

Recycled Wastewater Reuse Project

Barwon Heads Golf Club



Horticulture Australia



For the past three years the Barwon Heads Golf Club has been the setting for the AGCSA's recycled wastewater trial.

With the second irrigation season now complete, AGCSATech manager John Neylan provides an update of the ongoing Horticulture Australia-funded treated effluent trials at Barwon Heads Golf Club.

INTRODUCTION

The Australian Golf Course Superintendents Association (AGCSA), with funding from the Barwon Heads Golf Club and Horticulture Australia, has established a trial at the Barwon Heads Golf Club to monitor the effects of irrigating with recycled wastewater. In April this year, the second irrigation season and associated monitoring program was completed.

The supply source of the Class C treated wastewater is from the local water authority plant approximately 8km to the west which also services 13th Beach and The Sands, Torquay. The Barwon Heads Golf Club elected to irrigate greens, tennis courts and sensitive areas with a new potable water supply with reclaimed wastewater used on all other areas.

The project involves monitoring soil and water on the golf course as well as on a purpose built nursery green. The nursery green

has half the area irrigated with potable water and the other half with recycled wastewater and has been established with three bentgrass varieties and two *Poa annua* cultivars.

This project has provided a unique opportunity to monitor the effects of salts, sodium and nutrients on soils and turf quality and provides an excellent opportunity to monitor a site that has not previously used recycled wastewater.

The monitoring program that has been implemented includes weekly sampling of the effluent supply, sampling of the soils at 0-100mm, 100-200mm and 200-300mm depths and sampling watertable monitoring wells and ponds on the golf course.

SOIL AND WATER ANALYSIS

Water analysis

In the irrigation season of 2003/2004, water samples were collected weekly for a range of

tests and the typical water quality (*Table 1*) can be described as follows;

- Salinity varied from 960-1600 mg/L with several readings at 1500mg/L and over the monitoring period averaged 1324mg/L (See *Figure 1*). The salinity is considered to be high and is higher than the 2002/2003 sampling period;
- Average pH is 7.5 with a range of 7.1-8.5;
- Sodium and chloride are high and relate to the high salinity. Both elements have increased since the 2002/2003 sampling period;
- Sodium Adsorption Ratio is marginal due to the high sodium;
- Total nitrogen is moderate;
- Total phosphorus is high;
- Potassium is very high;
- All other elements are low to very low.

The main concerns with the effluent continue to be the high salinity, high sodium and high chloride.

Soil analysis

A large number of soil samples have been collected over the past three years and some of the representative results are detailed in Tables 2 and 3. As a control area, we have established a sampling point on a fairway that is irrigated with potable water and in the native soils where there is no irrigation or turf maintained.

The soils on the fairways are naturally alkaline with occasional outcrops of limestone. They are high in calcium, low in sodium and have moderate phosphorus levels. After the first season of irrigation there had been an increase in total salts and sodium and a slight decrease in calcium. At the August 2003 sampling, there was a reduction in soil salts and sodium due to the leaching of winter rains. Following the 2003/2004 irrigation period there was a moderate increase in soil salinity and a slight increase in sodicity

There has also been an increase in total phosphorus with little change in plant available phosphorus. This same trend has also been observed on the fairway that is irrigated with potable water and not effluent. The soil results do not indicate any movement down the profile.

The unirrigated site provides a good indication of the effects of the natural conditions on the golf course where there continues to be considerable variation between sampling periods.

The turf quality on the fairways has been monitored and it consists of an excellent sward of couchgrass with no signs of the effluent affecting the turf.

