New Zealand Vacation Community at Paunui-Tairua
Operates 5,000m3/day (1.3 million gpd) Subsurface Drip Reuse System

Technical Description
This technically challenging and innovative effluent reuse project involves irrigation disposal within the urban environment, is fully future proofed and incorporates many new to New Zealand technical developments. For example the scheme utilises sophisticated subsurface drip irrigation technology via a series of distinct and independently managed beneficial reuse options incorporating: Kennedy Park; the Paunui airstrip; and a replacement (including an enlargement) of the original Vista Paku infiltration galleries. Provision was also designed and consented to provide irrigation water for both existing nine (9) hole golf courses (The Pines and Lakes courses).
Executive Summary

Commissioned in December of 2009, the state-of-the-art Paunui-Tairua wastewater scheme disperses high quality treated effluent through an innovative subsurface drip irrigation system, feeding the local park, air strip, new town gardens and golf courses in this water constrained summer resort area – providing the ultimate recycling solution.

This effluent reuse irrigation project embodies the key principles of sustainability providing an area with restricted potable water, four very different kinds of irrigation utilising what was once considered an unusable waste product. Several of the cutting edge concepts incorporated such as the irrigation of an active airstrip, use of sophisticated irrigation pigging (system cleaning) and the unique intuitive control system which solves complex criteria are a first in New Zealand.

Located on a thin spit of sand with the Pacific Ocean to the east and the Tairua Harbour to the west the Paunui-Tairua wastewater disposal scheme was also designed to keep local waterways and estuaries as pollution free as possible. As the area draws some of its water supply from a series of shallow domestic drinking water bores, it was critical to ensure that these bores would remain unaffected and uncontaminated.

Designed by URS New Zealand Limited (URS), Paunui’s irrigation disposal system uses dripper lines with electronically controlled valves. Self-cleaning filter chambers and sophisticated pigging systems keep lines clean and prevent residue building up. Automated to rotate irrigation depending on fluctuations in output flow, the system is also designed to contend with high rainfall conditions.

Commissioned by the Thames-Coromandel District Council (TCDC), URS conceived, consented, designed, tendered and supervised the commissioning of this system which disposes of the combined wastewater from both the communities of Paunui and Tairua.

Consented to dispose of 5,000m$^3$ per day during non-holiday periods the system currently disposes of 1,000m$^3$ per day, increasing to approximately 4,000m$^3$ during the summer when both towns swell with holidaymakers. This is still well within the system’s current ability to process 11,500m$^3$ per day. By adding one more pump the system is capable of disposing 20,000m$^3$ per day, future proofing the system against projected growth and providing a lifespan of 30-50 years plus.

The disposal system received the ultimate initiation test as it was commissioned in time for the summer peak flow volumes of the 2009 / 2010 Christmas and New Year holiday season. Working to specification it handled the effluent volumes produced during this period with absolute ease, earning the communities it serves full support and for the first time in recorded history for the area, receiving no complaints as to effluent disposal.

In addition all receiving parties of the irrigated wastewater were so impressed by the positive changes to the community assets that it ultimately created the systems only problem - lack of desired volumes of treated effluent to meet all community irrigation objectives.
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The key technical elements include:
- Complex irrigation design and system layout;
- Four very different disposal components needing to all be holistically operated and independently managed within a single integrated scheme;
- Safe and clean irrigation and mainline cleaning;
- Simplified control of complex irrigation parameters;
- Fully compatible with an existing batch type wastewater treatment plant output;
- Beneficial reuse of treated effluent right within a community itself (i.e. not remote from, or outside, the community as is the case with most other land based disposal systems);
- Expandable and future proofed system incorporating the principals of sustainability and, 
- Fully consented very high rate disposal in a very public environment, supported by all key stakeholders.

