University of Southern Queensland

Faculty of Engineering and Surveying

Rationalisation of Wastewater Treatment Plants in Launceston

A dissertation submitted by

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In fulfillment of the requirements of

Courses ENG4111 and 4112 Research Project

towards the degree of

Bachelor of Engineering (Civil)

Submitted: October 2005

Abstract

The condition and level of treatment provided by the existing sewerage infrastructure and treatment facilities in Launceston is unsatisfactory by today's standards. An improvement of the standard of treatment of wastewater, and a reduction of the frequency and severity of overflows cannot be achieved without significant infrastructure upgrades and modifications.

A number of options have been considered, however it is obvious that two particular options warrant more detailed investigation. The options nominated involve a regional approach and a reduction in the overall number of wastewater treatment plants. The rationalisation will incur higher capital costs, however lower overall operating costs dictate that rationalisation will provide an economical long term solution.

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Limitations of Use

Certification

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Acknowledgements

I would like to thank the following people for their guidance, support and other assistance which has enabled me to complete this project:

Steve Ratcliffe, Geoff Brayford and Andrew Oakham of Launceston City Council (LCC) for providing supervision and guidance;

Raj Pakiarajah and Peter Stacey, also from LCC, for encouragement and allowing flexibility at work;

Kerry Forrest, LCC Resource Centre for assistance in finding relevant texts and previous reports;

Rod Bevan, LCC Asset Engineer (Pump Stations) and Sean Adams, LCC Waste Manager for providing advice and assistance to evaluate the operating costs of pump stations and treatment plants;

Dr Ernest Yoong, University of Southern Queensland, for his role as USQ Supervisor; and

Vanessa and both of our families for unwavering encouragement and practical support to enable me to complete this project.

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1 Introduction

Launceston is located at the head of the Tamar Valley where the North Esk and South Esk rivers merge to become the Tamar River. The Tamar River is tidal at Launceston and flows into Bass Strait at Low Head, approximately 70 kilometres to the north. The Tamar River Estuary forms an important habitat for many birds and marine species and is also an excellent recreation area for residents and visitors to Launceston and the Tamar Valley.

Launceston City Council (LCC) and the adjoining Meander Valley Council and West Tamar Councils discharge treated effluent from a combined population of 100,000 people into the Tamar River. It is important that a high quality of final effluent is achieved to minimise the impact on the downstream environment.

A number of wastewater treatment facilities in the greater Launceston area are approaching the end of their design life. The quality of treated effluent now required by the Department of Primary Industry Water and Environment (DPIWE) makes it necessary to include nutrient removal as part of any new work or upgrades to existing treatment plants. The Launceston City Council, Meander Valley Council and West Tamar Council consider that it may be more economical to decommission some of the smaller treatment facilities and invest in upgrading one or two major treatment facilities. Some investment in pipelines and other infrastructure would also be necessary to redirect sewage to the upgraded treatment facilities. Consulting Engineers have investigated and reported on various rationalisation options. The report includes recommendations and concept estimates for the infrastructure changes necessary to capture and transfer wastewater to one or two treatment points.

This Research Project aims to:

1. Undertake a literature review of the report titled 'Launceston Regional Wastewater Rationalisation Strategy' by GHD Consulting Engineers, May 2005, including:
   - Review the supporting documents such as previous reports;
   - Review the evaluations of the various options outlined in the report;
   - Identify common sources of nitrogen and phosphorous in sewage;
   - Research modern technologies for wastewater treatment and nutrient removal including benefits, limitations and costs; and
   - Speculate on the findings of the report and potentially suggest additional options or variations to the proposed options including alternative treatment technologies.

2. Identify the rationalisation option most likely to give the best outcome for the City of Launceston.

2 Background

For various historical reasons Launceston currently owns and operates five wastewater treatment facilities. Four of these are located within the city and suburbs at Norwood, Hoblers Bridge, Newnham, and Ti Tree Bend. The fifth facility is located at Lilydale, approximately 15 kilometres north east of Launceston. The suburbs of Prospect and Riverside adjoin Launceston and lie within the areas of the Meander Valley and West Tamar Councils. At present the West Tamar Council operate a treatment plant to service Riverside, and the Meander Valley Council also operate a wastewater treatment plant (WWTP) to service Prospect.

