

COUNTY LOUTH GOLF CLUB COURSE IRRIGATION



NOTES OF VISIT 8TH AUGUST 2017

PRESENT

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1. INTRODUCTION & EXECUTIVE SUMMARY

- 1.1** The purpose of the visit was to evaluate the existing irrigation system at County Louth Golf Club and comment on its current condition and provide recommendations as to remedial works required to bring it up to modern standards to provide efficient and reliable watering of the Golf Course.
- 1.2** The irrigation system is some 25-30 years old. We are not sure who installed the system. There has been limited remedial work undertaken to the hydraulic and electrical elements of the system other than reactive maintenance as / when required. It should be said from the outset that the irrigation system has been looked after and cared for reasonably well by the Greenstaff. However, the system is now becoming difficult to manage and maintain and is therefore in need of upgrading and modernisation.
- 1.3** When the irrigation system operates correctly it is within its designed capacities and it applies water to some of the designated areas. It is not possible to operate all areas of the golf course (greens, approaches, fairways and tees) in a single night which can be restrictive on course maintenance. The ultimate aim of any irrigation system, however, is not just to apply water to the some of the designated areas, but also to apply this water to all areas evenly across the surface providing even precipitation thus enabling the Course Manager to apply only the required amount of water that is needed by the turf – no more, no less. It is in these environs, as well as limitations on the hydraulic and electrical design, that the current system is deficient primarily due to the age and specification of the equipment.
- 1.4** The ability to apply water evenly will eliminate uneven growth and invasion of unwanted grass species, which can be caused by the requirement for over application to areas of

poor coverage, and thus provide a 'truer' playing surface.

1.5 An irrigation system on any course is an insurance policy to ensure optimal playing conditions are available during the summer period without the loss of grass cover and there is no getting away from it there is certainly a need to plan for upgrading / replacement of the irrigation system at County Louth GC.

1.6 The underlying problems with the irrigation system are;

- there is limited knowledge as to how much water is available for irrigation and therefore investigation into the water sources is required
- the age, construction and condition of the water storage area
- the type, location and condition of the pump house
- the age and condition of the pumping system and its operation
- the aging mains [25+years] and lateral pipe work
- the system hydraulic capacity is restricting in relation to system operation and watering time window
- the control system which is of varying ages and is prone to intermittent malfunctions and therefore cannot be fully relied upon
- poor sprinkler performance and coverage which is affecting surface and therefore playing quality and consistency throughout the course
- poor sprinkler positioning on the tees and greens (fairways not cheeked)
- mixtures of sprinklers and nozzles on the greens and tees
- system operating pressure at sprinklers and the lack of pressure regulation on solenoid valves
- a system design which does not allow for the efficient and smart use of water with much being wasted into areas not requiring irrigation

1.7 *The planning must therefore begin now to allow for an irrigation system upgrade.*

1.8 The way forward is to obtain an irrigation design to meet County Louth GC future requirements working very closely with the Course Manager so that all areas requiring irrigation are accurately and successfully irrigated. From this design a scaled plan, detailed specification and bill of quantities can be produced. This can then be sent out to tenderers to obtain 'like for like' quotations for the proposed works which are totally comparable and competitive. This can then form the basis of any budgets moving forward.

1.9 We would comment as follows;

2. EXISTING IRRIGATION SYSTEM

2.1 Water Source

2.2 The water supply for the irrigation system is from two springs on the golf course. One is beside the 4th Fairway and the other beside the 16th Fairway. The spring at the 16th Fairway is a backup supply. We are not sure how water is transferred from the 16th spring to the location of the irrigation booster pump station.

2.3 The spring at the 4th Fairway is essentially an open hole in the ground (which appears to be shuttered) which fills up with groundwater. Water from this open area of water is directly fed into the irrigation system via a booster pump station.