Complexity

There were a substantial number of conflicting constraints incorporating a large number of site specific obstacles including:
- The disposal system had to be future proof in terms of being able to handle ultimate predicted community flows, including flows which may include low pressure tropical storms with large influent volumes. However the system also needed to be able to handle very low off peak daily volumes due to the very low permanent population;
- The requirement to provide for both the future ultimate population including large tropical storms meant mainlines needed to be large, yet small winter volumes will mean low velocities in the disposal designs long pipelines which as a result would grow significant
quantifies of bacterial slime. Bacterial slime is one of the main causes for subsurface drip irrigation blockage (along with root intrusion).

- Pauanui is a water short area where supply of irrigation water has in the past been secondary to that of potable drinking water. Hence there are several local amenity areas which could benefit from treated effluent reuse technology if it could be demonstrated to be: safe to the public; vandal proof; would not limit public accessibility; and not create any cross contamination of rainfall runoff;
- Shallow private potable drinking water bores near the preferred disposal areas meant that it was imperative that the solution needed to prevent cross contamination
- The specific requirements of Kennedy Park, the airstrip and the Vista Paku disposal systems were all totally different, requiring different irrigation configurations and application rates, very different management regimes and different priorities for beneficial reuse;
- The users of the various areas involved all sought a positive and beneficial reuse effect from the irrigation in periods of summer drought, but in periods of rain they expected the disposal system to cope and handle the effluent volumes without negatively impacting on their area of interest (i.e. golf course, park or airstrip etc). During wet periods irrigation capacity is also reduced, hence there was a need for simple and easily implemented wet weather irrigation strategies. The predicted wastewater influent volume was also potentially so large that long-term storage was not a viable option.
- The existing treatment plant produces effluent in batches and at a prescribed rate (in order to be compatible with existing processes such as ultra-violet disinfection). As such the irrigation needed to be able to respond to these treated effluent supply conditions;
- The irrigation control system would need to be stand alone for ease of local operation, but also easily integrated into both the wider treatment plant control system, while also being compatible with TCDC's own remote SCADA telemetry system;
- The disposal system also needed to meet requirements to log irrigation volumes to each individual area for resource consent purposes and operate within distinct and very different consented application rates for each of the different irrigation options (i.e. golf course(s), Kennedy Park, Vista Paku and the airstrip);
- Site specific requirements included:
  - Kennedy Park - as available for summer carnivals involving large tents the solution needed to accommodate deep tent pegs.
  - Pauanui airstrip - propeller wash needed to be controlled especially around taxi way areas adjacent to houses (i.e. lush grass cover required to hold the sand surface in place), but also needed to provide a very safe landing and takeoff area (i.e. wet and dry patches not acceptable).
  - Vista Paku - needed to be designed and configured to accept an internationally significant high rate of irrigation, while also providing for an aesthetically acceptable landscape located in the middle of the community.
  - Golf courses - wanted the ability to take irrigation water when they needed it (as a matter of priority). However if not required on any given day the system needed to be able to automatically dispose of the treated effluent elsewhere within the community.
- The disposal system needed to be unobtrusive within the community and compatible with all other users and requirements such as Parks and Reserves re maintenance, the Community Board and other key local stakeholders re aesthetics / noise / odour etc; CAA and users of the airstrip;
- Unlike most other existing irrigation effluent reuse schemes, the Pauanui system needed to be installed on an active airstrip, to be built through the middle of a community going about its business and also involved a live wastewater treatment plant. The current disposal system also needed to be decommissioned and the wastewater cutover to the new system (i.e. there was no practice run, the new system needed to work first time as per specification).
Innovation

The large number of conflicting constraints (described previously) all needed to be overcome through innovation as many of the final solutions incorporated into the resultant system had not been attempted in New Zealand before. Each also needed to be addressed in a simple and pragmatic manner in order to allow for ease of operation and maintenance in this comparatively remote location.

In order to address all the complex and often conflicting requirements, a series of innovative solutions were adopted in the design, construction and ongoing management of the scheme.

