rise again, will face problems. Unless the water table can be permanently, artificially lowered below the base of the reservoir, the liner may push out from the bed and the sides and be damaged. In addition, digging at or beneath the water table, is extremely difficult - the walls and bed of the hole rapidly merging into a large amorphous pudding. Reservoir sites should therefore be up and away from valley bottoms and on plenty of deep, well structured and drained land.

The next question normally asked is, 'Can we put one in the centre of the course and use it as a water feature?'

Unfortunately the answer to this is normally, 'no'. The accepted depth to which water in an ornamental pond or lake can be drawn down, is just eight to 12 inches. Full reservoirs are often pretty -but a less than full one can be ugly. A reservoir is used for storage and by design must be drawn down to a great extent in the season. If the reservoir is not drawn down, all the water below that level is unnecessary. A reservoir in August that has been lowered by four metres may look very ugly indeed and must be sited well out of the way of aesthetically-sensitive eyes.

"Ah, but such-and-such club have a reservoir they draw from and that looks fine!", is the common rejoinder, but in fact that club will almost certainly have a borehole that tops up the reservoir during the day, at a low, constant rate, or another reservoir which does the same. Either way, the lake from which they pump is just a temporary holding, or balancing reservoir, with little nett loss occurring from it.



13,500m³ reservoir for greens tees and approaches at Spalding GC

SURVEY AND DESIGN

Once a club has decided it needs to investigate the viability of a reservoir, potential sites need to be investigated to determine the construction feasibility and thus the site design parameters. A good relief survey of the site should be taken at an early stage and trial holes excavated as deep as possible - ideally to the water table or even bedrock. Most small reservoirs are generally constructed on a balanced excavation basis, whereby the amount of spoil arising from the excavation, becomes the impounding embankments above the excavation.

Observing the structure of the substrate, testing its on-site strength, removing samples and analysing them as required in a laboratory, will give a good indication as to all the slope angles needed on the finished structure. It will also allow the maximum depth of excavation to be set. Correct slope angles and a detailed specification for the embankment construction methodology is critical to the long term stability of the reservoir structure. Only on-site investigation and geotechnical examination will ensure that, with the correct safety factor, a reservoir's embankments will pass the 100 year test mark.

Slope facing at Kent National

Test digging will indicate the presence of suitable clay on or near a site, which can then be further explored. Clay lined or clay cored reservoirs are fine - if all other conditions are ideal. However, leaving slopes open to saturation and erosion almost always results in the design requiring shallower embankment slopes. This makes for a bigger reservoir 'footprint' and thus a larger reservoir site. The economies of scale mean that ordinarily, clay lined reservoirs are not considered for small projects. Guarantees that the water will not leak out can also only be given for synthetically lined reservoirs. Almost all synthetic lining systems incorporate a polymer membrane above a protective 'carpet underlay'. The quality, specification and thickness of both the waterproof membrane and the protection layer need to be very carefully specified. Correct site investigation should lead to the most suitable lining system, but it is important that the lifespan of the lining is accurately accounted for and the liner warranty carefully scrutinised. Clubs should be budgeting to replace their reservoir liners every 25 to 30 years, not 10 or 15, irrespective of whether they're constructed in soft sand or flinty chalk.

The optimum depth for a golf course reservoir is between 4m and 8m. This allows for an efficient excavation whereby, in principle, one cubic metre of excavation stores, not only one cubic metre of water below ground but also one cubic metre of water above ground, by its contribution to the embankments. The capacity of the reservoir is calculated as being the amount of water required by the irrigation system in a 40 or 50 year drought. Nett losses due to evaporation must be added to this, a safe freeboard for wave action and an allowance for dead water at the base of the reservoir. On a reasonably level field a reservoir of 12,000m³ (sufficient for most 18-hole greens and tees systems) may occupy a total footprint

area of one and a half to two acres. A reservoir of 25,000m³ (for many 18-hole fairway systems) may require two and a half acres. A 50,000m³ reservoir may require four or five acres.