- 2.4** The exact volumes of water which are available from the water supplies are largely unknown. There is therefore a need to undertake investigations to ascertain how much water is available from the sources as this has a direct impact upon the operation of the irrigation system. We would recommend that an irrigation design is produced so that before any investigations are undertaken into water availability the volumes of water required during any 24-hour period for irrigation are precisely known.
- 2.5** The supply from the 4th Fairway (where the irrigation pump station is located) is reported to supply 38m³/hr. Whilst this seems a large quantity taking water directly from the source at 38m³/hr would not be sufficient for an irrigation system covering greens putting surfaces, green surrounds, approaches, fairways, walkways and tees during a 9-hour watering window.
- 2.6** It is imperative that County Louth maintain detailed records of water usage so that they can justify their need for a supply rate in the future. Detailed records were not available and this is something which must be implemented in the future. A dedicated water meter is required to obtain this data.
- 2.7** The water quality from the sources we understand has never been analysed. We would recommend that the quality is analysed annually for salinity, pH and alkalinity as a minimum. If the high pH and alkalinity is having a detrimental effect of the turf quality and incidence of disease then there are methods of reducing the pH etc using systems such as acid injection.
- 2.8** The water quality in the open hole for the 4th Fairway supply had large volumes of algae (see photo) which is not good for water quality and the irrigation system.
- 2.9** *Recommendations;*
- *Investigate the water availability from the sources.*
 - *Investigate water resourcing for the golf course irrigation system.*
 - *Procure an irrigation design which meets the golf club's future requirements to ascertain precisely the daily quantities of water required for irrigation.*
 - *Monitor the pH and alkalinity levels and correct these as necessary.*
 - *Ensure no algae at the water supply source locations.*
- 2.10** **Water Storage**
- 2.11** There is no dedicated water storage for the irrigation system.
- 2.12** In the future it may be sensible to have an above ground water storage tank which will provide a buffer between the volumes of water available from the irrigation water sources over a 24-hour period and the volume of water needed to be applied to the golf course during the foreshortened irrigation time window during the night of 8-9 hours.
- 2.13** The total volume of water available for irrigation based upon a 38m³/hr supply rate and no water storage are as follows;

2.14	Water available in 24 hours for irrigation with current design – 38m ³ /hr x 8hrs from the water supply	304 m ³ /in 8 hrs <i>304 m³/day available for irrigation</i>
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2.15 To ensure adequate water is available, the following table shows approximate water usage for different sizes of irrigation system to replace E/T during dry periods of weather;

2.16	<i>System – 18 holes</i>	<i>Water Required per Day</i>
	Greens putting surfaces	60 m ³ /day
	Greens putting surfaces and tees playing areas	110 m ³ /day
	Greens putting surfaces, green surrounds and tees playing areas	180 m ³ /day
	Greens putting surfaces, green surrounds, fairways and tees playing areas	550 m ³ /day

2.17 Therefore based on the above it can be seen that with the current daily volumes of water available for irrigation it is not possible to irrigate the greens, approaches, fairways and tees in any 24 hour period.

2.18 If a water storage tank was installed to provide a buffer water storage area based upon a 38m³/hr supply rate into the tank then the following would be true;

2.19	Water available in 24 hours for irrigation – 38m ³ /hr x 8hrs from the water supply Storage tank volume (350m ³ usable, estimated)	304 m ³ /in 8 hrs 350 m ³ /in storage <i>654 m³/day available for irrigation</i>
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2.20 The above scenario is based upon the storage tank being filled during the day time when the irrigation system is not operational and the water source replenishing water in the water storage tank during an automatic irrigation cycle during the night.

2.21 *Recommendations;*

- *Plan for replacement of the water storage tank.*
- *Ascertain the daily irrigation requirements and install buffer water storage capacity as required. Any water storage tank should be the same design specification to that we have used at Portmarnock or the Island (capacity to be determined) There will also be a requirement to look at the design of the irrigation system, considering any future upgrading plans. The location of any water storage tank will need to be ascertained.*

2.22 Pump House & Pump Station

2.23 The irrigation pump station and controls are in their own dedicated concrete block building beside the 4th Fairway ‘open hole’ at the spring location. Whilst the block work appears relatively sound it is likely to be in the wrong location for any future upgrading

works, however, this is not known precisely at this stage. The size may also be too small for a larger fully automatic irrigation booster pumping plant as may access into the pump house.