From the outset URS designed the disposal system to incorporate the three (3) key local areas of beneficial reuse directly under TCDC control with the capacity and intelligence to handle all future daily projected volumes (with allowance for large tropical storm inflows) as well as making sure that the maximum projected daily short-term volume requirements were able to be disposed of within any 24 hour period.

Irrigation Pump Station Design

Working with a very constrained space allocation required considerable innovation in the design and construction of the purpose-built irrigation pump-station. Buried and located within a truck driveway, it is designed to have trucks park on top of it. It also incorporates multiple dry well vertically mounted centrifugal multistage pumps and a wet well with automatic level detection to effectively manage flow, capacity and sudden changes in volume. The irrigation system has banks of automatic field valves of approximately similar flow rates. As the level rises within the pump-station (when the treatment plant releases a batch of treated effluent), the control system detects the water level and matches the number of pumps and active irrigation to suit automatically. The pump-station also incorporates provision for future growth.

Mainline Design and Volume Management

The issues of large mainlines, typically low velocity and bacterial slime growth have been handled in a variety of innovative ways, principally: a specialist mainline ‘pigging’ system (propulsion of a plug through pipes to perform certain tasks – in this instance cleaning); automatic self cleaning filters in the irrigation fields themselves, and specialist subsurface drip technology incorporating fully compliant anti-microbial inner tube linings.

The mainline ‘pigging’ system involves pipe sizes ranging from 355mm down to 160mm, incorporating: angles; bends; tees; manual valves etc, and involving some very deep receiving manholes (one estimated deeper than six (6) metres). Since commissioning this system has enabled successful cleaning of the pipes from bacterial slime, while also allowing for very safe operation of both launching and pig (plug) retrieval. The system has been designed to return all dirty flushed water directly back to the treatment plant through the
existing sewer reticulation network. The system design also allows full operator access for maintenance.

We are not aware that this design or any other effluent subsurface drip irrigation system with such a complex mainline cleaning and pigging requirement is currently operating anywhere else in the world.

**System Controls**

The purpose designed control system incorporates proprietary technology involving a combination of wireless and localised hard-wired automatic control. Each automatic valve has been fitted with a special automatic actuator incorporating local intelligence. The central control unit has been programmed to be compatible with both the local wastewater treatment plant control system and TCDC's main SCADA control system (via remote telemetry).

Key mainline sections have standalone water flow meters and the central control unit has been programmed to log on a daily basis the totals of water sent to each area (which is a resource consent requirement). While very complex in output, the control has been programmed to be operator friendly. The operators basically just select the priority for the day (or period) i.e. wet weather mode, or dry summer peak mode (or other preset standards) and the system automatically sets the irrigation priorities throughout the entire system. It then runs the system automatically and sequentially around the irrigation zones as effluent becomes available from the wastewater treatment plant. The system also automatically ensures each different irrigation remains within the resource consent limitations (which are also different for each zone).

These are complex control requirements and we are not aware of any other irrigation system in New Zealand that has such complex requirements.

**Addressing Specific Site requirements**

Given the very different existing land uses and specific requirements presented by each of the three (3) key irrigation areas (i.e. Kennedy Park; Pauanui airstrip and Vista Paku), very different yet subtly similar innovative irrigation configurations were developed.

*Kennedy Park*

Approximately one (1) hectare in size and typically used as a passive community park, Kennedy Park has an existing cricket wicket and some large buried fire hydrants and nearby large pine trees. It is also occasionally used for summer carnivals involving large tents. The system developed for this area involved subsurface drip irrigation buried deeply (over half a
metre – to be safe from large tent pegs) but designed to receive a moderately high irrigation rate (i.e. 100+mm/day or similar – i.e. 1,000+m³/day). In order to install the tube to this depth and to get through the large roots of the nearby pine trees, a specialist vibratory installation machine was purpose designed and built for this area. A moderate drip spacing was designed as disposal volume was of greater importance in reuse than park aesthetics.