The existing treatment plants have been designed to meet the effluent standards that were introduced in 1974. In July 2001 those standards were replaced when the Department of Primary Industries, Water and Environment (DPIWE) published Emission Limit Guidelines. The guidelines require Council to take steps to achieve discharge levels equivalent to those achievable using ‘accepted modern technology’ (AMT). The timeframe for compliance with the guidelines is to be determined on a case by case basis between the plant operators and the regulatory authorities, however it is expected that the AMT emission limits should be achieved within five years (from June 2001).

The major difference between the previous and current emission limits is the requirement for removal of nitrogen and phosphorous. Currently none of the treatment facilities are able to remove nitrogen or phosphorous and upgrading any of the facilities to meet current emission limits would require significant expenditure. Another important factor for consideration is the cost of replacing equipment that is currently in use at the facilities and nearing the end of its serviceable life.

For the West Tamar and Meander Valley Councils it may be more economical to negotiate for the wastewater to be treated by Launceston. Likewise for Launceston, it may be more economical to rationalise the number of wastewater treatment facilities. To do so may involve decommissioning the smaller and older treatment facilities and investing in upgrades at one or two of the larger treatment facilities. This would need to include investment in infrastructure such as pipelines, pumping stations and detention storage’s to enable flows to be diverted to the remaining treatment plants.

On behalf of the Councils involved, GHD Consulting Engineers have investigated and reported on various rationalisation options. The report considers several rationalisation options including:

1. Catchment rationalisation;
2. Upgrading existing wastewater treatment plants to comply with the Emission Limit Guidelines; and
3. Rationalisation of wastewater treatment plants and upgrade to meet emission limit guidelines.

The extent of the report is covered in more detail in the literature review.

3 Literature Review

A major focus of the project is a review of the report by GHD Consulting Engineers titled "Launceston Regional Wastewater Rationalisation Strategy, 'Report on Rationalisation Options Investigation'." Other relevant legislation and reports of previous research are noted and briefly reviewed below.

Supporting Documents (also by GHD) –

- Norwood WWTP – Preliminary Design, Upgrading/Replacement Options (March 2002)
- Ti Tree Bend, Newnham, Hoblers Bridge and Norwood – Review and update of 1991 Report on Nutrient Removal (September 1999)
- Report on Biosolids management Strategy (January 2001)
- Report on Centralised Sludge Handling Facility Preliminary Design (April 2003)

Previous Research and Reports –

- Norwood Sewage Treatment Plant Upgrade: Nutrient Removal Options (Haines, February 2000)
- Newnham – Ti Tree Bend Rationalisation (Henderson, 2003)

Relevant Legislation –

- State Policy on Water Quality Management 1997
- Emission Limit Guidelines for sewage treatment plants that discharge pollutants into fresh and marine waters – Department of Primary Industries, Water & Environment

3.1 Launceston Regional Wastewater Rationalisation Strategy, 'Report on Rationalisation Options Investigation'

3.1.1 Catchment Rationalisation

Within the Ti Tree Bend treatment plant catchment there are sub-catchments which have a combined drainage system in which sewage and stormwater share the same pipe, and sub-catchments which are separated. In rainfall events, both the drainage system and certain points at the Ti Tree Bend treatment plant are liable to overflow resulting in diluted sewage being spilt into the rivers. The report proposes that the separated sub-catchments be piped directly to the treatment plant without being merged with the combined system. This would potentially reduce the frequency and severity of overflows of the combined drainage.

3.1.2 Upgrading existing wastewater treatment plants to comply with the Emission Limit Guidelines

This section of the report is based on the assumptions that:

- Prospect and Riverside catchments are discharged to Ti Tree Bend WWTP
- Ti Tree Bend, Hoblers Bridge, Norwood and Newnham WWTPs are upgraded to include nutrient removal

3.1.3 Rationalise WWTPs and upgrade to meet emission limit guidelines

This section of the report is based on the assumptions that:

- Prospect and Riverside catchments are discharged to Ti Tree Bend WWTP
- Ti Tree Bend and Hoblers Bridge WWTPs are upgraded to include nutrient removal
- Norwood and Newnham WWTPs are modified to pumping stations to transfer wastewater to the remaining treatment plants

The report includes recommendations and concept estimates for the infrastructure changes necessary for the above options. The emission limits are determined by the type and classification of the environment of the discharge waters. The changes and costs are based on the reasonable assumption that the Tamar River (Ti Tree Bend discharge) is classified as 'marine' and that the North Esk River (Hoblers Bridge discharge) is classified as 'freshwater'.

