EASTERN SELWYN SEWERAGE SCHEME - PLANNING FOR GROWTH, BUT PLANNING IT WISELY

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ABSTRACT

The Eastern Selwyn Sewerage Scheme (ESSS) was developed to meet the existing and future needs of the towns of Prebbleton, Lincoln and Rolleston. The purpose of this scheme is to ensure a staged and managed approach to the development of wastewater bulk conveyance, treatment and disposal infrastructure while providing equality in the scheme costs for existing residents, new developments and future generations.

A structured approach was taken to define the limitations of the options considered, and to develop an equitable approach for each of the communities. Considerations were made on how best to use existing assets to offset the capital expenditure of the scheme. These are investments already made by existing ratepayers and, if used appropriately, could benefit the final solution.

A balance was made between the need to accommodate immediate growth and develop infrastructure required to cater for the future flows expected from the changing needs of the communities. Components of the scheme were staged to either allow upgrading without compromising ongoing operations or developed in a modular fashion to minimise the impacts of future construction.

This paper examines the processes considered, approach taken and the option developed to meet the Council's challenges.

KEYWORDS

Sewerage, Treatment, Resilience, Staging, Infrastructure Reuse, Minimising Capital

1 INTRODUCTION

In the late eighties and early nineties, the configurations of the wastewater systems for the eastern Selwyn District towns of Prebbleton, Lincoln and Rolleston were not as they are now. Significant changes were needed at that time to meet environmental requirements while catering for residential and commercial growth, drivers that remain to this day.

For Rolleston, the community was initially developed with onsite treatment and disposal of wastewater via septic tanks. Developers identified the potential for the growth in the town with availability of land for subdivision and proximity to major service routes to Christchurch, and to the west coast. The initial solution was development of the Helpet wastewater treatment plant (WwTP). This plant was built on the southern boundary of the community at the edge of the zoned urban extent. Growth within the community exceeded the population projections for the initial development and a further expansion was undertaken. The attraction of the growing community once more drove growth rates such that, even with this staging, there was already pressure for more capacity. In 2003, a wastewater master plan was adopted for Rolleston to service the present and future needs, including wastewater infrastructure, staged WwTP design and land purchase to provide for treated effluent disposal.

For Lincoln, the continued discharge of oxidation pond effluent to the L2 stream was deemed unacceptable and an alternative solution was required. The standalone solution for the Lincoln community was dictated by finding a point discharge for the treated effluent. The recommended solution was for land based discharge at an appropriate location with treatment at Lincoln via Sequencing Batch Reactor (SBR) tanks in combination with the oxidation pond. The nearest land identified as being suitable for land disposal was some distance away bordering Selwyn Road, in the vicinity of what is now adopted for land disposal as part of the ESSS. The disposal option adopted was via an arrangement reached with Christchurch City Council (CCC) to discharge partially treated wastewater to the Christchurch City wastewater system rather than develop the standalone option.

For Prebbleton, as with Lincoln, a discharge agreement was reached with CCC to connect to their wastewater system. Unlike Lincoln, there is neither the level of pre-treatment nor buffer storage afforded by the oxidation pond. Therefore the growth of the Prebbleton community was significantly impacted by the amount of wastewater servicing that can be provided under the CCC agreement.

The growth of Prebbleton and Lincoln was limited by the discharge restrictions as defined in the CCC agreement. Without an alternative solution being adopted, no further growth could occur. Similarly for Rolleston, there would be limited growth without greater capacity of treatment and conveyance being constructed in accordance with the master plan, even on a standalone basis. Selwyn District Council (SDC) therefore decided to investigate the options available for servicing the wider community to meet current and future needs, and subsequently formed the basis for the establishment of the Eastern Selwyn Sewerage Scheme.