Pauanui Airstrip
Approximately six (6) hectares in size, it is the disposal area closest to most of the nearby private bores. The irrigation of the airstrip had the reuse requirement of remaining green through the summer in order for the grass to remain vigorous to hold the sand base from being blown away (especially to prevent damage to the taxi ways) and prevent propeller wash making adjacent houses dirty with wind blown sand. Accordingly the irrigation was specifically designed to handle a conventional irrigation rate in the first instance, with a shallow subsurface drip irrigation installation in order to maximise aesthetics and uniformity of the beneficial reuse effect. The system was also designed to handle a moderate irrigation rate in the future if required. Due to the large volume of shallow drip tube a specialist multi-tube insertion machine was also developed for this area to minimise time crossing the airstrip while in use. The system was also laid out to have minimal effect on the airstrip use during operation with all filtration and other equipment installed in such a manner to meet all Civil Aviation Authority (CAA) requirements.

This is the first actively used airstrip anywhere in the world (that we are aware of) to use subsurface drip irrigation with treated effluent. The USA Air Force currently uses subsurface drip irrigation for treated effluent (in favour of sprinkler irrigation) on land surrounding an Air Force base. This is because buried irrigation does not force the worms to the surface - they found sprinkler irrigation forced worms to rise to the soil surface increasing bird activity which presented a significant threat to their planes.

Vista Paku
The Vista Paku median system is comparatively small in size, yet is designed to operate at a very high irrigation rate (i.e.1,500+mm/day). We are not currently aware of any commercial community effluent subsurface drip irrigation system anywhere in the world that operates at application rates of this order. Requiring a unique design, special techniques for installation (due to the high density of drip emitters required to achieve the high application rate), a special manufacturing run in the USA of the subsurface drip irrigation material (due to its non standard nature) and the construction of a totally new purpose designed high rate disposal media bed following the decommissioning of the old disposal system. The newly developed disposal areas also needed special innovative engineering to ensure the kerbing design prevented the stormwater from accessing the disposal fields (and vice versa) and that road integrity and strength was maintained.
Installation
Innovation was also bought to this project by the installation contractor in terms of practical installation, particularly in respect to avoiding existing services and minimising damage and inconveniences to the road reserve and local residents.

Depth of Technical /Professional Expertise

*Design* - This new process for effluent disposal protects the groundwater and wider surface receiving environments, while simultaneously providing a beneficial reuse via irrigation to a park, airstrip and median strip (via improved aesthetics, usability and new landscape planting). These developments enable several significantly different beneficial reuses via irrigation to the advantage of the community in a water short environment, from what is normally considered a waste product (i.e. human effluent).

The key to this system is how it has been managed by careful design and construction to be almost invisible to the community. All the community see is the results of the beneficial reuse; the actual disposal of effluent is out of sight and out of mind.

New techniques have been developed for:
- Irrigation design and system layout;
- Safe and clean irrigation and mainline cleaning;
- Simplified control of complex irrigation parameters;
- Beneficial reuse of treated effluent right within a community itself (i.e. not remote from, or outside, the community as is the case with most other land based disposal systems); and,
- Fully consented very high rate disposal in a very public environment, supported by all key stakeholders.

*Large Capacity* - This system is not only complex by involving several different and linked disposal areas, but it is large scale being consented for up to 5,000m³/day. It is however also future proofed by being designed (as installed) to handle in the order of 11,500m³/day if required. It has also been designed and physically installed such that with the addition of extra pumping the scheme may handle (if required in an emergency) up to 20,000+m³/day. This makes it not only one of the most advanced subsurface drip disposal systems in the world, but also we believe one of the largest.