Other issues raised in the report and worthwhile noting here are the significant additional hydraulic load due to inflow and infiltration and the reliance on the City Rising Main. A reasonable portion of the current catchment of the Ti Tree Bend WWTP is pumped from the Margaret Street pump station to Ti Tree Bend via the City Rising Main. The pipeline is old and is laid in soft soils. Future rationalisation schemes should consider providing a second pipeline to provide an alternative course for wastewater which would reduce the environmental risk associated with reliance on a single pipeline.

3.2 Report on Upgrading of Major Plants to Reduce Nitrogen and Phosphorous Levels in the Final Effluent (1990/91); Ti Tree Bend, Newnham, Hoblers Bridge and Norwood – Review and update of 1991 Report on Nutrient Removal (September 1999)

The original report gives a brief introduction and explanation of the effects of nitrogen and phosphorous in the environment, typical sources and concentrations in sewage, and methods of removal. For each of Launceston's wastewater treatment plants the report then recommends a nutrient removal process, describes the necessary changes, and provides an estimate of the construction and operating costs. For all sites it is recommended that phosphorous be removed by chemical precipitation. For Ti Tree Bend and Norwood sites nitrogen is recommended to be removed by nitrification and denitrification processes. The Hoblers Bridge WWTP is expected to have high levels of ammonia in the influent due to the abattoir and saleyards, and is recommended for ammonia stripping. Nitrogen removal at the Newnham treatment plant is expensive due to the need to construct a nitrifying filter.

The purpose of the 1999 report was to update the cost estimates, review the emission limit requirements and re-assess the suitability of the previous recommendations. The result was a recommendation for further assessment of biological methods of phosphorous removal. The reason for this being the increased cost of chemical dosing. The levels of ammonia in the influent at Hoblers Bridge were also reported as being significantly less than expected in 1990. Nitrogen removal via the nitrification/denitrification method is considered appropriate.

3.3 Report on Centralised Sludge Handling Facility Preliminary Design (April 2003)

This report focuses on the sludge handling options for Ti Tree Bend WWTP. The designs are generally based on five different scenarios from the current situation to sludge treatment in the year 2023 assuming Ti Tree Bend also handles sludge from Prospect, Riverside and Newnham. The information is not particularly helpful to the rationalisation project at this stage, however cost estimates may be useful for verifying the estimates in the rationalisation report.

3.4 Norwood Sewage Treatment Plant Upgrade: Nutrient Removal Options (Haines, February 2000)

This report describes the sources and results of nitrogen and phosphorous in wastewater and describes the environmental effects of excessive concentrations in the environment. A table of average effluent quality (at the time of research) shows that the Norwood plant is well short of meeting the current discharge requirements. There is also evidence that the water quality in the North Esk River deteriorates rapidly between the Station Road bridge and the Henry Street bridge. Both the Norwood and Hoblers Bridge WWTPs discharge into this section of the river and there are a number of stormwater discharge points as well. Between the two measurement points the concentrations of nitrogen and phosphorous increase, dissolved oxygen decreases, and there is a significant increase in the suspended solids and bacteria counts.

The report considers chemical and biological means of removing nitrogen and phosphorous and concludes with a recommendation for combined biological nitrogen and phosphorous removal. The proposed process would include a backup chemical phosphorous removal facility and constructed wetlands for effluent polishing.

3.5 Newnham – Ti Tree Bend Rationalisation (Henderson, 2003)

This investigation was carried out internally by LCC staff. Seven different options were investigated including gravity mains, rising mains, additional pump stations, upgrades and rationalisation of pumping stations. The investigation included estimates of capital and operational costs for each option. Option 5 was recommended at a predicted 30 year cost of $5,890,000.

Option 5 features minor works at the Newnham Treatment Plant, construction of a 750mm diameter gravity sewer to Clyde Street, construction of a new pump station at Clyde Street, and rising main to Ti Tree Bend WWTP. This option also includes constructing gravity sewers from Bank and Plumer Streets and connecting into the Newnham – Clyde Street gravity sewer. Bank and Plumer Streets have been an environmental health issue to Council for some time due to the lack of a cost effective sewerage option. The work also involves construction of gravity sewers to Clyde Street which would make the Mowbray Street and Lytton Street pump stations redundant. The Hope Street pump station would also be upgraded to reduce the frequency of overflows.

Options 1 and 2 are approximately $200,000 cheaper than Option 5. However, Option 5 is preferable to Option 1 for two reasons. One of the reasons is that Lytton Street pump station can be diverted to Clyde Street. The other benefit is that the rising main of Option 5 can be laid at a relatively shallow depth in comparison to a gravity sewer which would need to be 8.0 metres deep at Ti Tree Bend, and would also require a lift station at the inlet to Ti Tree Bend.