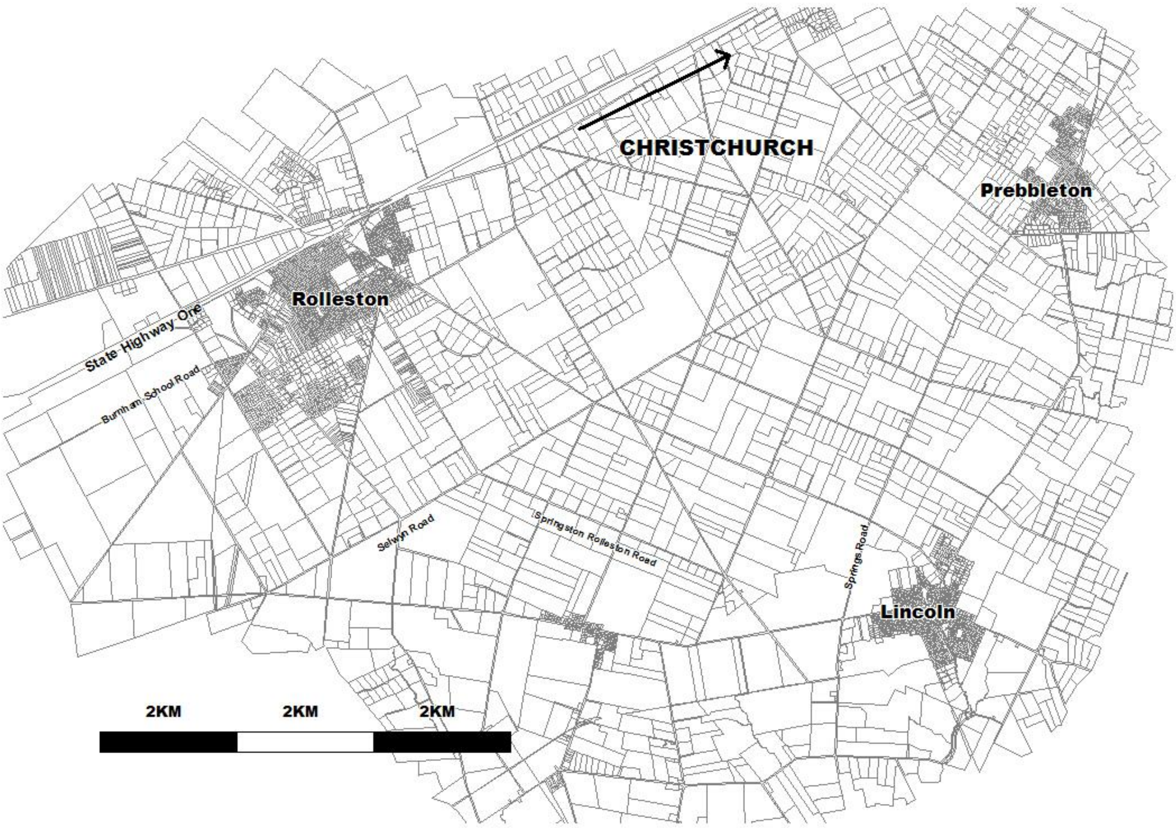

Figure 1: Location plan of the Eastern Selwyn District Towns

2 SCHEME DEFINITION

2.1 FRAMEWORK

The development of the ESSS in 2007 by MWH was framed by;

- planning requirements for the District,
- compliance with the action plans, particularly for wastewater, defined within the Greater Christchurch Urban Development Strategy (UDS), and
- the District Vision Statement associated with the SDC 5 Waters Strategy

2.1.1 PLAN CHANGES

The urban development within each of the Eastern District towns was undergoing review to plan for the increasing demand to release land for development while maintaining the character of each town. Plan Change 7 was developed to define the changes in land use and the density of development to meet the expectations of the wider community. Specific provisions were made to implement Subdivision and Medium Density design guidelines to achieve the desired urban design outcomes.

2.1.2 UDS

The UDS is a strategy document developed by the various district and regional authority partners within the greater Christchurch region. Consultation for and development of the UDS document took place between 2004 and 2007 to establish a collaborative approach to sustained growth. The document provided a detailed strategy, including guiding principles and a framework for implementation.

For SDC, there was some flexibility in the deciding the locations where growth could occur. However, there were agreed horizons for growth and an agreed number of household connections were defined. Accommodation of the projected growth and the timing of implementation formed a key aspect to the ESSS.