*Ease of Operation* - While the design and control systems are complex – these innovations sit mainly behind the scenes and allow the complexity of the scheme to be managed on a daily basis with relative ease by the operators. These specifically developed control and system processes allow the system to respond automatically when treated effluent becomes available from the treatment plant, then sequentially delivers this to the required areas in a filtered form ready for use via the buried irrigation. All in such a manner as to be compatible with the different resource consent conditions for each disposal area. The system also automatically makes best use of available effluent to maximise community benefit from the irrigation, dependant upon the priority set by the operators at any particular time.
Other key advances from this project to the industry are the special techniques and solutions developed. For example this system is designed to be readily cleaned via a number of different methods namely scouring, chemical cleaning, self cleaning filters and mainline pigging. All options can be undertaken in a very clean and safe manner by the operators. Additionally the final design solution has been developed to enable the system to continue to operate reliably and robustly within a variety of potentially negative conditions over the long-term.

Providing several positive community reuse benefits, in a very benign and unnoticeable manner was also critical in developing the scheme. Community areas are able to be irrigated with treated effluent whilst continuing to be available for unimpeded and safe use by the public. The public is also able to reap the benefits of an improved asset in a water constrained area through the ability to reuse the treated effluent in this manner. Coastal assets have also benefited as the disposal system has eliminated direct discharge of treated effluent to the ocean and local estuary.

**Elegance of the Solution**

The original effluent disposal system had significant limitations on capacity and operability as the surface of the sand constantly became blocked and needed to be scraped clean. The system was also visually unattractive and not in keeping with the ambience of this upmarket beach resort community.

URS’s drip disposal irrigation system is considered by key stakeholders to be elegant in its unobtrusive and hidden nature. The significant improvements made to community aesthetics and usability of public areas in this water short area during summer drought conditions (when most of the population is at Pauanui to use these amenities) coupled with the elimination of effluent discharges to the estuary and ocean exemplify the appropriateness of the solution.

An example of the confidence the community has in this system is that the airstrip management (in conjunction with TCDC Parks Department) are now establishing a new species of fine turf grass on the airstrip in order to make maximum use of the benefit available from the new irrigation system.

In addition, the parties receiving the effluent were all so impressed by the benefits of their reuse allocation that they are all seeking an increase in allocation in order to reap further benefits.

The 2009 / 2010 Christmas and New Year holiday season was the first time in the history of the Pauanui community there were no complaints received about the effluent disposal.
Environmental Considerations

The introduction of treated wastewater to the Pauanui sand aquifer had the potential to present a number of risks to human health and the environment through:

- ingestion of groundwater via potable use,
- contact within the groundwater discharge and surface water mixing zone,
- consumption of shellfish,
- aerosols from spray irrigation of groundwater at the golf course(s).

In order to demonstrate to the regulating authorities that these risks were low, considerable technical assessment of the effects to groundwater and surface water quality were made prior to the selection of the final disposal solution at Pauanui. The technical assessment has identified solutions for future disposal of wastewater at Pauanui that maximises the benefits to all stakeholders concerned.

Quantifying loading rates was of primary importance in the initial assessment of disposal options to enable detailed design and to assess the risks of breakout or ponding. Furthermore, the induced hydraulic gradients associated with groundwater mounding were critical to establishing the velocity and dilution factors important to contaminant transport in the aquifer. A number of phases were undertaken to assess how the aquifer responded to recharge at different rates.

Over the 2003-2004 summer period a trial subsurface drip irrigation system, 300m long and 30m wide was installed and operated at rates that varied from 70 to 150mm/d (650-1,350m³/d). A network of groundwater monitoring wells was also installed and water level and quality data collected from October 2003 to October 2004. Soil moisture probes were used to measure saturation at 10cm depth increment in the top 1.0m of the soil profile within the irrigation field.

To assess the likely degree of groundwater mounding associated with the disposal at various application rates, extensive 2D and 3D groundwater modelling was undertaken. Calibration of the flow models was achieved using observation data from the trials and compliance monitoring, data collected from a 7 day pump test of the municipal supply bores, and from the seasonal water level record from around an additional 30 other piezometers located around the peninsula.