2.24 The pump station uses three Grundfos CR pumps which are of varying ages and operated from a pressure switch to provide a pressurised irrigation system. The pump station, however, was not operating correctly during the visit and it was reported there have been problems over the 2017 season. There is a pressure vessel and with modern H&S there is a need to ensure this is regularly [at least annually] checked for integrity to confirm it is in suitable working order. It was not known when the pressure vessel was last checked and therefore it needs to be checked urgently.

2.25 The pump station design is 25+ years old with what appears to be a single newer Grundfos pump and two older Grundfos pumps. Despite the newer pump the control and configuration is antiquated and not harmonised and we would recommend a new fully automatic pump station to operate the golf course irrigation. The location of this will need to be determined in any future irrigation designs.

2.26 In the future we would recommend a fully pressurised main line pipe work system. A fully pressurised system ensures that the mains pipework feeding the control valves and sprinklers around the course is 'pressurised' 24 hours a day. We would also recommend the use of 'variable speed' technologies in any future pump station design (using a minimum of two pumps with controls manufactured by the pump manufacturer to ensure maximum efficiency and harmony of operation), incorporating a fully pressurised pipe work system, as this will enable the pump station to match the precise flow of the system, saving on electricity and irrigation system wear and tear.

2.27 There will be a need to ensure that sufficient three phase power supplies are located at the pump house to operate the future pump station. The incoming supplies should be checked and confirmed by a NICEIC or Irish equivalent qualified electrician.

2.28 *Recommendations;*

- *There is likely to be a need for a new pump house beside a new water storage tank. A fully lined GRP pump house would be suitable – see appendix photos – or similar block built construction as the existing pump house.*
- *Ensure the pressure vessel is checked (short term).*
- *Ensure the pump station is serviced so it can get through the 2018 season [it will need replacing in the future so limited funds should be spent] (short term).*
- *Replace the existing pump station using modern technologies.*
- *Confirm the available power supplies at any future location.*
- *Any future pump house and pump station works should be undertaken with full consideration of the future design requirements of the irrigation system to the golf course.*

2.29 ***Mains Pipework***

2.30 There appears to be no scaled GPS plan of the irrigation system infrastructure for the golf course. Having access to accurate and scaled as laid plans are fundamental to understanding the design of the current irrigation system and for location of these services (pipe work, cable, valves and sprinklers) during any championship event. It would also be very difficult to produce accurate plans at this stage without detailed

knowledge of the exact routing of the pipework and cable. The information gathered on the routing of the existing main line is very much in the heads of the Greenstaff and has been obtained from leak locations and verti-draining etc. This makes commenting upon the hydraulic design (pipe work network) etc very difficult.

- 2.31** The existing mains pipework appears to be;
- 30+ year old uPVC (un-plasticised poly vinyl chloride) of sizes reported to be 3” and 2” for mains
 - 30+ year old uPVC of sizes reported to be 1½” for laterals to sprinklers
 - Some areas of newer PE (polyethylene) pipe work have been installed, however, these are sporadic and in small areas
- 2.32** At present when problems occur with the mains pipework these failures occur at glued joints, along sections of main line and around valve boxes. uPVC pipe work is jointed (glued) every 6 or 12 meters and therefore there is likely to be over 1,600 pipe work joints on the main line alone. The problems also increase with increased usage i.e. during a dry summer when the system would be required most. The average lifespan of a uPVC mains pipework system is in the region of 20 years depending upon installation quality and conditions.
- 2.33** On a links golf course with free draining sands it is also nigh on impossible to find all leaks as some do not show themselves above the surface. This is made more difficult as the routing of the existing uPVC mainline pipework is not known due to the lack of accurate as laid plans provided when it was installed, and the fact that there is no control cable installed with certain sections of the pipework which could be used to ‘trace’ its route. It is likely therefore that the extent of leaks is unknown.
- 2.34** The availability of spare repair couplings for the uPVC pipework is also becoming more difficult to obtain.
- 2.35** *Recommendations;*
- *To provide an efficient irrigation system which can irrigate the greens putting surfaces, green surrounds (where required), approaches, fairways and tees playing surfaces there is a need to replace the mains pipework network. The same is true for the lateral pipe work to the greens, fairways and tees etc. We would recommend that County Louth obtain a detailed irrigation design for the golf course which can then be used as a management plan to upgrade/replace the irrigation system in phases as dictated by finances and timescales.*
- 2.36** **Control System & Control Cable**
- 2.37** The control system infrastructure is generally 30+ years old, however, the decoders and controller have been upgraded. The controller, which is only a small element of the overall system, was replaced in 2017. It is a Rainbird ESP-LXD wall mounted, electronic, decoder controller. Whilst this is suitable for operation of the irrigation system as currently designed we would recommend a computerised irrigation controller in the future as these provide more flexibility for finite control of water and where water is applied.
- 2.38** The control cable network uses a two-core cable which is 30+ years old. The Greenstaff do experience some problems with the control cables. The Rainbird decoders are known to be very reliable.