2.1.3 SDC 5 WATERS STRATEGY

SDC developed a set of governing principles to guide the decision making process related to the development and implementation of the wastewater schemes. These are outlined in their 5 Waters Strategy document and formed the basis for developing ESSS. Any decisions reached would need to refer back to and reflect on the seven principles of sustainability adopted by SDC. These are:

1) Make decisions based on the four aspects of well-being (Environmental, Social, Cultural and Economic)
2) Observe the Precautionary Principle to provide contingency and enable adaptability of our Community
3) Seek “intra-generational” and “inter-generational” equity
4) Internalise environmental and social costs
5) Foster community welfare
6) Act to halt the decline of our indigenous biodiversity and maintain and restore remaining ecosystems
7) Consider and promote the sustainability of our neighbouring communities and work with governing bodies for sustainable outcomes.

2.1.4 GROWTH PROJECTIONS

The population growth projections for Christchurch City, Waimakariri District and Selwyn District were defined and established in the UDS documentation. These figures have been adopted and carried forward into the predictions of residential growth for locations in the east of Selwyn District. Further assessment was completed by Business and Economic Research Limited (BERL) to define the growth horizons for the various communities. This information is compiled below as a summary of the projected populations in the form of population equivalents (PE) for the ESSS.

	Unit	2010	2016	2026	2041
Predicted Population (BERL Adjusted)	PE	17,620	25,800	34,730	39,240

Table 1: ESSS growth projections – BERL Adjusted

Staging of the elements of the ESSS was considered within the context of the growth predictions. If the proposed staging period is too small, then the next stage of development would proceed immediately on from the initial construction. If the proposed staging period is too large then there would be inefficient operation of the equipment and plant, and a cost burden on the community. History to date for the Rolleston community is that growth has been higher than anticipated and has resulted in premature upgrading of infrastructure.

The projected populations were compiled prior to the recent Canterbury earthquakes, and catered for the expected growth at that time. The full impact of residential and commercial property relocation as a result of the earthquakes is only now being realised and these population projections will change. An approach to both the bulk conveyance and the Rolleston WwTP (referred to as the Pines WwTP) has been taken to stage the capital investment as much as feasible to defer capital costs without compromising the performance of the system while having the ability to alter the timing of improvements if growth rates accelerate.

2.2 OPTIONS CONSIDERATION

2.2.1 DISCHARGE

The fundamental criterion for the scheme was the ability to dispose of the wastewater. There was no spare capacity under the existing discharge agreements with CCC to meet the growth predictions for either Prebbleton or Lincoln. Options to increase the allocation were formally discussed with CCC staff throughout the options development stage and through to completion of the consenting of the irrigation block at the Pines WwTP. Limitations within the downstream network and the timing of future upgrades meant the discharge volumes could not be increased and therefore SDC needed to provide an alternative solution.

Discharge of treated wastewater via waterways was not considered viable due the water quality requirements and the cultural sensitivity of the ultimate receiving environment (Lake Ellesmere / Te Waihora). Therefore, two viable solutions were considered, Land Disposal and Ocean Outfall Disposal.

Each of these viable solutions were evaluated against the four well beings and tested against their compatibility with the District and UDS visions statements. In comparing the Land Disposal and Ocean Outfall options, each had a similar weighting in terms of scores against the Environmental and Social well beings, however Land based disposal was clearly favoured over Ocean Outfall disposal with higher scores against Economic and Cultural well beings. The Ocean Outfall option was estimated as being ~30% ($33M) more expensive than the Land based disposal option. The Land based disposal option had a smaller risk profile and a higher certainty of outcome than that of the Ocean Outfall option given the existing consent (circa 2004) established for treatment and land disposal at the Pines WWTP site.

For Land Disposal, localised treatment and land irrigation was considered. The land in the vicinity of the communities of Lincoln and Prebbleton is not suitable for land based discharge due to the soil types and high groundwater table. A centralised option at the existing Pines WwTP site was considered the most viable solution for Land Disposal due to:

- Availability and suitability of adjacent land for irrigation disposal.
- Ability to consent for the proposed activity (existing consent on the adjacent land)
- Reuse of existing infrastructure.
- Upgrades would be required of the wastewater treatment infrastructure at Pines WWTP for Rolleston in the immediate future to meet the continuing growth. This would allow integration of treatment solutions.