Water quality data from the wells used for historic compliance monitoring at Vista Paku allowed direct observation of the aquifers ability to reduce bacteria through filtration. The assessment of risk associated with pathogens for the proposed land disposal was undertaken using the groundwater models to calculate travel times to determine die-off rates based on the predicted seepage velocities. The modelled scenarios indicated that following the high level of wastewater treatment prior to land disposal, pathogen concentrations would not present a risk to human health under any exposure pathways after reduction by dispersion effects, further microbial die off, filtration and adsorption.

In order to further understand the actual risks that may be presented by viruses in groundwater (given the theoretical die-off times could be up to 12 months) URS undertook a collaborative research program with Environmental and Scientific Research (ESR) to perform field experiments to actually measure viral die-off. Consents were obtained to inject inert viruses, bacteria and tracer chemicals at two sites, over a number of pilot and live tests. The experiments were completed in 2009 and, to our knowledge, represented the first successful research of its kind undertaken in a sand aquifer in New Zealand. The results of the experiments support extremely high removal rates of viruses, with adsorption being identified as the key mechanism for the attenuation. This research will form the technical basis upon which a variation to consent volumes will be sought in the future to accommodate the increased disposal rates expected.

In short, the consenting and design of the land treatment and disposal system at Pauanui was underpinned by sound scientific data, complex predictive analysis using modern industry tools and leading edge scientific research, demonstrating the harmony of science and engineering to reach the objectives set by TCDC and the community.
Management Skills

The overall Project Management was undertaken by TCDC, with URS providing all technical input managing the design, consenting and construction tendering process. Community consultation and actual onsite day to day construction management was also handled by TCDC, deferring to URS for technical assistance and commissioning.

The successful construction tenderer was Hopper Construction, and a very healthy “best for project” relationship between TCDC, URS and Hopper Construction developed which meant all unforeseen obstacles encountered were discussed openly and resolved together with input from all. This relationship is considered one of the key reasons why the project was completed on time and on budget, and was able to operate effectively and without incident under its first season of full load.

Given the intrusive nature of the project’s construction to the community roads, private residential entrances, airstrip, parks and community gardens, considerable consultation expertise was required with individual residents and key stakeholders including Environment Waikato and the Civil Aviation Authority, to ensure that the design and installation received total community support.

Client Satisfaction

“The Pauanui community has, from the outset of consultation for the resource consent for waste-water disposal, expressed their desire for the waste-water to be used beneficially in the community for irrigation rather than simply disposed of. The consequence of this reuse requirement was a set of very high quality standards for the wastewater from the treatment plant. In addition all disposal would be subsurface with controlled rates and quantities of discharge.

To achieve these requirements an innovative solution was essential and the design produced by URS has been just that. In every respect it has met the targets required whilst including a substantial allowance for future-proofing.

Fundamental to the success of this project has been the absolute commitment of all parties involved to achieve the best quality outcome possible. All involved identified with the innovation and importance of the outcome. The willingness of the construction contactor to innovate to enhance the complex and new techniques necessary to construct the irrigation systems was also essential to the overall success of the project.

Wastewater disposal is a controversial and emotive problem for all communities and this solution is the best sustainable solution achieved to date in New Zealand. For Thames-Coromandel District Council it is particularly problematic with five fold increases in population in its coastal resort settlements.

From a client perspective it has been an excellent outcome as it has satisfied the desires of the community, the need to protect the environment, the requirement to conserve water and to meet the future needs of a growing community.”

Gordon Reynolds – Project Engineer, Thames-Coromandel District Council
Appendix B: Client Letter
Appendix C: Photo Selection
Specialist purpose designed pig launcher
Irrigation pump station construction
New Vista Paku landscaped disposal bed
Installation throughout the community
Effluent disposal on an active airstrip