HEALTH AND SAFETY

Many reservoirs are scraped and pushed into shape by bulldozers and similar plant. Others are constructed using 360 degree excavators and dump trucks. However they are constructed, the most crucial component of the build is the correct specification for the construction of the embankments and a variety of plant is available for this. All of this plant must be transported to site. Ensuring an adequate and safe haulage route through tight rural roads and across the golf course, is an important consideration in the siting of the reservoir and its safety planning.

Almost all reservoir construction projects are subject to the Construction Design and Management Regulations 1994 (the CDM Regs). As a golf club, this means that you have legal responsibilities to the health and safety of the project both during and after construction. No blind eye should ever be turned to these regulations and clubs can be prosecuted for not following the regulations irrespective of whether any injury actually occurs. The very positive side of the CDM regulations is that by following a few simple codes of practice, accidents are very few and far between in reservoir construction. The CDM Regs also lay out the relationship between all the parties. The club will be the client, the engineer is the designer and possibly the planning supervisor and the contractors are principle contractors and sub-contractors. This prevents any grey areas of responsibility and ensures that the contract relationships are seamless. The creation of an agreed Health and Safety Plan, by the planning supervisor at the project's feasibility stage, is a must. As with many modern regulations (though not all), embracing the CDM Regs wholeheartedly is the only way to ensure your project is safe and that you are protected as a club. It is even possible to nominate an 'agent' to assume these risks for you.

The issue of a safety fence around the finished product is one of the most talked about subjects in a reservoir project. All reservoirs must have some escape method if somebody falls in but keeping the wildlife and local teenagers out to start with, is a major issue. Any reservoir situated near a housing estate or public footpath ought to have a properly specified fence, to recognised health and safety standards. This should be situated at the bottom of the external embankments, so as to minimise its visual impact against the sky-line. However, a more remote reservoir need not require one. It is one of the vagaries of law and insurance that one can walk directly off a cliff into the sea or a river with little recourse to the landowner, but a strong case would need to be made that a reservoir's risks had been minimised if a suitable fence had not been included in the design.

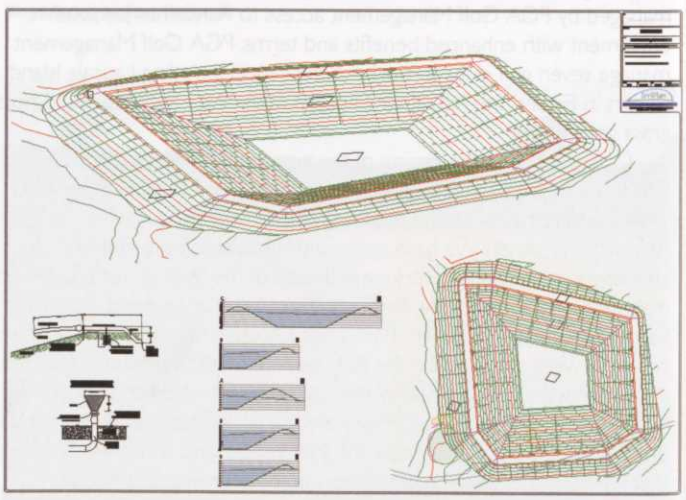
ENVIRONMENTAL AND PLANNING CONSIDERATIONS

Reservoirs can be almost any shape and size. Fitting them into corners of fields, between hedgerows, or fitting them to existing hillside contours, are common processes. If the reservoir construction is part of a new abstraction licence, often a consideration at an early stage is to look for the nett environmental benefits of a reservoir.