2.2.2 SCHEME CONFIGURATION

Establishing the fundamental requirement regarding the discharge of treated effluent set in place both the likely position of disposal and the parameters / expectations for the quality of the final effluent (subject to obtaining resource consents). Having completed the consenting process four years prior to this investigation for the existing Pines WwTP meant that a baseline had been established and could be considered as part of confirming the scheme configuration.

The core configuration was developed to be aligned with the expected growth within the communities and to incorporate the existing wastewater infrastructure. In a simple sense, once a discharge position of the Pines WwTP was defined then the next stage was to consider how to convey the flows from the various towns to that site.

The static lift between Lincoln and Rolleston is 50m over a distance of approximately 16km. A pumping system was required to minimise both the pumping heads within the network and the residence time of flows in the pipeline network. Likewise a decision was required as to how best to connect Prebbleton to the ESSS given the expected design flows and the timing of residential development. A description of components of the scheme and staging are provided in Section 3.

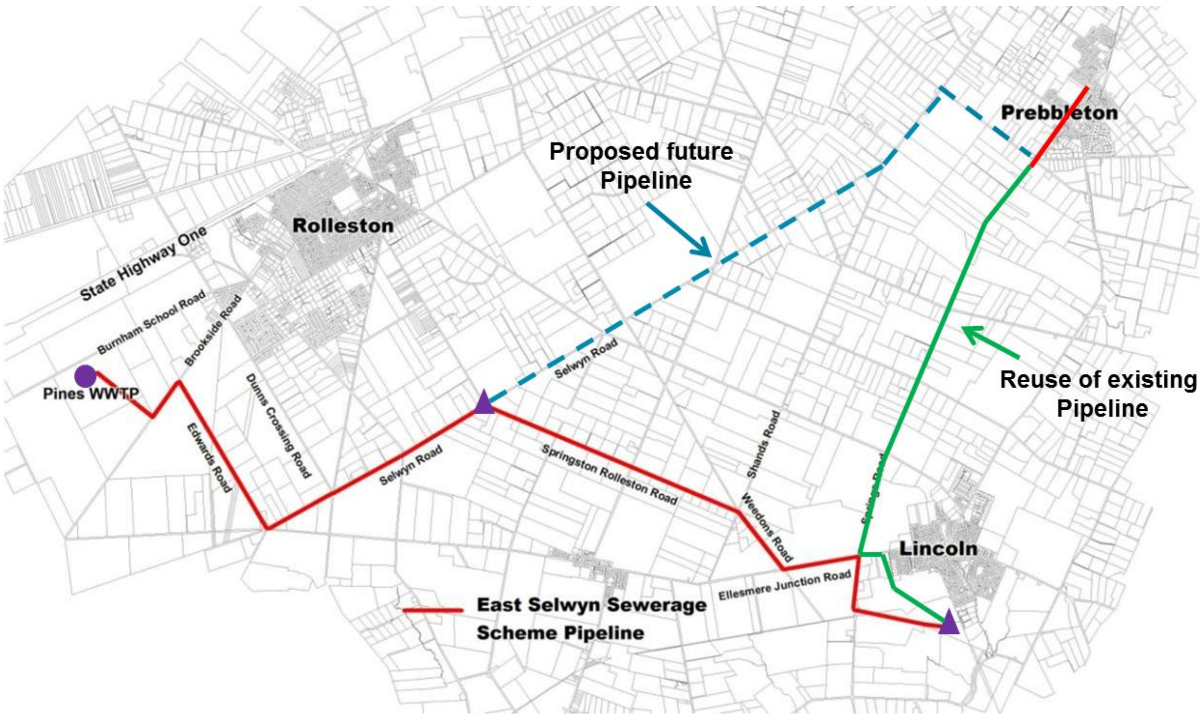

Figure 2: Configuration of the ESSS

3 CONVEYANCE DEVELOPMENT

3.1.1 PIPELINE SIZING – MINIMISING CAPITAL INVESTMENT

The balance in developing a pumping system of this nature needed to be found in being able to accommodate existing flows while planning for future growth rates. The pumping regime needed to be developed to meet the average dry weather flow (ADWF) for the connected population at the beginning of the scheme's life and to meet the peak flows for the future town development. A Net Present Value (NPV) analysis was completed to determine the best approach for sizing the pressure mains. The principal options were a single pipeline for peak flows, twin pipelines with a staged installation and a single pipeline for averaged peak day flows.