- 2.39** The existing control cable is unlikely to be suitable for re-use with the modern generation of irrigation computer control systems, however, manufacturers do have computerised controllers, often with many of the same features which could possibly be used with the existing control cables although this would need verification from the irrigation manufacturer. As the main line pipe work must be upgraded, however, then then new control cables would be installed with the new pipe work.
- 2.40** *Recommendations;*
- *Replace the control system including, controller (a computerised controller should be installed), control cables and decoders / communication modules when undertaking upgrading works to the hydraulic element [main line] of the irrigation system.*
- 2.41** ***Greens Irrigation***
- 2.42** The sprinklers on the greens use a mixture of Rainbird 51DS / 47DS impact driven sprinklers. These sprinklers are now really obsolete and should not be replaced. Many sprinklers are in a poor working order. Gear driven sprinklers are now the industry norm.
- 2.43** The sprinklers on each green all operate at the same time from a solenoid valve which is remote from the green. There are usually four or five sprinklers on each green. This is known as ‘block’ irrigation as the sprinklers operate in ‘blocks’. Whilst this level of control was acceptable 20+ years ago it is now not. The disadvantages are lack of control of where water is applied to the putting surfaces affecting uniformity of moisture levels and surface condition / playability.
- 2.44** Modern irrigation design allows for all the green sprinklers to operate individually to provide individual head control using valve-in-head sprinklers. The advantage of valve-in-head gear driven sprinklers are the smooth, slow rotation speeds which allow for even coverage, the ability to have individual valve-in-head control without using a separate solenoid valve [to target water to specifically where it is needed, thus saving water] and individual head pressure regulation so as to provide even flows and distribution.
- 2.45** The sprinkler spacing’s were checked on greens 2nd / 4th / 13th / 17th. These were found to be variable on most of the greens ranging from 14m to 24m between the sprinklers. Where sprinkler spacing is poor this will affect the water distribution onto the green and therefore how uniformly the greens are watered. The only way to offset this is to use variable nozzles in the green sprinklers which is never ideal and not the norm. This would also be more difficult with block control.
- 2.46** During the visit the operating pressures at individual greens sprinklers were taken using a pitot gauge [these were not taken when an automatic cycle was operated from the irrigation computer controller so unfortunately are not a true reflection of night time pressures]. The sprinklers were operating anywhere between 5.0bar and 6.5bar depending upon where the green was located on the golf course.
- 2.47** The variable operating pressures of the sprinklers will influence the volume of water being applied to each green and this is likely to vary during each automatic irrigation cycle. It is therefore impossible for the Greenstaff to consistently apply a set volume of water to any green on the golf course which will make moisture management of the

putting surfaces extremely challenging, if not impossible. The reason for the variable operating pressures of the sprinklers and therefore random water volume applications affecting uniformity to each green is due to the lack of pressure regulation at the solenoid valves. Modern valve-in-head sprinklers have in-built pressure regulation which negates this problem. Pressure regulation cannot be added to the solenoid valves on the golf course.

