ON-SITE WASTEWATER MANAGEMENT - A COMMUNITY AND ENVIRONMENTAL ASSET

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ABSTRACT

On-site wastewater management was forced on a tourist development at Byron Bay on the far north coast of NSW because the existing community's sewerage system was at capacity and unable to cope with additional developments. The planned resort development appeared thwarted by environmental planning constraints around the performance of small-scale packaged treatment systems handling up to 50 kL per day. Initially, it was planned that reclaimed water be used for landscaping and toilet flushing. The former was deemed environmentally unacceptable because of close proximity to an intermittently closed estuary and high water table, while local health officials debated the latter as a potential public health problem. In a Land & Environment Court decision, development consent was granted with numerous stringent conditions on treatment plant operation, including subsurface irrigation of reclaimed water for landscaping and refusal for reuse for toilet flushing. Strict monitoring and reporting regimes were also set.

The five-star resort is now complete, with 92 units enjoying high occupancy and serviced by a state-of-the-art sewage treatment system. With the addition of stormwater collection for landscaping, the resort makes significant savings by avoiding use of the community's scarce drinking water resources. The reclaimed water is of sufficiently high quality that toilet flushing is likely to be approved and landscaped areas have been increased. With the resort at full capacity, excess reclaimed water is piped to the local golf course, where it is used for aesthetics and irrigation of a landscaped area that would otherwise be without supplementary water.

While the resort owners have financed the synergy from the reclaimed water use at the golf club, the benefits to the wider community are numerous. This example of modern wastewater treatment and beneficial reuse of reclaimed water is verified by daily, monthly and quarterly monitoring of treatment plant operation, reclaimed water quality, soil and groundwater monitoring at both the resort and the golf club. This paper illustrates the reclaimed water quality and low footprint the resort has on the environment while protecting public health and enhancing community amenity.

Keywords: community asset, decentralised, nano-filtration, package treatment plant,

1 INTRODUCTION

The areas for growth of residential and tourist developments cannot be constrained by the availability of reticulated sewage schemes nor should the remoteness of a suitably located sewerage system be used to deny development for population expansion and community infrastructure. With the construction of modern municipal sewerage systems unable to meet the increase in urban development, peri-urban developments are the simple early sacrifice and some planning policies restrict single households to 4000 m^2 on the basis that such an area is required for adequate on-site treatment and disposal of domestic effluent. Such policy may have been reasonable a century ago, but today's engineering progress has lead to affordable on-site wastewater treatment that requires a smaller footprint, produces high quality water while reducing demand for scarce drinking water.

A modern five-star tourist facility at Byron Bay, on the far North Coast of New South Wales, was permitted after the developer won approval by the Land & Environment Court to construct its own on-site wastewater treatment system and use the effluent for on-site irrigation of landscaped areas. *The Byron at Byron Resort* (The Resort) gained additional conditional approvals for recycling of effluent for toilet flushing and off-site irrigation at the Byron Bay Golf Club (BBGC). While the water system is an integrated whole-of-cycle approach, the cost to the community for sewage treatment and the demand for drinking water for toilet flushing and irrigation are significantly reduced by the independent approach of a decentralized wastewater treatment system.

Other communities could benefit if such systems were higher on their current priorities instead of disinterest and sometimes antagonism.

This paper outlines the benefits, to owners and the community, of an appropriately designed, professionally operated and regularly monitored wastewater treatment system that meets the expectations of NSW Health and the local Byron Shire Council's On-site Sewerage Policy.