The disadvantages of Option 2 are firstly, as for Option 1, Lytton Street cannot be made redundant, and secondly the detention time in the rising main would frequently be four hours. This may see the need for an oxygen injection station to avoid odour problems.

3.6 State Policy on Water Quality Management 1997

The policy applies to all surface waters, coastal waters and groundwaters that are accessible to the public and/or are connected to or flow into publicly accessible waters. In broad terms, the purpose of the policy is to ensure that the quality of Tasmanian waters is protected or enhanced, whilst still allowing for sustainable development. The policy also aims to reduce pollutants, ensure water quality is monitored, ensure that those causing or benefiting from pollution contribute to the cost of monitoring and treatment, and promote efficient catchment and resource management.

3.7 Emission Limit Guidelines for sewage treatment plants that discharge pollutants into fresh and marine waters – Department of Primary Industries, Water & Environment

This document includes an explanation of the background to the State Policy on Water Quality Management 1997 and explains the process of determining the Water Quality Objectives (WQOs). In summary, the process is as follows:

- The ‘Protected Environmental Values’ (PEVs) of a waterway are set determined by consultation with the community of users, stakeholders and interest groups associated with the waterway. PEVs may include protection of aquatic ecosystems, recreational purposes, drinking water and agricultural uses; and

- Once the PEVs have been set, the Board of Environmental Management and Pollution Control (the Board) will determine the water quality guidelines necessary to achieve and maintain the PEVs.

The Emission Limit Guidelines (ELGs) were determined from a review of Accepted Modern Technology (AMT) in the wastewater industry and represent a standard that is both economically and achievable. Compliance with the ELGs will generally satisfy the Water Quality Objectives. Where the guidelines are not applicable the Board will advise an appropriate alternative.

For new and upgraded plants the emission limits are listed in Table 1 below.

Table 1 – Emission Limits for new & upgraded wastewater treatment plants

Parameter	**Freshwaters (marine)**		
	50 % ile	**90% ile**	**Max**
BOD	5 (10)	10 (15)	15 (20)
Non-filterable residue	10	15 (20)	20 (30)
Thermotolerant Coliforms	(200)	(500)	200 (750)
Oil and grease (mg/L)	2	5	10
Total nitrogen (mg/L)	7	10	15
Ammonia – Nitrogen (mg/l)	1	2	5
Total phosphorous (mg/L)	0.5 (1)	1 (3)	3 (5)
pH			6.5 – 8.5

Existing plants are expected to comply with the ‘Interim Discharge Requirements’ which are set out in Appendix 2 of the ELGs. The timeframe for upgrading to AMT discharge quality is case dependent, however at the time of publishing the ELGs (June 2001) a broad goal of five years was set.

4 Nutrients in Wastewater

4.1 Sources and environmental effects of nutrients in wastewater

The presence of nutrients in natural waterways is quite normal, and in fact, the aquatic plants and animals utilise the nutrients as a source of food. The abundance of plants and aquatic life varies in proportion to the conditions such as temperature, clarity, salinity, availability of dissolved oxygen, and availability of food (nutrients). Excessive concentrations of nutrients, particularly nitrogen and phosphorous, can disrupt the balance by promoting the growth of algae and aquatic plants. This condition is known as 'eutrophication' and its effects on the waterway and aquatic life are:

– an increased demand for dissolved oxygen and thus reduced availability for fish;
– restricting the flow of the waterway; and
– reducing the penetration of sunlight into the water.

The conditions leading to possible eutrophication vary depending on the circumstances of each particular waterway. Factors which influence the point of eutrophication of a waterway include temperature, clarity and flow (retention time, turbulence/mixing). Approximate concentrations of nitrogen and phosphorous which may lead to eutrophication of waterways are nitrogen; 0.05 to 1.10 mg/L, and phosphorous; 0.002 to 0.230 mg/L (unspecified source, cited by GHD, 1990).

Influent tests conducted by the Launceston City Council from 2000 – 2004 (Regional Wastewater Strategy, GHD, 2005) showed that Launceston's domestic wastewater typically contains nitrogen at a concentration of 50 mg/L (TKN) and phosphorous at a concentration of 10 mg/L. The catchment of the Hoblers Bridge WWTP includes an abattoir and saleyards, consequently the design concentrations used by GHD were increased to nitrogen at 150 mg/L TKN and phosphorous at 100 mg/L.