2.48 The solenoid valves for the greens irrigation are showing the signs of 25+ years and will need replacement.

2.49 *Recommendations;*

- *The golf club should plan for replacement of the green irrigation using modern valve-in-head control and back to back sprinklers to allow for independent control of the putting green over the green surround thus allowing water to be targeted to where it is needed and not wasting water.*

2.50 Tee Irrigation

2.51 There was less time spent looking over the tees irrigation [5th / 14th / 15th / 16th]. This was because its infrastructure is of similar age to the greens i.e. some 25+years old, however, in a worse condition. The tees irrigation is extremely inefficient and often the sprinklers are damaged and do not pop up / operate correctly.

2.52 The sprinklers use predominantly Toro & Hunter gear driven sprinklers with the sprinkler and models variable on the same tee.

2.53 All tees within a teeing complex are also operated off one solenoid valve and therefore it is impossible to schedule irrigation efficiently thus wasting water. This is compounded by the fact that the sprinkler spacings are very poor (wasting much water) and vary from tee to tee on the same solenoid valve. It is therefore completely impossible to control moisture levels consistently on the teeing surfaces.

2.54 The solenoid valves use Richdel models, like the greens, which are not fitted with pressure regulation (it cannot be fitted). This means that during operation the sprinklers are subject to full system pressure minus any friction and elevation losses. With the nature of the golf course there will be some sprinklers which are operating at 8+bar when they are likely rated for less (this is the same for the greens). This will damage the sprinklers and affect their operation etc.

2.55 Poor operating pressure was mentioned on some tees such as the 5th – see photos.

2.56 *Recommendations;*

- *The golf club should plan for replacement of the tees irrigation.*

2.57 Approach & Fairway Irrigation

2.58 During the visit minimal time was spent reviewing the approach and fairway irrigation. This is because it is used less than the greens and tees and therefore has a lower priority.

- 2.59** The fairway irrigation does operate very like the greens and tees i.e. blocks of sprinklers off a single solenoid valve. There are normally three sprinklers per solenoid valve. The sprinklers are believed to be gear driven models, Rainbird R70. Depending upon the level of ongoing maintenance it is likely the sprinklers are in a poor state of repair with rotation speeds variable.
- 2.60** The fairway sprinklers are configured in an ‘in-line’ configuration. Therefore the sprinklers are prone to wind disturbance and do not apply water to the fairways evenly with areas not receiving water. In-line configurations are wasteful of water, extremely inefficient and are not really suitable for links courses.
- 2.61** The 18th fairway has a double row installed, however, it was reported not to be fully operational.
- 2.62** *Recommendations;*
- *The golf club should plan for replacement of the fairway irrigation.*

3. FUTURE IRRIGATION DESIGN

3.1 During the visit discussions took place about the requirement of any future irrigation design. We would recommend the following;

3.2 Areas to be Irrigated;

- Greens putting surfaces
- Greens surrounds [independently operating from the greens]
- Walkways from Green to Tees [where necessary]
- Approaches to Greens
- Fairways [avoiding overthrow into semi / rough areas]
- Walkways from Tees to Fairways [where necessary]
- Tees playing surfaces with minimal over throw onto peripheral areas

3.3 Irrigation Time Window;

The designed irrigation time window should schedule the weekly peak irrigation requirements for completion within approximately 7x 9 hour irrigation periods

3.4 Application Requirements;

We would propose to discuss the designed application quantities with your Course Manager.

4. CONSULTANCY WORKS

4.1 During the visit STRI/RHA were asked to put forward how they might help County Louth in upgrading the irrigation system.

4.2 It is very difficult to put forward any accurate budgets for upgrading of the irrigation system without undertaking some design works specific to the golf course.

4.3 We would therefore recommend that County Louth obtain an irrigation design for a system looking to the future. This design should include scaled plans, specification and conditions and a detailed bill of quantities.