2 PLANNING APPROVAL

Understandably, local authorities fear the proliferation of independent isolated wastewater treatment systems that may be poorly maintained or operated contrary to approvals and well outside 'best practice management'. In the event of system failure, the Council bears ultimate responsibility under the Local Government Act 1993 and the Protection of the Environment Operations Act 1997 for any health and environmental consequences of the failed system. It is easy to understand Council's concern that the system initially planned, then installed and operated is done so with the benefit of sound knowledge and professional management. So too is it easy to understand the frustration from the developer when there is disbelief that a private operator could run a system as efficiently as a Council, yet records show that failure in municipal systems is a frequent occurrence. Suggesting that because on-site systems (septic tanks) have a high failure rate or that modern aerated wastewater treatment systems (AWTS) are inadequately maintained does not correlate to larger package treatment plants. Sydney Water's Blackheath sewage treatment plant (STP) discharged an effluent with a mean faecal coliform (FC) of 1400 cfu/100 mL and an observed maximum of 14000 cfu/100 mL in the 2004-05 period (Sydney water 2005) into a World Heritage Area. Yet conditions on packaged treatment plants are set at < 10 cfu/100 mL (90^{th} percentile) and for water recycling, even more stringent conditions are set on viruses and parasites (NSW RWCC, 1993).

Prior to the proposed development of the current tourist facilities, the 17.2 ha of land was zoned partly 2(t) tourist area zone, 7(a) Wetland zone and 7(b) Coastal Habitat pursuant to the provisions of the Byron Local Environment Plan (LEP) (LEC, 2000). Previous owners had constructed numerous wetland areas and the land had been used since 1970 as a picnic ground and for weddings and receptions. That the land was 'man-made' wetlands and not pristine wetlands was most obvious.

The original development application lodged with Byron Shire Council was refused and this refusal challenged by the developer in the NSW Land & Environment Court (LEC). At the time, the municipal STP at South Byron (now decommissioned) was at maximum loading and the Council had a moratorium on new connections to the sewer. In effect, the development was entitled to one standard connection (900 L/day) for the previous approvals (one house) and 12 for the 12 cabins, and certainly had no entitlement to 136 tourist units and ancillary facilities. The only means of meeting Council's LEP was to show that a decentralised sewage system was feasible. The economics of the stand-alone system was never contested, as that financial burden was a matter of commercial consideration only. Other issues contested are not part of this discussion.

In making its findings, the LEC (proceedings No.10114 of 2000) approved the development of 92 units and other facilities with many conditions for the design, installation, maintenance and monitoring of the sewage treatment system and the land application area. All conditions required scrutiny by the Council prior to commissioning. One concession to which the developer agreed was that Rous Water, the local authority managing water and sewerage in the region, would take over the operation and monitoring of the STP after the system was proven to meet the performance criteria. The resort owner was always responsible for all costs of operation, maintenance and monitoring of the system.

A subsequent appeal before the LEC (No.11073 of 2005) won the approval for redirecting excess reclaimed water from The Resort to Byron Bay Golf Club (BBGC) where it would be stored in a lined dam and then used for subsurface irrigation of the landscaped area along Broken Head Road.

3 THE BYRON AT BYRON RESORT

The two-stage development has seen the construction of a five-star resort of 92 luxury units in four blocks with centralised facilities including 230 seat restaurant, specialty facilities, conference rooms, gymnasium, day spa, swimming pool and staff amenities. These facilities are built around the complex of water features and an extensive boardwalk through the area and along to Tallow Creek with access to the ocean beach. The area is extensively landscaped, weeds removed regularly and indigenous species replanted. Significant effort to control mosquito nuisance is conducted.