At Lincoln, the proposed location for the main pump station was adjacent to the existing SBR tanks at the Lincoln Oxidation pond site. By using these tanks, which are less than 20 years old, the future peak day flows can be buffered to allow pumping of averaged peak day flows and therefore minimising the size of the discharge main required. Taking this approach helped to:

- reduce the size of the pipeline infrastructure through to the Pines WwTP (twin 500mm pipelines reduced to one 500mm pipeline from Lincoln to Rolleston, 700mm pipeline reduced to 630mm pipeline from Rolleston to the Pines WwTP).

- reduce the size of the wet well chambers as additional storage of emergency provisions is partly accounted for with these tanks using the existing infrastructure to offset the capital costs.

An additional benefit of this approach is to minimise the residence time within the pipeline particularly at the early stages of development. A single pipeline approach was therefore selected.

3.1.2 PUMP STATION DEVELOPMENT – MINIMISING CAPITAL INVESTMENT

Under Plan Change 7, the urban extent of Rolleston will expand to the south requiring a pump station to be established to service the growth and convey flows to the Pines WwTP. The conveyance of flows from Lincoln WwTP (the initial collection point for wastewater from Prebbleton, and Lincoln) required a booster station at an intermediary point between Lincoln and the Pines WwTP to minimise heads within the network. A single pump station was positioned such that it could meet these combined requirements avoiding the duplication of infrastructure. The Selwyn Road pump station therefore becomes a hub for the collection of flows and the focal point for future development options.

3.1.3 SERVING PREBBLETON – REUSE OF EXISTING INFRASTRUCTURE

A pipeline directly from Prebbleton to Rolleston could be required for the long term servicing of the Prebbleton community. However, an interim stage has been adopted to use the nearby existing pipeline between Lincoln and Christchurch City (which would otherwise become redundant) to convey flows from Prebbleton to Lincoln and then on to Rolleston. This does require a degree of control at the discharge of the pipeline at the new pump station as there is a negative differential head between Prebbleton and Lincoln. The benefit of connecting in this manner, outside of the offsetting of capital investment is the additional flow conveyed in the pipeline between Lincoln and Rolleston to provide flushing flows.

A decision on the timing of the pipeline between Prebbleton and Rolleston being installed will be based on the monitoring of flows, growth rates and performance of the installed infrastructure. The ultimate decision will be based on:

- Growth in Prebbleton exceeding the capacity of the reused, existing infrastructure

- Combined growth in Lincoln and Prebbleton exceeding the capacity of the installed ESSS pressure main

By taking this approach, the projected date for installation of the Prebbleton to Rolleston pipeline using existing growth projections has been pushed out to 2026.

3.1.4 RESILIENCE – REUSE OF EXISTING INFRASTRUCTURE

The existing oxidation pond at Lincoln has been incorporated into the development of the scheme. Prior to the development of the ESSS, the wastewater from Lincoln was partially treated in the oxidation pond prior to discharge to the Christchurch City wastewater system. As mentioned above, the pipeline from Lincoln to Christchurch is being used for the conveyance of flows from Prebbleton to Lincoln. The pond, as it is currently configured, has been incorporated as an emergency provision in the event of significant issues within the pumping system such as a burst pressure main or similar. The configuration has been maintained to divert flows from the Lincoln wastewater system but has also been incorporated in the design of the pressure mains to allow gravity drain down from the Selwyn Road pump station in Rolleston. This mitigates the risk of significant discharges of wastewater directly to the environment allowing valuable time for repairs to be undertaken.

The pressure mains connecting Lincoln and Prebbleton to Christchurch city will not be abandoned as these too form part of contingency measures in the event of issues within the ESSS.

