Selwyn District Council
Concept for Pines II Irrigation

1 Introduction

Pines I treated wastewater irrigation scheme was developed in 2004, to serve the predicted growth in Rolleston.

The Pines I irrigation system involved staged development of a total 80ha on the south side of Burham School Road.

The 80ha irrigation site was originally surrounded by the pine plantation of the Selwyn Plantation Board Ltd (SPBL), however in 2006/07 this land was converted to pasture.

Rapid growth has continued in Rolleston, with similar pressure on other communities in the Eastern Selwyn area. This future growth has recently been formalised into a combined Council's Urban Development Strategy (UDS) with significant growth in the communities of Prebbleton, Lincoln and Rolleston (as well as other Council areas).

Treatment and disposal of sewage for some of these communities has been either a problem or a growth restriction. The Selwyn District Council considered future sewerage options for these communities (MWH Report "East Selwyn Sewerage Scheme Options Scheme Configuration and Risk Assessment", November 2007), concluding the preferable option was to integrate sewage disposal in the Eastern Selwyn area and expand the previous Pines concept with treatment and disposal of high quality effluent at the Pines site and potentially on or around the recently converted pasture land owned by SPBL. The expanding irrigation concept is called Pines II, with the collection system serving Prebbleton, Lincoln and Rolleston called the Eastern Selwyn Sewerage Scheme (ESSS).

The specific area and extent of the Pines II site has not been defined (either within the SPBL or by design requirements), however in developing initial concepts, the entire SPBL land has been considered.

The initial thoughts regarding the Pines II scheme was presented to the adjacent landowners in April 2008, inviting a response by way of a questionnaire. The responses are presented in a summary report (MWH May 2008) and form important development criteria and objectives for the Pines II concepts.

A landscape and environmental setting baseline study and irrigations options review study has also been undertaken, and the conclusions from these also form an important input to developing the Pines II concepts.

From the inputs, this report develops various irrigation options with the objective of determining a basis for further discussions and developing a preferred option.

2 Discussion on Criteria and Concepts

2.1 Irrigation Quality

The stakeholders clearly identified the expectation of a high quality of treated effluent with minimal environmental impacts. Such requirements are the basis for fulfilling the RMA obligations and gaining a consent.

The present Pines I discharge is based on high quality treated effluent of a standard above most typical treatment systems in New Zealand and close to the best. The process is an aerobic “mechanical” system (termed activated sludge) with additional process of biological nitrogen reduction (BNR) and UV disinfection.

The activated sludge process provides efficient reduction of the organic contaminants with a settling process (via a clarifier), producing a clear liquid. Prior to irrigation, this is further treated with UV light to reduce microbes to a level that could be expected in average quality surface waters. To reduce the risks of nitrates getting into groundwater, the nitrogen content of the final treated wastewater is reduced by the BNR process. This also allows the hydraulic loading rate and the nitrogen loading rate to be better balanced, allowing the optimum land area.

In the activated sludge process, contaminants (food) are converted to cellular biomass, which is eventually concentrated into an earthy paste termed sludge. There are a variety of controlled disposal options for this material.

The existing Pines I treatment plant has operated to expectations (refer MWH Report on Annual Monitoring for the Pines WWTP, May 2008), hence there is no reason to consider that continuation of the present process would not be appropriate for Pines II. Similarly, environmental monitoring of the Pines I irrigation system shows minimal impacts and that predictions provided in the current process were being met.

Given there is no new technology that can provide a material gain on the present processes, and that the present processes are likely to be the optimum, it is concluded Pines II should be based on the same processes as Pines I.

2.2 Groundwater Impacts

Linked to the desire for irrigation of a high quality treated wastewater, stakeholders required little or no groundwater impacts. Clearly with any surface activities, there is the potential for groundwater impacts and a likely key issue is the extent of any groundwater impacts and effect on others.

The existing Pines I site was reasonably well isolated from adjacent owners and groundwater users, by the extensive surrounding SPBL plantation land. This land provided a separation distance of at least 300 meters. With probably expanding the Pines II irrigation concept into SPBL land, this buffer area could be lost with reduced distances to other land owners and greater risk or effects to users of groundwater. In the worst case, groundwater may or may be perceived to be adversely effected, and as this would be an unacceptable situation, either the Pines II scheme would need to provide an alternative water source or not adversely effect groundwater.

While not defining or conceding the likelihood of adverse effects on groundwater, the question of the scheme providing an alternative water supply was raised with the adjacent owners in the first round of consultation, with the general response that groundwater should be protected but if it was necessary to provide an alternative supply to overcome any risks (real or perceived) then this could be acceptable as long as there were no cost implications.

The matter of groundwater protection is not just a matter of scientific calculations and monitoring, as often the sources of contamination cannot readily be defined. Many of the groundwater abstraction system in the adjacent area are from shallow wells and hence could be subject to influences from true groundwater contamination but also from adjacent surface activities or poor well construction. There is a high possibility that contamination observed in distance landowners wells may not be caused by the Pines irrigation system, but due to the scheme proximity and nature of the operation, it is perceived to be the problem. While monitoring shows that monitoring bores close to the irrigation area are clear, it is likely that the perception of risk of contamination will remain.