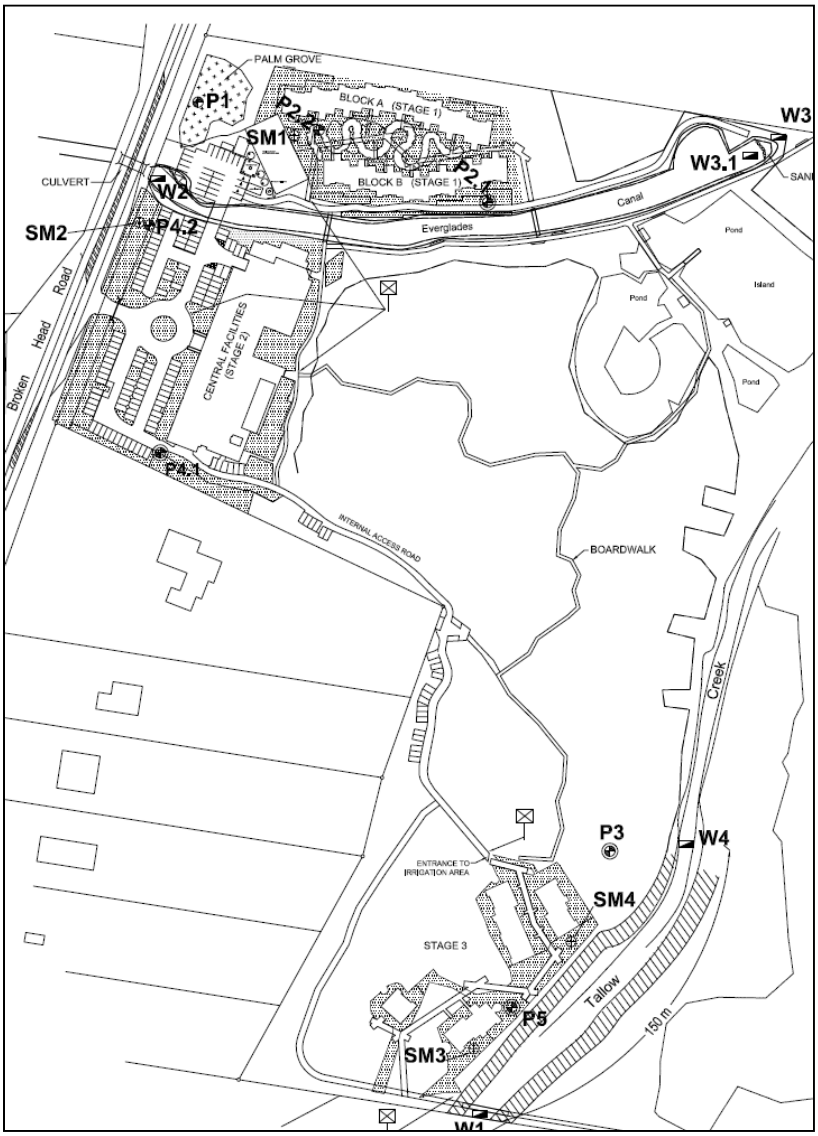

Figure 1 Layout of *The Byron at Byron* Resort
Source: Land Partners Limited 2007

Figure 1 shows the layout of the facility and in particular the small footprint the facilities have on the land. The "Everglades Canal" drains significant upstream development through the site.

Tallow Creek, a closed, intermittently opened estuary also drains significant upstream semi-urban areas as well as suffering from tidal surges of sea water, periods of stagnation prior to natural opening of the sand bar at its mouth. Water quality in both waters passing though The Resort is mostly influenced by outside resources. The current range of monitoring points for stream water (W), soil (SM) and groundwater piezometers (P) are shown.

A more extensive suite of monitoring points existed during development and construction phases.

The extensive boardwalk through the wetland area is marked on Figure 1 and provides significant opportunity for public awareness of wetland issues.

3.1 The Decentralised System

The 60 units of Stage 1 (blocks A, B and centralised facilities) were constructed and connections made to the on-site STP. Three duplex submersible pump stations, external to the STP, collect sewage and trade waste from the kitchen, day spa, pool waste and amenities; sewage from Stage 2 units along Tallow Creek; a single submersible from the wedding chapel pumps to the end of the Stage 1 units where it gravitates to pump Station 1 (another duplex submersible). During Stage 1 the reclaimed water was pump-out by Richmond Waste until the operation of the plant was confirmed to meet the performance criteria. This activity was supervised by AIM Pumps Pty Ltd.

The STP contains a collection well with a submersible shredder pump, an activated sludge bioreactor with denitrification that intermittently decants to the two intermediate tanks thence through disc filters, and ultraviolet (UV) disinfection to the 600 kL main storage tank under the tennis court. From a smaller holding tank the effluent receives nano-filtration, further disinfection, pH correction and then passes via a booster pump and filtration for use as landscape irrigation around the resort.

