SUBSURFACE DRIP IRRIGATION OF OMAHA GOLF COURSE FAIRWAYS WITH TREATED EFFLUENT

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ABSTRACT

In 1999, in addition to the existing 825 lots developed in the 1970's, a new 600-lot subdivision was commenced at Omaha Beach. Omaha Beach is a popular recreation beach community north of Auckland. In conjunction with the new residential development the existing 9-hole golf course was expanded to a full 18-hole course. The existing wastewater treatment and disposal infrastructure were upgraded and expanded.

Omaha is a horticultural and agricultural area with a shortfall of groundwater limiting extensive local irrigation. After evaluating the irrigation alternatives, in this case a key component of both the wastewater plant upgrade and the new golf course expansion was the subsurface drip irrigation of treated wastewater under the new fairways and surrounding landscape.

The system has operated successfully since installation in 2002. It includes buried drip irrigation incorporating sustained release herbicide impregnated drip emitters and antimicrobial lined tubing. As a result of this initial success the system was expanded in 2004 as part of the Omaha South Stage 2 development.

KEYWORDS

Subsurface drip irrigation (SDI), golf course, effluent reuse, Omaha

INTRODUCTION

Omaha Beach is a popular coastal residential resort located on a narrow spit of land about an hour north of Auckland, near Warkworth, and is situated on environmentally sensitive east coast sand dunes. The Omaha spit comprises sand over a peat base and is edged by Little Omaha Bay on the coastal eastern side, the Whangateau Harbour on the western side and the mainland west of the harbour.

A causeway about half way along the spit crosses the harbour, connecting it with the mainland. North of the causeway on the spit is the original residential development, which included a nine hole golf course, while the southern end of the spit is the site of the latest development.

The original Omaha North development was commenced in the 1970's and grew to consist of approximately 825 lots near the northern end of the beach. A sewage treatment and disposal system was constructed in 1989 to meet the dual needs of both sewage treatment for this Omaha community, and a reclaimed water supply for horticultural activities on farmland immediately adjacent to the treatment facility. In conjunction with this original residential development a nine-hole golf course was constructed in 1973. This system incorporated a separate groundwater bore drawing 3,000 m^3/year which was used to irrigate the greens by pop-up sprinklers (outside of

opening hours), and the tees by handheld hoses connected to quick coupling valves. The fairways are not irrigated.

In 1999, a further development of 600 residential lots was commenced at Omaha South. In conjunction with this, a new nine-hole golf course was built in 2002 adjacent to the existing course, to provide a full 18-hole course with the original and new courses being linked at the causeway. Some of the fairways, rough and surrounding landscape areas of this new course are irrigated with subsurface drip irrigation (SDI) using treated effluent from the newly upgraded and expanded community wastewater facility. When planning the additional subdivision the new and extended golf course was seen as an important asset to enhance community recreational values. Omaha is a groundwater short area with very limited fresh water irrigation supplies and it was considered important that the new golf course incorporate effluent irrigation if practical. An area of the golf course was also required to supplement the mainland irrigation disposal system at the wastewater treatment facility as there was not sufficient land available for year round disposal of the total projected volume of the future extended community population. Any treated wastewater irrigation disposal system on this new golf course had to fit with both the ambiance of the new development as well as associated environmental and public health sensitivities.

WASTEWATER TREATMENT

The Omaha communities collect water from roof/tank supply for household potable use and a community water supply scheme is not planned. The average volume of wastewater for disposal is projected to vary from approximately 165 m^3/day in year 2000, to 740 m^3/day in year 2015, and a holiday flow of 1,500 m^3/day. The wastewater collection system consists of a conventional gravity reticulation system through both the original Omaha North and new Omaha South subdivisions supplying a pump station on the spit. This then delivers the raw untreated wastewater to the wastewater treatment plant, which is located at Jones Road (on the mainland), via a PVC rising main. The original rising main was 200mm but this was replaced in 2002 by a new larger capacity 300mm line to cater for the higher volumes to come on stream with the larger future community.