Nitrogen and phosphorous are contributed to the wastewater through human excreta and the wastes from domestic and commercial water use. It is estimated that between 30 and 50 percent of phosphorous is contributed through the use of detergents (Sydney Water website, 2003, Public Health Engineering Study Book, USQ, 2001). Orthophosphates and Polyphosphates are released by the bacterial breakdown of organic compounds. Nitrogen is generally present as amino acids, proteins, urea and ammonia (Public Health Engineering Study Book, USQ, 2001).

4.2 Nutrient Removal Methods

The methods available to remove nutrients are described in detail in many texts including 'Wastewater Engineering Treatment and Reuse' by Metcalf and Eddy. A comprehensive summary is also given by GHD on Pages 3-10 in their 1990 report on 'Upgrading of major plants to reduce nitrogen and phosphorous levels in the final effluent'.

In brief, the methods available to remove nitrogen include biological means, ammonia stripping, breakpoint chlorination, selective ion exchange, and packed bed reactors.

The biological nitrogen removal process involves two distinct reactions; nitrification and denitrification. In the nitrification stage ammonia is converted to nitrate by aerobic autotrophic bacteria. Nitrification is possible in either the activated sludge or the biological filtration processes. If sufficient nitrification is not achievable in the biological filter, the efficiency may be improved by adding either specific nitrifying filters or packed bed reactors into the process.

Packed bed reactors involve a fine filter media in a sealed unit. Typically the wastewater flows from top to bottom whilst oxygen is pumped through in the opposing direction. The abundance of oxygen promotes the growth of nitrifying bacteria.

In the denitrification stage nitrate is converted to nitrogen gas by facultative heterotrophs. Denitrification can be achieved by incorporating an anoxic zone within the aeration tank of an activated sludge plant, or by a specific denitrifying tower at a biological filter plant.

Selective ion exchange is a relatively simple process involving Clinoptilolite, an ammonia selective Zeolite which is used as an exchange media to remove ammonia from the wastewater. The process of regenerating the Clinoptilolite is more complicated and produces wastewater with a high TDS content.

Nitrogen can also be removed by ‘breakpoint chlorination’. The disadvantages of this process include the formation of undesirable ammonia-chlorine compounds and also the level of control and supervision to prevent the production of organo-chlorines.

Ammonia stripping is another method of nitrogen removal. The method involves spraying the sewage as fine droplets into the top of an enclosed tower while air is passed up through the middle of the tower. Ammonia stripping may not be suitable in Launceston’s climate. GHD have quoted nitrogen removal efficiencies of 95% at 20°C dropping to 75% at 10°C. Also the tower is prone to icing if the air temperature reaches freezing.

Phosphorous may be removed from sewage either biologically or by chemical precipitation. Although it is possible to reduce phosphorous concentrations to 2 mg/L using biological methods concentrations in the range of 4-5 mg/L are more realistic. By comparison the typical concentration of the influent is generally around 10 mg/L, and discharge license conditions will generally require the effluent to have a maximum concentration of 1mg/L.

Chemical precipitation by the addition of soluble aluminium or iron salts, or lime is a more reliable means of reducing the phosphorous concentration to 0.5 – 1 mg/L. The disadvantage of chemical precipitation is that it generates a greater quantity of sludge which will again incur handling and disposal costs.

5 Review of Options

5.1 Preliminary Discussion

In their report titled Launceston Regional Wastewater Rationalisation Strategy, 'Report on Rationalisation Options Investigation', the consultants offered three options as follows:

Option (a) Upgrade the existing wastewater treatment plants at the existing locations;

Option (b) Upgrade Hoblers Bridge WWTP and Ti Tree Bend WWTP; and

Option (c) Upgrade Ti Tree Bend WWTP and divert all sewage flows to Ti Tree Bend.

The works required and estimated costs for all of the options are based on providing nutrient removal and increasing the capacity of the plants so as to meet the flows and effluent limitations expected in 2025. The works and costs are based on duplication or expansion of the existing treatment equipment and facilities. Modern and emerging technologies have not been considered at this stage.

The consultants report has not specified a design life for the facilities, but has been based on population and flow estimates for the year 2025. If the works were implemented immediately they would presumably only be adequate for 20 years. Previous work by Launceston City Council officers has assumed a design life of 30 years. This would require the upgrades to be adequate until 2035. Assuming a growth rate of 1% per annum, the population would increase by 22% in a 20 year period, or 35% in a 30 year period. The anticipated total Average Dry Weather Flow (ADWF) of wastewater is estimated as 49 ML/d in 2025 and 52 ML/d in 2035. These estimates assume that flow due to trade waste and dry weather infiltration remains constant. For the purpose of this report, a design life of 30 years has been adopted and the minor increase of flow (in comparison to 20 year lifespan) has been ignored.