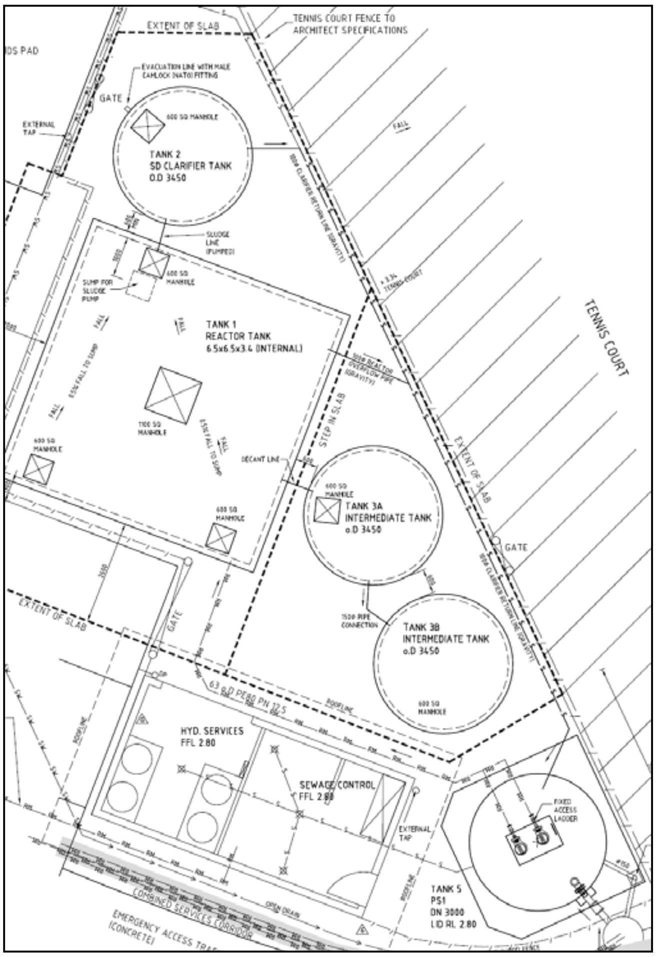

Figure 2 Wastewater treatment at The Resort
Source: Aspect North, Lismore 2002

Incoming sewage, as measured in January, February and March 2007 had a BOD_5 of 310-524 mg/L, TP 7.6 to 10.2 mg P/L, TN of 54 to 75 mg N/l and an ammonia concentration of 27-48 mg/L

In early 2006, a nano-filtration membrane filter was installed on the final effluent to remove viruses. To satisfy the requirements for toilet flushing, the effluent must be tested and meet the performance criteria for three months. To date that final stage has not been approved.

The last results for virus testing were below detectable levels. However, the occasional exceedance of faecal coliform readings is sufficient to delay recycling for toilet flushing.

Wastewater generation from 1 February to 31 May 2007 averaged 35.8 kL/day. Records of occupancy are not matched against wastewater discharge, although in the early operation of the plant, the daily rate of 250 L/person was assessed for operational purposes.

Quality of the water from the plant has met the performance criteria and the management of the system has been passed to Rous Water for their operation and monitoring.

The data for the period 4 Feb - 30 May 2007 from the monitoring of the reclaimed water are shown in Table 1.

A problem with the sludge return in April elevated several readings for total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP). However, further filtration and buffering in the reclaimed water storage overcomes these minor inconsistencies. For the results in Table 1, the STP was operating at near capacity of 55 kL/day.

Table 1. Recent data for effluent from the STP, monitored by Rous Water

Limits	Al^{3+} mg/L	BOD_5 mg/L	Chlorophyl-a mg/L	EC dS/m	FC cfu/100 mL	Oil & Grease mg/L	pH	TSS mg/L	TN mg/L	TP mg/L
90^{th} percentile	0.35	5	2.2	0.99	1.5	< 5	7.56	17	14.8	0.6
Average	0.29	2.6	0.6	0.81	0.4	< 5	7.15	10.3	5.4	0.7
Licence	5	5	n.a.	n.a.	< 10	n.a.	6.5-8	10	6	1

Al^{3+} is soluble aluminium, BOD_5 = 5-day biochemical oxygen demand, EC = electrical conductivity

3.2 On-site Irrigation

In the step up from Stage 1 to the completed project, daily-reclaimed water increased from 16 kL/day to 55 kL/day and an increased irrigation area developed. Previously Council had restricted the on-site irrigation area to a maximum of 16 kL/day, significantly less than the resort's potential to generate. Due to the proximity of the facilities to public land along Broken Head Road, neighbouring property to the south, and proximity to both Everglades Canal and Tallow Creek, contiguous areas were irrigated from stormwater collected off buildings and stored in tanks. Areas away from boundaries were landscaped for irrigation with reclaimed water. However, the areas available for irrigation with reclaimed water required significantly less than the 55 kL generated each day.