Table 1 below outlines the raw and treated wastewater characteristics of the original Omaha wastewater treatment plant which incorporated a facultative aerated lagoon, oxidation pond, storage pond, followed by subsurface flow gravel beds, wetlands, pressure filters and Ultra Violet (UV) disinfection prior to final disposal via drip irrigation to either a purpose planted eucalyptus plantation on the designated disposal site, or via drip to the neighbouring private horticultural venture.

Table 1: Typical Omaha Raw Wastewater and Treated Effluent Quality (Boffa Miskell, 1999).

Constituent	**Unit**	**Typical Raw Wastewater**	**WWTP Discharge**	
			Median	**Upper 95% ile**
BOD_5	mg/L	300	3.2	9
SS	mg/L	300	15	43
Total Nitrogen	mg/L	55	1.5	3
Total Phosphorus	mg/L	15	2.8	5.3

Fecal Coliform	MPN/100mL	10×10^6	12	300

To cater for the new residential development, this existing treatment plant which is owned and operated by the Rodney District Council (RDC), was extended in 2002 by the addition of a porous ceramic dual media (PCDM) effluent filtration plant and new enhanced UV disinfection. The gravel wetlands were decommissioned, as were the original old pressure sand filters and manual disc filters. These were replaced in 2002 by an initial automatic self-cleaning screen filter designed to cater for just the Stage 1 extended disposal volume, which in turn was replaced by a larger unit, of a similar type, as Stage 2 of the irrigation disposal upgrade came on line in October 2004.

WASTEWATER DISPOSAL

Forest Irrigation

As described, the original disposal system (1989) was a surface drip irrigation system of approximately 10 Ha installed in a purpose planted short rotation eucalyptus plantation on the site of the Jones Road wastewater treatment facility. A separate valve and mainline connection was also provided to the neighbouring horticultural property which used the treated effluent through lay-flat drip irrigation tape under polyethylene mulch for irrigation of various horticultural crops. The basic management philosophy of the original irrigation disposal system was to store excess treated effluent in the large storage dam during winter and to enter into the summer months with this pond reasonably full and draw it down through extensive summer irrigation. Water not needed by the neighbor was irrigated to Council's eucalyptus plantation.

There are two environmental constraints to the Jones Road site that are important to irrigation and effluent disposal management; and these are a high winter groundwater level, and a shortage of potential groundwater for summer irrigation. While these constraints may appear in conflict, they arise because the area is predominantly peat over a shallow impermeable layer. Winter rain becomes perched near the soil surface, yet the deeper confined aquifers suitable for summer water use have limited capacity, are recharged some distance away in the hills, and are fully allocated.

During the early 1990's ownership of the horticultural property adjoining the Omaha wastewater treatment facility changed and the requirement for summer irrigation of treated effluent, due principally to a change in cropping emphasis, disappeared. In addition, to provide for the future extended projected wastewater volumes from both the original Omaha North and new Omaha South subdivisions, winter storage of the bulk of treated effluent was not a viable option given the geotechnical constraints of the site limiting significant extension of the storage dam. Added to this situation were other important associated issues such as the desire to include the nearby community of Point Wells (if required) in any wastewater upgrade, plus the expectation that as the community grew and more facilities became available, the ratio of permanent residents to summer holiday residents would grow. All of these issues would combine to significantly increase the projected winter wastewater inflow volumes.

It was clear that the Jones Road disposal system would need to be expanded to cater for the projected irrigation disposal volumes and that this combined new system would need to operate also effectively during winter periods as it was not practical to store all the treated winter effluent.

Also by the late 1990's when the new Jones Road disposal irrigation system was being considered it became apparent that the original drip irrigation disposal system had become severely blocked with bacterial slime build-up and had fallen into disrepair with machinery having been driven into the site and breaking sub-mains etc. While this system had used conventional drip irrigation of the time

when originally built (1989), technology had advanced and a program of upgrading the system to incorporate current technology in line with how it might be expanded to include the new Omaha South subdivision was commenced in 2000. The first step was to replace 25% of the old drip line with new specialized 'WASTEFLOW® drip irrigation technology, principally because it included a non-mobile antimicrobial inner pipe lining to mitigate the bacterial slime blockage problem.