To overcome this perception, either a very extensive monitoring program would be required (unlikely to ever be adequate to remove all perceptions), irrigation is not undertaken without extensive separation distances, or a safer alternative water supply is provided.

Given the probable need for maximum land use due to high land cost (i.e. reduce separation distances) and the difficulty of overcoming negative perceptions, there is some bias to expect the provision of a water supply to those close to the irrigation area.

If this eventuates, the supply would be for potable use (i.e. meet the NZDWS). As general groundwater contamination would not be expected, general groundwater abstraction and uses for irrigation and the like could continue. It could be expected in some farm situations that irrigation supplies would also provide stockwater and domestic drinking water. While the Council potable supply would be provided to replace this domestic supply, it may not always be practical or economic to separate out the stockwater and irrigation system. It may therefore eventuate that a farm stockwater system may remain extracting from the immediate groundwater system. If this is so, then not withstanding the provision of alternative domestic supply, it may be necessary to minimise potential groundwater contaminate to ensure stockwater protection.

2.3 Groundwater Protection Requirements

The following are statutory guidelines for water quality for either potable or stockwater use.

Indicator Bacteria

Potable (drinking water)	<1.0 E.Coli/100ml (NZDWS and ECan)
Stockwater	1,000 faecal coliforms/100ml (ECan)

Nitrogen

Potable (drinking water)	11.3g/m^3 Nitrate Nitrogen (NZDWS)
Stockwater	30mg/l Nitrate Nitrogen (ECan)

2.4 Suggested Groundwater Protection Distances

The methodology for determining groundwater impacts and assessments used for Pines I was also adopted for Pines II. The discharge quality and irrigation systems are likely to be similar to Pines I but the discharge quantity has changed, hence additional groundwater modeling was deemed necessary. Results for groundwater modelling using the DISPSOLV model are summarised in the Pines II AEE document (the full modelling report is contained in Appendix 16 of the main document).

The analysis focused on identifying groundwater separation required to meet potable drinking water requirements. This analysis considered two situations, being groundwater flow in homogenous conditions (with expected groundwater velocity of 2.9m/day), or a situation where there is fast flowing, permeable channels (with groundwater velocity of up to 200m/day). These groundwater conditions were assessed with the likely or mean treated wastewater discharge of 500FC/100ml for faecal coliforms and 7 mg/l for nitrate-nitrogen. Similarly, a worst case discharge of 10,000 FC/100ml for faecal coliforms and 10 mg/l for nitrate-nitrogen was also modeled. Table 1 presents the contamination distances or separation required to achieve drinking water and stockwater compliance for faecal coliforms. Table 2 presents the modelling results for nitrate-nitrogen.

Table 1: DISPSOLV Groundwater Dispersion Modelling Results for Faecal Coliforms

Contaminant Concentration	Groundwater Velocity (m/day)	Contamination Distance (m)	
		Drinking Water Standards	Stockwater Standards
Likely Case 500 cfu/100ml	2.9	20*	NA
Worst Case 1000 cfu/100ml	200	1,340**	170**

NOTES:
* denotes value based on assumption of 63% removal in unsaturated zone.
** denotes representative value including allowance for background concentration (96 cfu/100ml). Value presented in table is between the results determined for 20% and 63% removal in the unsaturated zone.
NA denotes concentration entering groundwater (including background) is below stockwater standards so contamination distance is not applicable.
Groundwater velocities represent worse case and typical values used in ECan guidelines (PDP 2002, Fietje, 1991)
From DISPSOLV model – distance before groundwater faecal coliform concentration meets NZ Drinking Water Standard (<1 cfu/100ml) and ECan Stockwater Standard (1,000 cfu/100ml).

Table 2: DISPSOLV Groundwater Dispersion Modelling Results for Nitrate-Nitrogen

Contaminant Concentration	Groundwater Velocity (m/day)	Contamination Distance (m)
Likely Case Discharge 7 mg/l Background 5.2 mg/l TOTAL 12.2 mg/l	2.9	400
	200	50
Worst Case Discharge 10 mg/l Background 5.2 mg/l TOTAL 15.2 mg/l	2.9	900
	200	110

NOTES:
Background concentration of 5.2 mg/l incorporated into all modeling results.
No removal in soil or unsaturated zone.
Groundwater velocities represent worse case and typical values used in ECan guidelines (PDP 2002, Fietje, 1991)
From DISPSOLV model – distance before groundwater nitrate-nitrogen concentration meets NZ Drinking Water Standard (conservative value adopted of 10 mg/l).
Compliance with Stockwater Standards not assessed as concentration entering groundwater (including background) is below standards so contamination distance is not applicable

The groundwater modelling assessment of effects for microbial contamination under the worst case scenario suggests a distance of 1,340m to achieve compliance with drinking water standards. This is considered very conservative and a microbial contamination distance of 20m is considered reasonable under likely and expected conditions.