The second appeal to the LEC gained approval for a holding dam and irrigation on the nearby BBGC, thus allowing expansion to Stage 2. This is discussed in a later section.

3.3 On-site Monitoring

Conditions of approval require a three-monthly monitoring of the surface waters, groundwater and soil in the areas where irrigation with reclaimed water is being used as shown in Figure 1.

3.3.1 Surface Waters

The results for the surface waters reflect elevated levels of stormwater entering Everglades Canal and Tallow Creek from urban areas upstream of The Resort. On many occasions the water flowing through The Resort is poor quality water that is likely to also influence the local groundwater. The soils are highly permeable sands, that have groundwater close to the surface, that responds rapidly to rainfall.

Table 2. Surface water results for four locations over three years (2005-2007)

Location	pH	EC dS/m	BOD_5 mg/L	TP mg/L	TN mg/L	Na mg/L	SAR	FC cfu/100 mL
Tallow Ck upstream	5.97	2.38	2.5	0.11	0.96	407	10.1	391
Tallow Ck downstream	6.15	3.29	1.5	0.09	0.89	543	12.2	393
Everglades canal Upstream	6.11	0.17	2.6	0.05	0.55	20	1.8	997
Everglades canal Downstream	6.10	1.37	2.7	0.05	0.60	245	5.2	1002

3.3.2 Groundwater

Influences on the groundwater include the adjacent waterways and the wetlands on the site, as well as the extensive use of surface mulch to encourage vegetation on these poor sands. Water quality in the control piezometer (P1), located near Everglades Canal adjacent to Broken Head Road fluctuates to the same extent as the piezometers at the other five sites and shows that changes to the groundwater by the development are of little consequence. All piezometers are registered under the Water Act.

3.3.3 Soil monitoring

Permanent soil sampling locations are shown in Figure 1. Measurements over the last three years indicate minor difference in the surface soil (0-100 mm), mostly due to the use of surface mulch, with increases in available phosphorus from the fertilisers and a change in TN from the organics in the mulch. These increases are improvements in what was previously highly nutrient-deficient sand. Changes to the subsoil (500 mm) mostly remain at deficiency status. The potential for leakage of nutrients to groundwater is very low, confirmed by the results of groundwater monitoring.

4 IRRIGATION AT BYRON BAY GOLF CLUB

Excess reclaimed water is pumped from the resort by dual submersible constant pressure pumps in the reclaimed water holding tank through a filter and UV system and delivered through a 65 mm rising main to a newly constructed 3.5 ML lined-dam at the BBGC. A separate pump station adjacent to this dam pumps water to an 8500 m^2 landscaped area along the boundary with Broken Head Road. Rothwells Pump and Irrigation of Alstonville installed subsurface drip irrigation with the appropriate filters, controls and scheduling and allowance for buffer distances as required by Council.

The BBGC had been using secondary effluent from Council's South Byron STP since the 1980's, delivered through a pipe under the road to a large lagoon on the golf club, as shown in Figure 3 to the north of the lagoon. This lagoon also captured stormwater from a large proportion of the golf course and, from measurement on three old bores, had a possible direct connection to groundwater. A pump station at the southern end of the lagoon pumped water to irrigated fairways and greens. Since decommissioning its South Byron STP, Council now supplies higher quality effluent from their West Byron STP for reuse on the golf course.