4 TREATMENT DEVELOPMENT

4.1.1 WWTP STAGING– MINIMISING CAPITAL INVESTMENT

There is significant investment required in the establishment of the redevelopment of the Pines WwTP. Each element within the plant has been considered on basis of design for the expected life of the structures and to meet the criteria of the resource consents obtained. The design life for the civil works is in excess of 50 years and this has been taken into consideration when defining the scope of the design. Also, any future staging at the site is not to compromise the operation of the WWTP, which means that space is to be allowed whether within structures for future mechanical plant, within major pipelines for future flows, or adjacent to facilities for future civil construction.

The initial stage of development was for a treatment process to treat 30,000 person equivalents (PE). The equipment and civil structures have then been designed in approximately 15,000PE modules to be staged for future growth. This takes the potential capacity of the WwTP out beyond the 2041 design horizon and out to the life of the civil structures without investing in the ultimate solution now.

The major civil structures (bioreactor/clarifiers/solar drying halls/irrigation pipework) and mechanical plant items have therefore been sized and are to be installed for the initial design horizon, and then in stages to meet the ultimate population of up to 60,000PE. This comes at a marginal cost now compared to replicating the configuration at a later date.

Also incorporated into the design was process resilience without compromising the capital investment in the plant. The major process elements (inlet/bioreactors/clarifiers/UV) were established with a dual stream process to allow for one bank to be out of operation while still maintaining, at least, ADWF treatment.

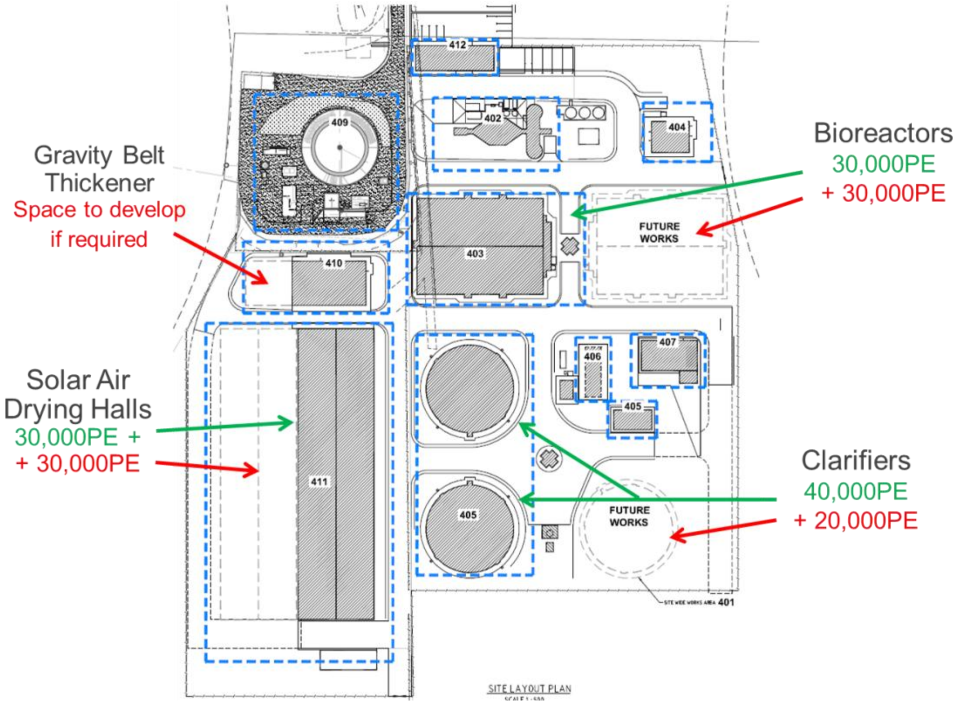

Figure 3: Staging at Pines WwTP

4.1.2 INTEGRATION OF EXISTING WWTP – REUSE OF EXISTING INFRASTRUCTURE

In 2005, there was investment made in the development of the existing Pines WwTP. A compact site was developed with a design capacity of 6,600PE. The existing site can be seen in the top right corner in Figure 3. The design of the new WwTP was centered on the development of two process trains, one for the Liquid Stream and one for the Solids Stream. Consideration was given to how to incorporate the existing structures into the design to make best use of the built infrastructure.