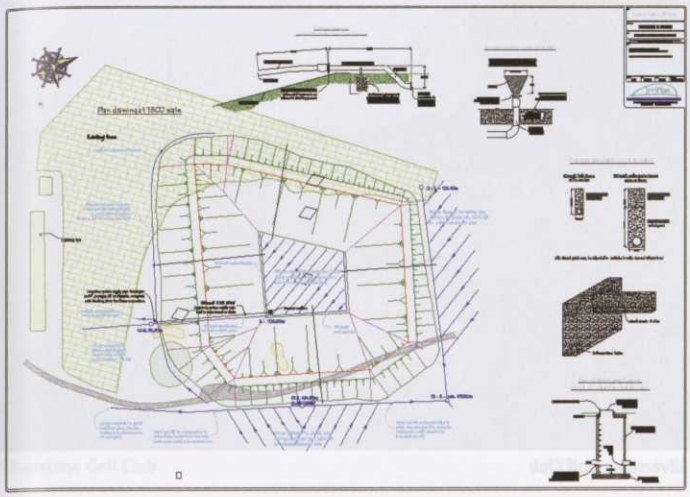
Putting energy into water in order to move it long distances in municipal pipelines; chlorinating that water at great expense; and then applying it to a golf course, is plainly wasteful of energy. Simply abstracting, conserving and applying water locally has an immediate environmental benefit. However, in recent years treating the reservoir itself as an environmentally beneficial structure, has become important to the Environment Agency and to planning departments around the country. A properly managed and fenced off area can provide excellent protected habitat. About the only animals that need to be excluded are deer, foxes, rabbits and, of course, pet dogs. Using wildflower seed blends can provide a valuable habitat for small rodents and birds.

Synthetically lined reservoir embankment sown with a wildflower seed mix

A floating island provides refuge and shade for fish and nesting sites for wildfowl



A good design is essential for planning and for tendering contractors



A lined reservoir not far off being ready for filling

Finished embankment surface

Non-geometric shapes, marginal shallows, access ramps for amphibians and ducklings, and even floating islands that rise and fall with the water level, can help to promote a reservoir both visually and environmentally. For very little cost, a new reservoir can be favoured and supported by the Environment Agency, your local Wildlife Trust and the Local Authority by making a significant contribution to habitat creation.

CONSTRUCTION

The whole process, from feasibility, through engineering design and specification, to supervision and post-construction observation, should be handled by an independent firm of suitably qualified consulting engineers. The finished design should be well modelled and presented using dedicated civil engineering software so that the club and the local planning department know exactly what will be constructed.

Correct plans with sections and detail drawings will allow competing contractors to provide prices on a like-for-like basis.

The purpose of the golf reservoir is to store water, so that it can be applied through the irrigation system in the summer. Though construction must be seen as an individual project, the reservoir is just one component of a larger system - from the collection of the water, through to its emission from the sprinklers' nozzles. Fitting the reservoir into the overall abstraction and irrigation system must not be left to chance.

Each reservoir is a bespoke component of the irrigation system, therefore budget prices are notoriously difficult to predict without the feasibility, design and tendering stages being complete. Generally, the deeper the excavation and the more level the site, the lower the costs. Shallow reservoirs above high water tables and reservoirs constructed in rocky or hard ground tend to be the most expensive.

At today's prices, a 12,000m^3 synthetically lined construction may cost in the region of £70,000 - £130,000, a 25,000m^3 lined reservoir may cost £120,000 - £180,000 and a 50,000m^3 lined reservoir is likely to be in excess of £160,000.

An abstraction licence itself, may take some time to be awarded but reservoir planning and design processes also do not happen overnight. The most appropriate time of year to construct a reservoir is in late summer or early autumn when the land is generally drier. Carrying out major earthworks in winter can dramatically push prices up as contractors have to cost in the days when the weather makes excavation and movement too difficult. With this in mind, for a late summer construction, a contractor must be appointed at least three months before and as planning consent can take six months or more, clubs should allow themselves a minimum of one year planning.

As pressure on water resources grows, the cost of water increases and its reliability of supply decreases. One of the best ways to ensure that you have a sufficient known quantity of water for your summer's irrigation system, is to be able to stand beside your own private reservoir in March and see the water for yourself. Saving your little bit of water that would otherwise run off to the sea, puts you back in control and removes your dependence on third parties.

Marcus White CEng BSc (Hons) MSc MIAgrE MASIC is a member of the Institution of Agricultural Engineers and of the American Society of Irrigation Consultant.

He is a Director of Derbyshire based consulting engineers, Irriplan Limited, who specialise in irrigation engineering, reservoir engineering and water resource management for golf courses. For more information visit: www.Irriplan.net.