**Table 1: Effluent water analysis
Barwon Heads Golf Club**

CHEMICAL ANALYSIS WATER CHARACTERISTICS	IDEAL RANGE	2003/2004	2002/2003
pH, units	5 - 8	7.3	8.0
Electrical conductivity (microS/cm @25C)	<750	2500	1800
Salinity by calculation (mg/L)	<450	1500	1100
Total alkalinity, as CaCO3 (calc.)	<150	170	170
Bicarbonate, as HCO3 (mg/L)	-	210	210
Carbonate, as CO3 (mg/L)	-	<1	<1
Chloride, as Cl (mg/L)	<100	480	370
Sulphur, as SO4 (mg/L)	<100	120	90
Calcium, as Ca (mg/L)	<100	37	30
Magnesium, as Mg (mg/L)	<100	33	25
Hardness, calculated as CaCO3	<150	230	180
Sodium, as Na (mg/L)	<70	330	260
Residual Sodium Carbonate (calc.)	<1.25	-1.16	-0.14
Sodium Adsorption Ratio - SAR (calc.)	<10	9.5	8.5
Nutrients			
Nitrate + Nitrite, as N (mg/L)	*	4.3	2.3
Total Kjeldahl Nitrogen, as N (mg/L)	*	2.8	3.1
Total Nitrogen, as N (mg/L)	*	7.1	5.4
Phosphorus, total as P (mg/L)	*	7.3	8.8
Potassium, as K (mg/L)	*	57	>50
Other			
Iron, as Fe (mg/L)	<1	<0.05	0.09
Cadmium as Cd (mg/L)	0.01	<0.0002	<0.0002
Chromium as Cr (mg/L)	0.1	0.013	0.01
Copper, as Cu (mg/L)	<0.2	0.004	0.009
Nickel Ni (mg/L)	0.2	0.006	0.004
Lead Pb(mg/L)	0.2	<.001	0.001
Zinc, as Zn (mg/L)	<2.0	0.14	0.078
Mercury as Hg (mg/L)	NG	<0.0001	<0.0001
Arsenic as As (mg/L)	0.1	0.002	0.002
Manganese, as Mn (mg/L)	<0.2	0.02	
Boron, as B (mg/L)	<2.0	0.25	

**Table 2: Soil analysis
Irrigated 9th fairway (0-100mm)**

Element	Apr-02	Nov-02	Apr-03	Aug-03	Apr-04
pH	8.0	7.6	8.1	7.6	8.3
Total Salts (mg/kg)	446	891	1247	683	983
P (Olsen) (mg/kg)	14	16	8	15	7
Total P (mg/kg)	740	720	470	500	700
%Na	2	2	7	4	6
% Ca	90	88	83	83	80

**Table 3: Soil analysis
Unirrigated 2nd fairway (0-100mm)**

Element	Apr-02	Nov-02	Apr-03	Apr-04
pH	7.5	6.1	5.9	5.7
Total Salts (mg/kg)	267	178	475	89
P (Olsen) (mg/kg)	3	1	<1	<1
Total P (mg/kg)	ND	55	35	ND
%Na	2	7	19	4
% Ca	82	69	52	72

Results at the end of the 1st irrigation season
 Results at the end of the 2nd irrigation season

**Table 4: Soil analysis
Fairway irrigated with potable water (0-100 mm)**

Element	Aug-03	Apr-04
pH	5.7	6.5
Total Salts (mg/kg)	446	387
P (Olsen) (mg/kg)	18	4
Total P (mg/kg)	200	400
%Na	4	7
% Ca	72	67

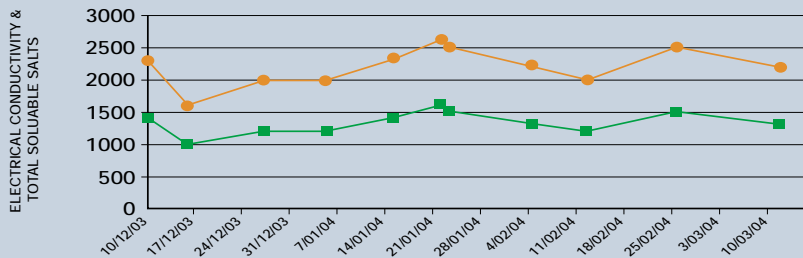


Figure 1:
 BARWON HEADS GOLF CLUB
 EFFLUENT MONITORING PROGRAM
 SALINITY 2003/2004
● Electrical Conductivity (microS/cm@25C)
■ Salinity by Calculation (mg/L)

NURSERY GREEN

Turfgrass trials

The nursery green has been established with the following turf species/varieties;

- Mariner (*Agrostis stolonifera*)
- Seaside II (*Agrostis stolonifera*)
- Penn G2 (*Agrostis stolonifera*)
- Grand Prix (*Agrostis stolonifera*)
- Penn State Poa (*Poa annua reptans*)
- BHGC Poa (*Poa annua reptans*)

The *Poa annua* species are a selection from the Penn State University (PSU) project being undertaken by Dr David Huff and the local type that occurs on the greens at Barwon Heads (BHGC Poa). The bentgrass cultivars were selected based on proven salt tolerance and availability of seed. In particular the research of Kenneth Marcum (*Salt tolerance varies in modern creeping bentgrass varieties. GCSAA Journal. October 2000*) was used as a guide.

The results for average turf quality after two seasons of effluent irrigation are detailed in Table 5 and Figure 2.

The results from the second irrigation season indicate that there have been no detrimental affects of using the effluent water compared to the use of potable water and there is no cultivar/water quality interaction. At this time the only significant differences are due to the species or cultivar.