Subsequently the original 10Ha eucalyptus disposal system was expanded in 2002 to include a new Wasteflow 5Ha surface drip irrigation system incorporating New Zealand native trees grown in a local nursery (Stage 1 upgrade) with a further 5Ha of subsurface Wasteflow drip irrigation through the remaining original grass paddock in early 2004 (Stage 2 upgrade), with the balance of the original system not rehabilitated in 2000 being replaced with new surface drip irrigation in October 2004, to give a total drip irrigation disposal area in the order of 20Ha at the wastewater treatment plant facility.

As will be described later there are several public health and environmental advantages to subsurface drip irrigation (SDI) of effluent compared to surface drip irrigation, but given the confined public access to this disposal site, surface drip disposal has been used in the existing eucalyptus plantation in order to prevent any damage to the roots of the trees (such as potential phytophthora infection) and in the Stage 1 Jones Road upgrade due to particularly shallow groundwater in portions of this system.

Both this forest drip disposal system and the golf course subsurface drip system incorporate multilayered soil moisture sensing using high frequency capacitance reflectometry. The data from these sensors is transmitted in real time to provide a basis for operational management of the irrigation.

However despite expanding the Jones Road disposal system, estimations still determined that effective irrigation of all the available irrigation area would not be sufficient and hence the concept of irrigating the new golf course was proposed.

New Golf Course Irrigation

The early concept for potential irrigation of the golf course had been to use sprinkler irrigation and to supply this system with a new pressure mainline from the upgraded wastewater facility, across the causeway. This system was proposed to also have included a new effluent storage dam on the new golf course with a new and separate filtration and pumping facility specifically for this system. A key component of this proposal was that this sprinkler disposal system was only proposed to be used during the summer months.

While rehabilitating the first 25% of the original Jones Road drip disposal system in 2000, on the strength of the successful New Zealand Aluminium Smelters Ltd SDI disposal system, URS also put forward the proposition of using an SDI disposal system on the new golf course in lieu of the sprinkler system, because not only would such an alternative offer the practical, public health and environmental advantages described later, it could also be engineered to provide specific unique advantages to the Omaha solution which could include:-

- Not requiring a separate effluent storage dam on the golf course;

- Not requiring a separate re-pumping system at the golf course (i.e. be directly online with the Jones Road disposal system at the wastewater treatment plant);

- Not requiring a new mainline from the wastewater treatment plant to the golf course, with instead URS proposing to "pig" (mechanically scour), clean and reuse the old decommissioned raw sewage 200mm PVC rising main, when the new 300mm line was operational;

- But probably most importantly given the sandy soil nature of much of the new golf course, winter disposal should be possible without deleterious effects to the golf course, but sufficient to reduce winter disposal at the Jones Road wastewater facility reducing the risk of winter groundwater contamination; and,

- Mitigate the need to construct the further winter dam storage which the sprinkler alternative required at the Jones Road wastewater treatment plant site.

These advantages all combined to make the SDI disposal option for the golf course not only technically superior to the sprinkler alternative, but also most importantly it was significantly more economical.

Accordingly in 2002 approximately 5.0Ha (Stage 1) of the fairways on the new golf course were installed with a new SDI system and have successfully been irrigated with treated effluent ever since. As a consequence, these fairways are lush and green throughout the year, as can be seen in Photograph 1. As a direct result of the success of the Stage 1 SDI disposal system a further 2.5Ha was installed as part of Stage 2 in September 2004.

The new nine-hole golf course is irrigated partly by a bore drawing 8,000 m^3/year, which is used to irrigate the greens and the bunker surrounds using a combination of automatic pop-up sprinklers and quick release valves with portable hoses for hand watering. This water allocation is effectively 80m^3 per day for 100 days per year. During detailed design and installation, care was taken to ensure that wherever possible common trenching and other practical advantages of having the effluent SDI and freshwater pop-up systems were employed with respective installation contractors and suppliers all working together to provide as high a standard of results as possible for the community. Other examples of this compatibility are similar automatic control valves and control equipment to simplify and rationalize spare parts and reduce complexity for the operators.