Steve Cherry, Course Manager at Silverstone

Silverstone Golf Club

Solving water shortages

As more drought orders come into force never has water storage been such a vital issue - where every drop of water counts. Maureen Keepin reports...

As most of the earth is covered by water - more than 70 per cent - and the UK is wetter than most countries, we would not expect a dramatic problem to arise with regard to supply.

But with only one per cent of this resource readily accessible, global warming, climatic changes, increased use of water, more housing, no notable increase in reservoirs, no grand plan and water companies losing a staggering 3.6 billion litres of water each day through leaks - water management is a serious issue which needs to be addressed. In these critical times, ponds, lakes and reservoirs come into their own.

SEEKING SOLUTIONS

Collecting water from the golf course during wetter periods, for use in the drier times, is an extremely sound proposition for most clubs. Serious and expensive damage can occur very quickly if grass roots are unable to obtain sufficient water to make up for transpiration losses and the grass becomes stressed.

Basically the scheme involves collecting ground water and surface water run-off, channelling this into a piped drainage system and feeding that into a storage reservoir in the ground - which need or need not be lined.

"Everyone ought to be investigating this now, as there are planning issues which need to be overcome to build these resources," says Nigel Wyatt, Contracts Director for irrigation, drainage and water management specialist MJ Abbott.

"Time is of the essence and the requirements are different for every club."

Determining the amount of water you need to store is critical. If a drought order hits in July, clubs will need to store enough water for August to September. If the drought order comes into force in March, they will need sufficient water for the whole season.

As a general rule, when planning water storage requirements, clubs should allow for one inch (30mm) of water over a given area per week.

THE REMEDIES

Designing and planning water storage facilities can be carried out by experienced contractors who will take into account ecological and aesthetic issues. This ensures the functional requirement is met and that the project enhances the environment.

Gravity pipework alone is unlikely to be sufficient to take the water to the right place, so generally water will need to go through pumping systems into a series of reservoirs.

"The Belfry is a good example of this," says Nigel.

Water management was a prime concern when improvements were carried out to the Brabazon Course for the Ryder Cup. No summer abstraction of water is allowed, so a large quantity of water is required to be stored over the winter. The irrigation storage reservoir at The Belfry, already one of the largest of its kind in this country, was extended to accommodate the storage of 15million gallons of water.

HOLDING WATER

Where feature lakes are installed they need to retain their water levels to be aesthetically pleasing, so the amount of water available for use should only be the top 200-400mm in depth. It is crucial they are kept free from a build-up of vegetation and weeds. Aeration helps with this, as it stimulates aerobic digestion.

For this reason, a preferred option is the construction of a reservoir within an area out of play - conditional on planning from the local authority. Generally the most economic solution is the method of cutting and filling. The first operation is the removal of the topsoil over the area of the site and then excavation of the subsoil can be carried out. On a level site it is possible to excavate the centre and place the fill to form banks and surrounds. Key to the success of this is ensuring compaction of the fill material within the bank.

LINING LAKES

There are two possible options for lining lakes and reservoirs. If the indigenous subsoil is clay, it may be possible to puddle this to form an impermeable layer. However, if the subsoil itself is permeable it will be necessary to install a man-made lining system.

Typically a geotextile underlay is used over the subsoil surface, followed by a polyethylene lining system. This lining system is sandwiched by another layer of geotextile and secured around the perimeter of the reservoir by a key trench. The final operation is to spread a protective layer of topsoil at a minimum depth of 150mm over the geotextile. This acts to protect it and enables growth of indigenous plant species.

"We can no longer take water for granted," says Nigel.

"Creating or increasing on-site water storage facilities is a sound solution more and more clubs are implementing."

So, what measures are clubs taking?

Silverstone Golf Club

At the Old Gorse GC in Oadby, near Leicester, attention has turned to reclaiming a lake, which dates back to 1961. Strategically sited at the side of the 16th green, this is now silted up and has large trees growing in it - but at the time had a capacity of 250,000 gallons.

"Water at the moment is a top priority," says Course Manager, Frank Kempster.

"We are not restricted at the moment, but we cannot be complacent."