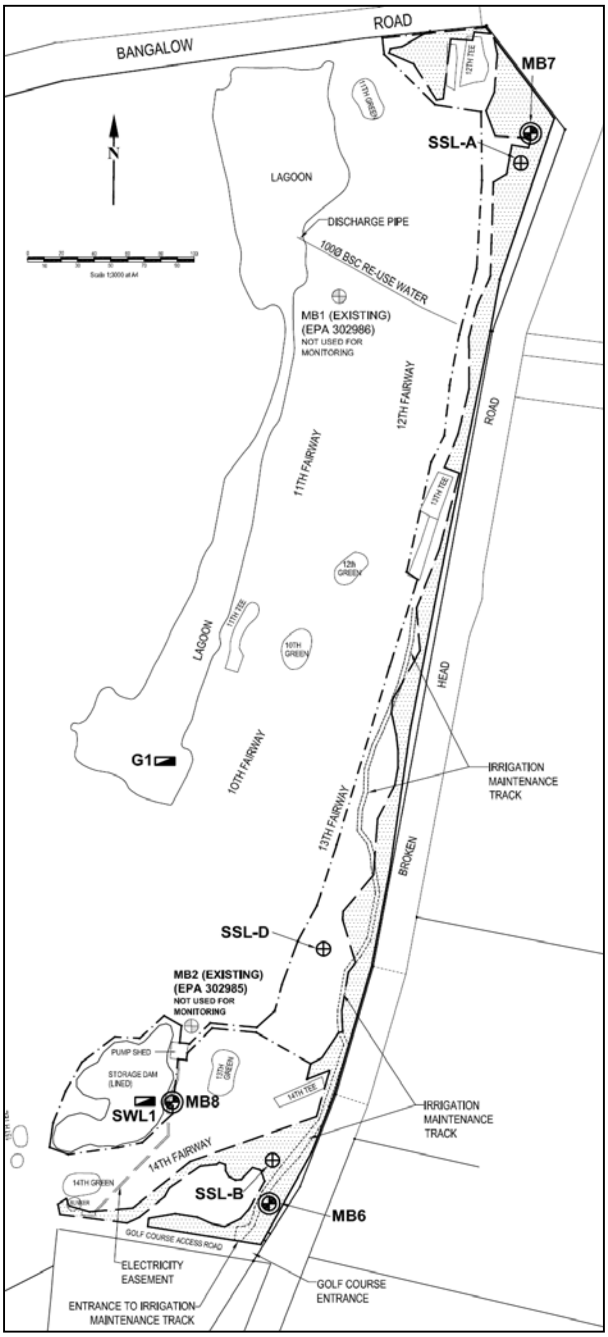

Figure 3 Irrigation area, lagoon and reclaimed water dam at BBGC
Source: Land Partners 2007

For whatever reason, The Resort was not permitted to discharge its high quality water into the same lagoon, necessitating construction of the lined dam specifically for the reclaimed water from the Resort.

Table 3 shows the previous quality of the water in the lagoon (southern end near pump station), the most recent data for water that is used for surface spray irrigation on the golf course and the water in the reclaimed water storage dam. The lagoon has a volume of about 21 ML and 1.6 ha surface area.

A report by Urbis JHD (2005) indicated that the mean concentration of 13.7 mg N/L from the council's works is over twice that permitted in the consent for the STP (6 mg N/L) and mean faecal coliform levels were 35 cfu/100 mL, over three times that permitted from The Resort (10 cfu/100 mL).

The slightly elevated FC are likely to be the result of bird life around the dam, since the reclaimed water leaves The Resort after final filtration and UV disinfection. The lower readings for sodium and SAR from the lagoon are likely dilution from rainwater and stormwater.

With its smaller surface area to volume, the reclaimed water dam is more strongly influenced by evaporation and less influenced by rainwater.

In October 2005, the Council's discharge into the lagoon had a BOD_5 of 37 mg/L and total nitrogen of 17 mg/L. As with all systems, any occasional 'hiccup' in the STP is firstly diluted in the 600 kL tank under the tennis court, and then the holding dam at BBGC, both large buffer storages.