Why Subsurface Drip Technology

Omaha Golf Course uses an advanced subsurface drip technology that overcomes the problems typically associated with effluent irrigation. The key features and advantages are:

- As all pipe-work is below ground, the system and its use are effectively hidden from public view, which is ideal for a golf course, and irrigation is able to proceed at any time, even while the golf course is in use.

- Effluent is applied below the ground surface, virtually eliminating aerosol and odor problems, the public health risk and the risk of surface runoff, even during rain, thereby enabling irrigation to occur year round.

- Pressure compensating drip emitters ensure an even distribution of effluent.

- The individual plastic emitters are protected against root intrusion by being impregnated with a long-term and slow sustained release herbicide, which is fully United States Environmental Protection Agency (US EPA) registered and compliant with New Zealand legislation due to its very benign method of application to the environment.

Photograph 1: Omaha Golf Course – SDI Irrigation of Fairway vs. Un-irrigated Fairway

- The polyethylene SDI irrigation tube is co-extruded with an antimicrobial lining, which reduces the build-up of bacterial slime on the interior of the pipe, protecting the drip emitters from blockage by slime.

- SDI is suitable for a wide range of effluent quality, provided public health concerns can be satisfied. By applying the effluent below the ground surface, it is also possible to continue irrigation, if desired, during rain, or high winds, with little risk of surface run off of effluent if good management and monitoring is adopted. These are very important system advantages for the Omaha golf course system where in certain instances the disposal system is located quite close to up-market residential sections, where disposal with sprinklers would not be a viable alternative.

- With SDI the treated effluent may permeate the soil, meaning that the rain which falls will run off the surface, but the effluent will be retained within the soil and be either taken up by plants or percolate through the soil while further natural treatment takes place.

Hence SDI is a useful option where disposal is required in both wet and dry conditions, which is usually the case with treated effluent.

As a result of these attributes the environmental impact of this particular SDI tube (Wasteflow) is extremely low. The antimicrobial lining of the plastic SDI tube is not consumed, as it is in a polymeric form and retained within the structure of the tube and as a consequence there is therefore zero discharge of the antimicrobial agent to the environment. Each individual plastic drip emitter is also impregnated with 'Rootguard™' which is a patented technology resulting in a very slow and

Photograph 2: Installing four lines at a time.

sustained release of very minute quantities of the herbicide trifluralin in a gaseous form, which is strongly adsorbed to the soil immediately surrounding the emitter discharge apertures protecting them against root ingress. The concentration of herbicide in the environment is therefore extremely low and relatively immobile.

A significant outcome of all the above described system attributes is that the Discharge to Land Resource Consent for the golf course SDI disposal system was granted unopposed, which is a key advantage for both the private developer of Omaha South and the Rodney District Council.

OUTCOMES OF USING SUBSURFACE DRIP TECHNOLOGY AT OMAHA

In summary the SDI disposal system involves installing rows of the above described specialist drip equipment at a shallow depth below the soil surface, to maximize the environmental capability for adsorption/neutralization via the unsaturated soil zone and the active root zone of the associated plant material.

One of the problems associated with effluent land disposal schemes is that the allowable winter disposal rate is usually lower than summer, requiring either a larger irrigation area, or very large storage volumes. The ability to continue irrigation in winter at a lower rate provided a cost advantage for using SDI at Omaha, by avoiding the need to increase the effluent storage dam capacity.

The operator feedback from the effluent irrigation scheme has been excellent. A major focus of the up-market Omaha development is to maintain property values through high quality solutions and this system is considered compatible with these project objectives. In addition, Omaha has a layer of sand over peat, which, when irrigated may lead to a short-term increase in groundwater, which in

turn may stimulate the growth of the Kahikitea forest adjacent to the golf course, which otherwise may potentially suffer from summer water shortages.

Overall the fairway irrigation system at the Omaha Golf Course using treated effluent via subsurface drip irrigation (SDI) has been very successful. The quality of the fairways on the course that are irrigated is significantly superior to the non-irrigated portions of the course. As there is insufficient deep groundwater for fairway irrigation the system has provided an effective reuse for the treated effluent that would otherwise have been difficult and expensive to dispose of, given that the designated forest area could not accommodate the total volume.

ACKNOWLEDGEMENTS

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