- 4.4** The starting point for any future design is a scaled plan of the course including existing irrigation infrastructure (as required). From an irrigation point of view a scaled aerial image / drone fly-over backed up by GPS mapping to confirm the outlines of the greens, fairways and tees would suffice. Spot heights on greens and tees are sufficient.
- 4.5** Aerial imagery can be obtained from OS Ireland (we believe) or the golf club could have a drone survey undertaken which can be Georeferenced in AutoCAD. Drone surveys are certainly the way forward. The cost of such a survey is approximately £3,000. The cost for GPS mapping [2D] for the outlines of the greens, fairways and tees as discussed above with plan an accuracy of +/- 1m (depending upon differential correction) would be approximately £1,800.
[excl VAT and out of pocket expenses / travelling]
- 4.6** Any irrigation design fees are difficult to predict at this stage without discussing further the requirements and aspirations of the golf club.
- 4.7** The tender documentation produced for the works would consist of a detailed plan, specification and bill of quantities. The advantage of sending out tender documentation on a common design and documentation is that County Louth can obtain costs which are competitive and comparable allowing an educated decision to be made about with whom to proceed.
- 4.8** STRI/RHA can carry out a range of services which include;
- GPS mapping of the course [for outlines of areas to be irrigated]
 - Preparation of outline and detailed irrigation design including scaled plans, specification and conditions, and bills of quantities
 - Tender documentation to send out to bidding contractors
 - Appraisal of the tenders submitted
 - Contract documentation for signature by the golf club and contractor
 - Monitoring and inspection of the works during installation

5. SUMMARY

- 5.1** To maintain a high quality golf course there is a requirement to have an efficient and reliable irrigation system covering the green putting surfaces (and surrounds where necessary), approaches, fairways (if necessary) and tees playing surfaces to supplement deficiencies in summer rainfall and to assist in various essential maintenance operations. The existing system does not provide the necessary efficient coverage, reliability and control features throughout that are required of a modern system.
- 5.2** Joe Mooney reported that the existing automatic irrigation system on the Course, although an essential maintenance tool, is used on a limited basis to encourage native bent and fescue grasses indicative of links golf, as over watering will promote weedier species. We would totally agree with this philosophy, however, when an irrigation system is used in this manner any inefficiencies in its infrastructure and operational capabilities become more apparent and there is a greater need for a reliable fully automatic system to act as an insurance policy to ensure water can be applied as and when required.
- 5.3** The aim of any irrigation system is to apply water evenly to the areas required, and to be able to apply sufficient water to maintain soil moisture during drought conditions to all of the areas within the specified irrigation time cycle. It should also take into account the

need for water conservation.

- 5.4** With the objective of County Louth Golf Club being to improve the coverage, operation and reliability of the irrigation system on the Course to bring the system up to modern standards there is a need to consider;
- **Investigations in water supplies**
 - **Investigations into water storage and irrigation system design**
 - **Installation of new irrigation pumping system in new purpose built pump house beside storage tanks [location to be determined]**
 - **Replacing the mains pipework and control cable to ensure efficient and reliable watering to all areas**
 - **Installation of new automatic irrigation to the greens and immediate green surrounds**
 - **Installation of new automatic irrigation to the approaches**
 - **Allowance for fairway watering and installation as necessary**
 - **Installation of new automatic irrigation to the tees**
 - **Installation of new computerised control system**
- 5.5** With many areas of the irrigation system aging over the golf course randomly patching up the existing irrigation system would be a waste of money and time and to be honest could cause more problems than it solves. If any part is upgraded it will likely influence the balance of the current system which may cause further problems and therefore a dedicated and committed phasing of any upgrading works is required.
- 5.6** The financial dilemma of upgrading an irrigation system is one faced by many golf clubs and for certain it is better to spend any money wisely than throw it away. County Louth is going to be faced with replacing major areas of the system at some stage very soon. As mentioned previously any new system should provide efficient, uniform irrigation with water application being related to evapotranspiration and the ability to target water precisely where it is required.
- 5.7** Should County Louth wish to visit other venues where we have worked to look at their irrigation infrastructure we are certain this could be arranged and we would be pleased to help in any way. RHA have worked at many golf courses including golf courses such as Portmarnock, Royal Portrush, Ballyliffen as well as those in the UK such as St. Andrews Links, Turnberry, Royal Birkdale, Royal St. Georges etc. all of whom have irrigation systems at various ages.
- 5.8** Finally it is important that any irrigation design carried out must meet County Louth's current and future requirements. This will enable a structured Management Plan to be implemented, and followed, in an approach to upgrading the system to meet current industry standards and County Louth's time and financial resources. To this end the system should be designed to irrigate all the necessary areas, apply the correct amounts of water to these areas, and operate within the desired nightly irrigation time window.
- 5.9** A fully automated irrigation system which is correctly designed, installed, managed and operated will not have a detrimental effect on the condition and quality of any golf course.