The structures of the existing plant were used in form the first stage of the solids treatment stream, converted into aerated sludge digester and gravity thickener prior to transferring of the digested sludge through to the centrifuges. This made use of the existing blowers for the aeration system and used the configuration of the tank to provide the dual purposes of sludge aeration and gravity thickening.

4.1.3 SLUDGE MANAGEMENT – MINIMISING OPERATING COSTS

A large portion of the operating cost of the existing Pines WwTP was the handling and disposal of sludge. The waste sludge was carted off from the site and disposed of. The intention of the solids stream is to substantially reduce the volume of material that is required to be taken from the site. Part of this process is the thickening of the sludge through the sludge digester and dewatering via the centrifuges. An addition to these elements is a solar air drying hall into which the sludge at approximately 18% dry solids is placed and then turned over slowly by an automated process.

The drying hall makes the best use of the natural climate in Canterbury to increase the moisture removal rate, provide a residence time for the removal of pathogens, and minimise the volume to be removed from site. A 70% dry solids content is targeted as an output of this process, providing a significant decrease in the volumes of biosolids to be removed from site. The surrounding land has been consented for the disposal of Grade Aa biosolids. Testing will prove whether the pathogen and metal content of the biosolids can achieve this standard. If so, further savings will be made with disposal on adjacent pasture land.

Photograph 1: Solar Air Drying Halls

4.2 ESTIMATED SAVINGS

It is possible to quantify the savings associated with the approach taken in the development of the conveyance system and treatment for the ESSS. These estimated cost savings, represented as Net Present Value (NPV) figures, are summarised in Table 2.

Reference		Basis for assessing savings	Estimated Cost Savings
Minimising Capital Investment			
Pipeline Sizing	Conveyance	Buffering of peak future flows in existing SBR tanks rather than constructing a second 500mm diameter pipeline from Lincoln to Rolleston	$4.2M
Pump Station Development	Conveyance	Combined duty pump station instead of a second pump station to solely service the southern Rolleston area (45l/s)	$0.4M
WwTP Staging	Treatment	Delaying the second of three stages of WwTP development until population growth projections are reached	$3.8M
Reuse of Existing Infrastructure			
Serving Prebbleton	Conveyance	Deferring the installation of the Prebbleton to Rolleston pipeline until the growth in Lincoln and/or Prebbleton exceed installed capacity	$3.4M
Integration of Existing WwTP	Treatment	Constructing a standalone structure to serve the same purpose as the converted WwTP	$3.2M
Minimising Operating Costs			
Sludge Management	Treatment	Comparison of costs (OPEX and CAPEX) for dewatered sludge management with and without the drying halls installed	$3.9M
		Total	**$18.9M**

Table 2: Estimated Savings for ESSS

A cost saving has not been derived for the inclusion of the existing oxidation pond as emergency storage, which provides further resilience for the scheme. To construct a similar storage basin would come at considerable cost; however this type of development would not be typical for a scheme of this nature. The pond has been included as it is a valuable embedded cost and asset for the community and provides an additional level of environmental protection. This level of protection meets key requirements as defined under the four well-beings and the SDC 5 Waters Strategy and Vision Statement.

5 CONCLUSIONS

The Eastern Selwyn Sewerage Scheme has afforded SDC the opportunity to meet the challenge of accommodating immediate growth while developing required infrastructure to cater for the future flows expected from the changing needs of the communities.

An approach to both the bulk conveyance and the Pines WwTP has been taken to stage the capital investment as much as feasible to defer capital costs without compromising the performance of the system while having the ability to alter the timing of improvements if growth rates accelerate or decline.

Minimising capital costs has been achieved by considering how to best incorporate the existing infrastructure into the design of the scheme. A holistic view has been taken to integrate the requirements of the communities with the bulk conveyance of flows.

ACKNOWLEDGEMENTS

We would like to thank the teams from MWH NZ Ltd and Selwyn District Council for their efforts and contributions in developing the basis for this scheme.

REFERENCES

CCC, WDC, SDC, ECan, NZTA, Ngāi Tahu (2007) 'Greater Christchurch Urban Development Strategy and Action Plan'

SDC (2009) 'Selwyn District Council Five Waters Strategy'

SDC (2008, and subsequent updates) 'Selwyn District Plan'