Table 3. Irrigation water quality from lagoon and reclaimed water dam

Location	pH	EC dS/m	BOD_5 mg/L	TP mg/L	TN mg/L	Na mg/L	SAR	FC cfu/100 mL
Lagoon - Oct 2005	7.42	0.65	1.5	0.1	2.0	67	3.2	50
Lagoon - May 2007	7.81	0.72	2.4	0.12	0.81	94	3.6	20
Reclaimed water dam May2007	7.82	0.7	3.9	0.2	1.5	112	5.3	260

SAR is sodium adsorption ratio

4.1 Monitoring on Golf Course

As with the approval for the resort, the approval for the irrigation onto BBGC required monitoring not only of the surface water (SWL1), but also of groundwater (MB 6,7 & 8) and soils (SSL-A & B) in the irrigation area. Control points are also monitored at MB8 and SSL-D, against which changes can be correlated. There are no such requirements for the extensive areas irrigated with water from the lagoon which is water sourced from West Byron STP and stormwater from the heavily fertilised golf course.

Three soil-sampling sites are located adjacent to the irrigation area, as shown in Figure 3; two for monitoring the irrigation area and the third (SSL-D) as a control. Since irrigation commenced in December 2005 the differences between the control soil and the two sample sites have only shown marked differences in the surface where the drip line was laid over existing soil surface, fertilised and covered with mulch. The new plantings required fertiliser, as the soil is nutrient deficient coarse sand. Increases in the subsoil (500 mm) were less marked, as the fertiliser stayed at the surface, and these nutrient deficient soils remain nutrient deficient in the subsoil.

Similarly with the piezometers, changes from pre-irrigation to post-irrigation are minor, and even with the high application of fertiliser during the landscaping of this irrigation area, phosphorus and nitrogen levels in the groundwater have shown a reduction, rather than an increase. However, that is to be expected, as the soluble nutrients in the reclaimed water are miniscule compared with the requirements of the plants. Like the fairways and greens on the course proper, these landscaped areas will require chemical inputs to maintain growth during the first five years of plant establishment.

4.2 Current fertiliser rates

The potential volume of irrigation water is 55 kL per day less the 16 kL required for irrigation around the resort. Over the year, that equates to 14 ML of water available for irrigation. Taking the current rate of nitrogen and phosphorus from Table 3, the annual nitrogen load is 21 kg and the annual phosphorus load is 2.8 kg. When one considers the probable requirement of the irrigation area at 1 ha is 150 kg TN and 20 kg of TP, the quantities in the effluent are but a small proportion of annual requirements. The irrigation load, about twice the usual rate for high production areas, is of no consequence to these sands.

5 COMMUNITY ASSET

The Byron at Byron Resort has developed a tourist resort without a significant impost on the community's water assets, because its reclaimed water is used for irrigation and its stormwater used to supplement the irrigation water for other parts of the complex where buffer distances are in force. The requirement for water for landscaping the resort could be in the order of 40kL/day, on top of the 55 kL required for normal consumption at full occupancy. This requirement has now reduced to 55 kL and, with the likely approval for toilet flushing with reclaimed water, the draw on reticulated water may be as low as 40 kL per day. The value of the landscaping and the wetlands boardwalk are assets in the whole of community wetland education.

The reuse of the remainder of the reclaimed water at the BBGC had provided a major landscaping asset along the club's boundary with Broken Head Road that would otherwise not have been viable without the contribution to infrastructure by *The Byron at Byron Resort*. Work has been completed at no cost to the club. Therefore, the total project of the resort and the Golf Club irrigation has saved 55 kL/day of raw sewage being discharged into the community's sewage scheme, and at least 16 kL of water for irrigation. Other than sludge disposal off-site and all laundry being contracted out, demands on sewage and water are lower than had the project not been decentralised.

6 CONCLUSION

The Byron at Byron Resort has a state of the art decentralised sewage treatment system complete with nano-filtration, funded by private enterprise, supervised by Rous Water, providing assets to the community in many ways.

The contributions it makes to the Byron Bay Golf Club and the amenity from the landscaped areas allow the resort to operate at full capacity without being encumbered by reliance upon already stretched community facilities. In the last seven years, the project site has developed from a defunct wetland facility to contain a five-star rated tourist facility based upon high conservation values, renewable resource management and end of line benefits to the water cycle. Based on the results of ongoing monitoring, the resort is sustainable and the community benefits long lasting.

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