At the time the reservoir was built, every green had its own hydrant and to water the course hosepipes were connected to these, with free standing sprinklers.

"It was in 1972 we decided to go on to an automatic system and initially the plan was to fill a holding tank from the reservoir," he says.

"We found we were watering more and the diesel pump just could not transfer enough water into the holding tank to water the greens at night.

"As a result, in 1973 we went on to mains."

To water more efficiently, a new irrigation system was installed in the winter of 2005, together with a new mains supply.

Looking back, Frank realises he and many others were quite naive about irrigation systems.

"Too much irrigation was being carried out then and the greens were watered for 45 minutes each," he says. "Now with the new system the most we apply is eight to 10 minutes and only on certain greens."

Within the next five years the club is looking at cleaning out the lake, which has a clay base, and increasing its size. They are also considering whether it would be beneficial to have the lake lined.

A third of the golf course drainage currently goes into this lake together with all run-off from the A6, which passes infront of the club.

"When we do get a wet winter, if we excavate sufficiently, we will have good storage capacity. "Our aim is to make mains our back-up, rather than the sole source."

Proposals are to make a special feature of the lake, by bringing the water closer to the green and planting it up to attract wildlife.

Willow trees at the side of the green are being thinned, with three to be taken out this winter.

Frank's father was Head Greenkeeper at the club from 1959 to 1969 and it was after this, in the 1970s, when there was a period the club did not make any major investments. "Now we are having to play catch up, as there are more than 12 golf clubs within a 10 mile radius, so it is a very competitive market," he says. "Every endeavour is being made to improve player enjoyment and this will certainly be enhanced by bringing the lake back as a major feature."

Over at the Silverstone GC in Buckinghamshire, two new holes, bringing the course up to 20, will have their part to play in addressing drought issues.

"This will give us greater flexibility and keep playing conditions high," says Steve Cherry, Course Manager."We can switch the course around if areas do get stressed by drought conditions."

Plans are to play the new holes May through to October and then rest and refresh them by going back to the original holes.

On the water front, three reservoirs and a borehole supply their water needs. With a current total capacity of 250,000 gallons of water, the club is looking to extend this towards the end of the year.

"Two smaller reservoirs are sited down in the lowest part of the course and our main reservoir, which holds 150,000 gallons, is at the top," says Steve.

The electronic pump feeds water up to the top reservoir which is always kept topped up by the smaller lakes. "Down the bottom the level of water has dropped by eight feet, so if we do get another three weeks of dry weather there could be a problem," commented Steve. A 47 metres deep borehole is also used to supply water, but if extraction is constant for more than one month this supply is drastically reduced.

Currently the club is in the process of installing irrigation to the tees, which means extra water will be required to service them.

"Our plan is to double the capacity of the bottom reservoirs, making them a more interesting feature of the course, as they run alongside the 14th and 16th holes."

To achieve better feeds into the lakes, wider channels are currently being created.

Recognising the importance of addressing all water issues, Steve will also be implementing an overseeding programme this autumn, using more drought resistant Top Green cultivars.

"We have been looking at the best mixture to use on our course with seed agent Rigby Taylor," he says. "Golfers want to play 365 days of the year, so the formulation will help retain good grass cover in all weather conditions."

With water shortages continuing, there is a real urgency for clubs to create long-term water plans - and fully justify the water they use for irrigation by keeping records of how much they apply, when, where and why.

WATER-SAVING WAYS

- Draw up a schedule to identify areas requiring water.
- Confine irrigation to crucial areas of play.
- Train staff to work on increasing levels of awareness of water efficiency.
- Regularly check irrigation systems for leaks.
- Inspect sprinkler nozzles to ensure they operate properly.
- Upgrade, replace or computerise your irrigation system and use weather station for greatest efficiency.
- Water at night or early in the morning, when it is not windy.
- Use more drought tolerant turfgrass species and wetting agents.
- Encourage rooting and do not cut grass too short during period of good root growth.
- Sharpen mower blades regularly to keep grass healthier and reduce its need for fertilisers and water.
- Mulch any landscaped areas and use drought tolerant plants.
- Use wash-down systems which recycle water.