Prepared by - Adrian Mortram, RHA/STRI; October 2017.

6 - APPENDIX – RISK REGISTER

County Louth GC

Risk Register

01/10/2017

Evaluation Matrix

		Likelihood					
		Remote	Unlikely	Possible	Likely	Certain	Legend;
Current Impact	Very Low	1	2	3	4	5	No action required
	Low	2	4	6	8	10	Planning for action required
	Medium	3	6	9	12	15	
	High	4	8	12	16	20	Action required
	Very High	5	10	15	20	25	

Items for Evaluation;

Evaluation Score / Risk Rating

1	Irrigation system age [approx 1990]	20
2	Incoming water supply; reliability and pressure	9
3	Irrigation water quality;	4
4	Irrigation water usage records;	8
5	Water transfer system(s); reliability and condition	12
6a	Water storage (reservoir); age, condition and sufficiency	12
6b	Water storage (tank); age, condition and sufficiency	n/a
7	Pump station & house; age, condition, reliability, sufficiency	12
8a	Pipe work; age, specification, condition and reliability	12
8b	Pipe work; size for system design and desired operation	9
9	Control cabling; age, condition, reliability and jointing	12
10	Isolation valves; condition and reliability	n/a
11	Solenoid valves; condition and reliability G / T / F	12
12	Green and approach irrigation; condition and reliability	12
13	Fairway irrigation; condition and reliability	12
14	Tee irrigation; condition and reliability	12
15	Green irrigation system coverage;	12
16	Fairway irrigation system coverage;	12
17	Tee irrigation system coverage;	12
18	System operating pressure (sprinklers);	12
19	Controller; age, support, condition and reliability	4
20	Planning for system upgrade; required	20
21	Preparation of management plan incl irrigation design; required	16

Notes; G / T / F; G=Greens, T=Tees, F=Fairways

7 - APPENDIX - PHOTOS

1 – Water supply @ 4th Hole – Note; water quality



2 – Pump house - @ 4th Hole



3 – Irrigation pump station within pump house – Note uPVC and manual prime etc



4 – Irrigation controller in pump house



5 – Potential site of new storage tank and pump house @ turf nursery beside 4th Holes



6 – Existing sprinkler connections

– Note; failing galvanised steel and poor articulation for adjusting sprinkler heights



7 – Typical solenoid valve – Note; valve condition and no pressure regulation



8 – Existing control cable



9 – Typical tee irrigation – Note; poor coverage [dry areas at corner]