The cultivars Penn G2 and PSU Poa had the best turf quality. In December 2003, there was a period of high temperatures that severely damaged the local ecotype of *Poa annua*, but had no effect on the PSU Poa. In February there was a blow out in the effluent supply and the plots were unable to be watered for 10 days. All species/cultivars were affected, however, they all recovered and the PSU Poa in particular survived the conditions extremely well.

Soil analysis

Soil samples were taken at the end of the irrigation period and the results are detailed in Table 6. In 2002/2003, the section that was irrigated with effluent had an increase in sodium and a decrease in calcium compared to the potable water irrigated area. There was also an increase in total and available phosphorus. Salinity and pH were similar for both areas of the green. However, the 2004 sampling indicates very little difference between the two treatments and the minor effects of the effluent appear to be overridden by the effects of fertilisers.

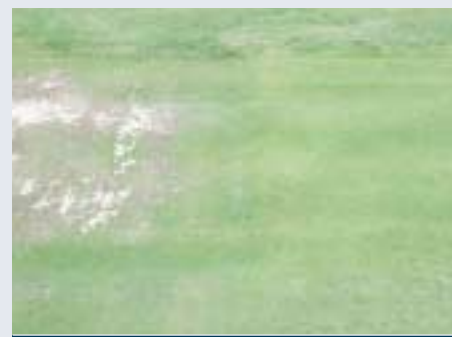
CONCLUSION

At the Barwon Heads Golf Club the second irrigation period has been completed using treated effluent that is high in salts, sodium and chloride. There was an increase in these particular elements in the 2003/2004 irrigation period.

On the fairways there has been an increase in sodium and a reduction in calcium, however, there has been no affect on turf quality with an excellent cover of couchgrass being maintained.

It is expected that if normal winter rains occur there will be a leaching of salts and sodium. The general calcareous nature of the soils appears to provide sufficient calcium once leaching occurs.

On the nursery green there is very little difference in soil chemistry and there is no significant difference in turf quality between the potable water and effluent treatments. 🌱



Nursery green trials - PSU poa (right) compared to local *Poa annua* strain

Table 6: Soil analysis - Nursery green

	Potable Apr 03	Effluent Apr 03	Potable Aug 03	Effluent Aug 03	Potable Apr-04	Effluent Apr-04
pH water	7.8	8.1	6.3	6.4	6.3	7.1
EC (dS/m)	0.12	0.11	0.06	0.05	0.06	0.09
Total Soluble Salts (mg/kg)	356	327	178	149	178	268
Total P (mg/kg)	<20	22	200	200	300	300
P (Olsen) (mg/kg)	9	15	6	10	4	7
%Na	7	17	4	7	11	13
% Ca	68	47	31	39	50	58
%Mg	15	22	11	14	10	6
%K	13	15	53	40	29	23
Organic C (%)	nd	nd	0.17	0.35	0.30	0.22
Copper (Cu) - DTPA	<0.1	<0.1	nd	nd	<0.1	<0.1
Zinc (Zn) - DTPA	0.3	0.3	nd	nd	0.21	0.22
Manganese (Mn) - DTPA	<0.5	<0.5	nd	nd	<0.5	<0.5
Iron (Fe) - DTPA	54	66	nd	nd	35	29

Table 5: Turf quality for nursery green

(0 = worst, 9 = best)

EW = Effluent water, PW = Potable water

Treatment	Apr 03	Aug 03	Sep 03	Nov 03	Apr 04	AVG
PSU poa-EW	6.3	7.8	7.0	7.7	7.2	7.2
BHGC-EW	ND	ND	6.0	6.3	5.7	6.0
Grand Prix-EW	5.7	6.3	6.3	6.2	6.7	6.2
Mariner-EW	4.8	5.7	6.0	5.5	6.2	5.6
Penn-G2-EW	6.5	7.2	6.3	6.8	6.2	6.6
Seaside II-EW	5.2	5.8	5.8	5.8	5.7	5.7
PSU poa-PW	6.5	7.7	7.0	8.0	7.7	7.4
BHGC-PW	ND	ND	6.3	6.0	4.0	5.4
Grand Prix-PW	5.7	6.3	6.3	6.3	6.8	6.3
Mariner-PW	5.3	5.7	6.0	5.5	5.8	5.7
Penn-G2-PW	6.5	7.3	6.7	7.7	7.5	7.1
Seaside II-PW	5.8	5.8	6.2	5.8	6.5	6.0
LSD <0.05	0.7	0.7	0.4	0.9	1.1	

Figure 2: Barwon Heads Golf Club
Reclaimed water trials - Nursery green