The analysis undertaken for the nitrate-nitrogen contamination suggests that under worst case conditions the maximum distance to achieve compliance with the drinking water standards is 900 metres. These results suggest that microbial contamination would represent a greater contamination distance than nitrate-nitrogen. Hence the separation distances defined for Pines II are based upon microbial contamination and not nitrate-nitrogen.

If an alternative water supply is not provided, it could be viewed that potable bores should be at least 1,340m away from the Pines irrigation system, to be sure no effects. As this is unlikely to be practical or economic, it increases and probability of providing an alternative water supply to those groundwater abstractions that are within 1,340m of the irrigation system. As noted in Section 3.2, not withstanding the probability of provision of an alternative potable supply, stockwater needs protection also.

While the appropriate stockwater indicator bacteria concentration could be debated, it is considered realistic to adopt the standard of 1,000FC/100ml, for stockwater sourced from groundwater. Using the same input parameters but requiring the 1000FC/100ml stockwater standard to be attained (assumes an alternative potable water supply is installed), the worst case microbial contamination distance is concluded to reduce significantly to that required for potable standards and a reasonable worst case contamination distance of around 170m could be expected. With a likely mean discharge concentration scenario (500 FC/100ml) the stockwater compliance levels are not an issue for the typical or mean discharge situation as the initial concentration entering the groundwater is below the adopted standard.

The practical situation is significantly better than the analysis undertaken in 2003, with mean faecal coliform concentration in the treated wastewater of 50FC/100ml rather than the 500FC/100ml allowed for.

Notwithstanding the possibility of the provision of an alternative potable supply to existing groundwater abstractions close to the irrigation area, it would seem prudent to maintain a reasonable separation distance to allow safe abstraction in a normal situation. From the information presented in the Pines II modeling results (Tables 1 and 2), this could be concluded to be either 20m (for a typical discharge with non-channeled flow), or 1,340m (for a worst case discharge with channeled flow). Given the low probability of continuous groundwater channeling, downstream bores being sited within a channel and the possibility of an alternative water supply, it would seen excessive to provide separation greater than 1,340m. The 170m separation distance estimate is sufficient to ensure safe stockwater.

A set back or buffer distance of 150 metres is provided on the western side of Brookside Road to provide separation for stockwater supplies. In addition, the road reserve is considered to occupy an area of approximately 20 metres. Hence the set back distance to potential stockwater supply wells would be 170 metres down gradient, from the edge of the potential irrigation area. Furthermore, it would be reasonable to assume that wells would be set back 50m or more from road side boundaries, hence the buffer distance is likely to be greater than 170 metres

Such set back requirements could avoid or reduce the need for shelter belts for aerosol control (as 150m is commonly considered adequate) or allow the development of rural residential lots in the 170m separation zone (with shelter belt at irrigation boundary).

2.5 Consideration of Water Supply Zones

Based on the worst case groundwater contamination risk distance identified in Section 2.4 of 1,340m, Figure 3 shows the proposed water supply zone, which extends beyond the risk zone to provide some contingency (*see Appendix 6 in main document*). Not only does the water supply zone cover the down gradient area, it also covers bores adjacent to the irrigation area that may draw from the groundwater due to pumping.

The rules for the water supply zones are likely to be:

1. Supply to dwellings for domestic use;
2. Stockwater supply by agreement;
3. Water quality to New Zealand Drinking Water Standards;
4. Domestic supply of $2m^3$/d/dwelling, unless agreed otherwise;
5. Farm, pasture block, and irrigation excluded;
6. Supply installed / connected six months prior to the implementation of adjacent irrigation blocks (some areas may be developed in 10 – 30 years);
7. Supply restricted or metered;
8. Council meets all of the capital costs and consumer connection point;
9. No fire supply capacity.

2.6 Consideration of Potential Irrigation Areas

The Pines II irrigation proposal seeks to expand the present irrigation into the adjacent SPBL land. At this stage, the extent of land required or available have not been fully discussed with SPBL, however these discussions are likely to consider all the SPBL land between Dunns Crossing Road to Burham Road and Main South Road to Bookside Road. The present land owned by SPBL and subject to discussion for Pines II irrigation is shown on Figure 2 (*see Appendix 6 in main document*). Based on unrestricted availability of SPBL land (to be confirmed) and the separation distances discussed in Section 2.4 of this document, Figure 1 shows the land that could be irrigated (*see Appendix 6 in main document*). This is based on the following parameters.

Minimum buffer zone separation:

- Road Boundaries - 20m (to allow for shelter belt)
- Road Boundary with adjacent private owners (with downstream groundwater abstraction possibilities)
  - 170m, with alternative water supply provided out to 1,340m away from irrigation

Figure 1 also shows square blocks where a movable sprinkler system, such as K-line irrigation, might be used to:

- Allow effective irrigation of that block
- Allow setback and shelterbelts / landscaping to suit adjacent residential owners
- Avoid dominance of center pivot irrigation and shelter belts close to the boundary

- Use low height / low pressure / low visual impact spray system in proximity to adjacent residential owners (other owners are on the other side of the road)

Due to the additional operational requirements of this system (for example, removal of lines for harvesting), it is likely that this block would be one of the last to be developed for irrigation)