10 – Typical tee irrigation

– Note; single sprinkler in middle wasting 40% of water off the teeing surface



11 – Typical green irrigation – poor pressure and coverage



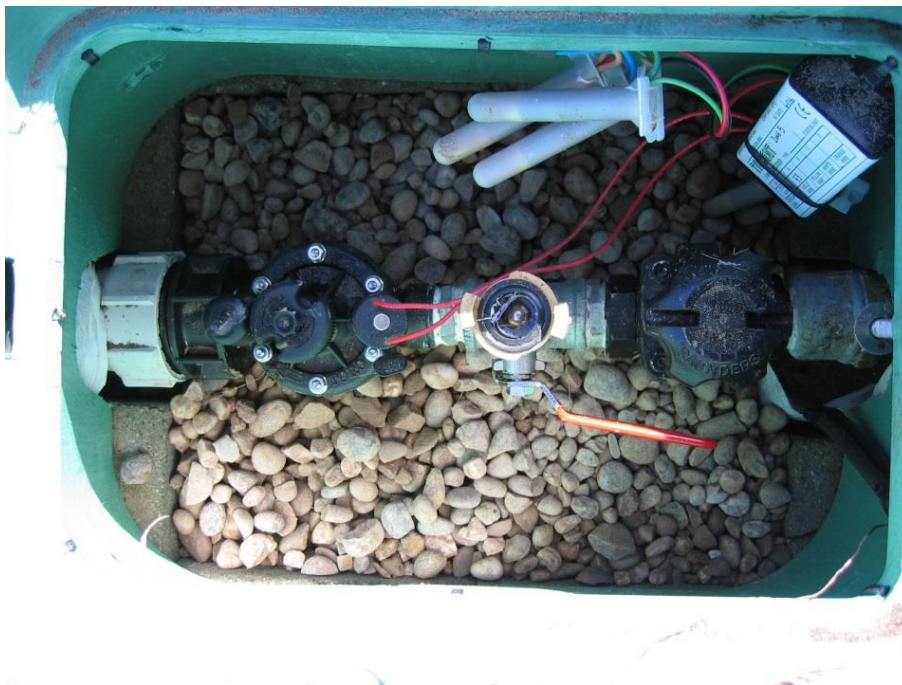
12 – Typical green irrigation – improved pressure, coverage still poor



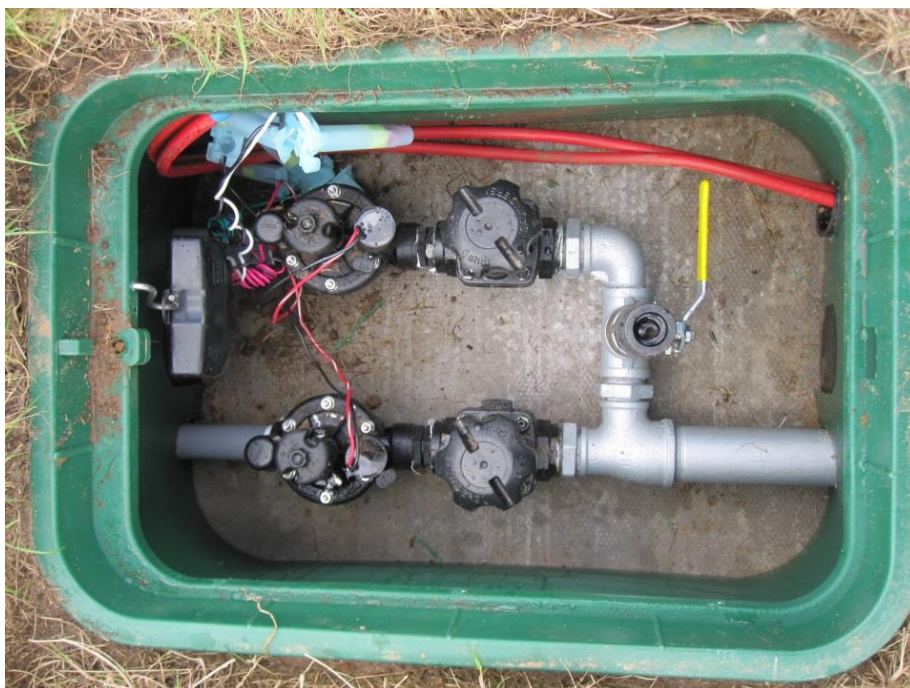
13 – Typical green sprinkler leaking around sprinkler head during operation



14 – Modern Tees Solenoid Valve [example photograph]
- note good access to all components etc.



15 – Correct Cable Terminations in water tight DBY/R-6 connectors [example photograph]



16 – Typical fairway irrigation – Note; single row and wind disturbance



17 – Typical fairway irrigation – Note; poor coverage shown by turf quality





18 – Modern Valve-In Head Sprinklers in Operation [example photograph]
– note good curtain of water and coverage [low angle nozzle shown for windy conditions]