The research and reporting undertaken by Council officers demonstrates that the proposed options can be varied to improve the effectiveness, or reduce the long-term cost of the options proposed by the Consultant. For simplicity, the options proposed by the Consultant are discussed and compared, then the Council's proposals are introduced and compared. The suggested options, anticipated costs, possible variations, and benefits are discussed below. The details of the various proposals are not repeated within this report. Readers requiring more detailed information are referred to the previous reports.

5.2 Options proposed by the Consultants

The operating cost estimates for the wastewater collection system are taken directly from Section 6.6 of the Consultants report. They include allowance for attendance for cleaning and checking every second day, maintenance at 10% of the value of the pumps, and electricity as calculated in Section 6.6.4. The cost to maintain the gravity and rising mains is considered to be minimal in comparison to the attendance, maintenance, and electricity costs and is not included in the comparisons.

The cost of operating the treatment plants is intended to be comparative only and has not been calculated for each proposal. Hence, the current operating budgets are nominated as the operating costs for Option (a), and these figures have been reduced and redistributed for the purposes of estimating Options (b) and (c).

5.2.1 Option (a) Upgrade the existing WWTPs at the existing locations

5.2.1.1 Norwood

The Norwood WWTP is an activated sludge plant which was constructed in 1978 and currently treats an ADWF of 3.53 ML/d. Current problems at the plant include:

- Prone to flooding if flooding of the North Esk river approaches or exceeds the severity of a 1 in 20 year event;
- Unable to cope with wet weather inflows;
- No on-site sludge handling facilities hence sludge is transferred by road to Ti Tree Bend WWTP; and
- Aging equipment.

The Norwood WWTP requires various works in order to overcome the current problems, improve the standard of treatment, and increase the capacity to treat the anticipated future flows. The works include:

- Construction of a flood levee;
- Upgrading the access road;
- Refurbishing and upgrading the inlet works;
- Partitioning the aerated lagoon to create separate aerobic and anoxic zones;
- Constructing an alum dosing facility;
- Refurbishing the existing clarifier and RAS and WAS pump stations;
- Upgrading the instrumentation and control; and
- Expanding the chlorine contact tank.

The estimated cost to upgrade Norwood is $4.1 million.

Figure 1 – Aerial photograph of Norwood WWTP

5.2.1.2 Hoblers Bridge

The Hoblers Bridge WWTP was originally constructed in 1964 and upgraded between 1988 and 1994. The original plant consisted of a primary sedimentation tank, stone media trickling filter and humus tank. The upgrade added screening and grit removal and an activated sludge plant. The purpose of the upgrade was to enable the plant to adequately treat trade waste flows from the saleyards and abattoirs at Killafaddy. The design capacity of the existing plant is 5.97 ML/d, including a trade waste flow of 1.3ML/d over a 10 hour period. Currently the plant treats domestic waste for a population of around 9,200. The ADWF at the plant is 2.44 ML/d including trade waste. At the time of research, trade waste flows were lower than the design flow due to changes in the operations at the saleyards and abattoir.

Current problems at the plant include:

- Odour problems (depending on activities at the abattoir);
- Washout of the activated sludge plant as a result of high inflows during prolonged wet weather; and
- Occasional foaming of the aeration tank.

The Hoblers Bridge WWTP requires various works in order to overcome the current problems, improve the standard of treatment, and increase the capacity to treat the anticipated future flows. The works include:

- Construction of a 5.7 ML storage basin;
- Replacing the existing grit washer and drum screen;
- Constructing an additional primary clarifier and transfer pump station;
- Constructing a 1700m^3 bioreactor;
- Installation of a-recycle and 2 WAS pumps;
- Installation of an alum dosing facility;
- Expansion of the chlorine contact tank to 300m^3;
- Increasing the capacity for sludge drying and pressing; and
- Constructing a new 600m^3 anaerobic digester.

The estimated cost to upgrade the Hoblers Bridge WWTP is $6.9 million.

Figure 2 – Aerial photograph of Hoblers Bridge WWTP

5.2.1.3 Newnham

The Newnham WWTP is a trickling filter plant which was constructed during the 1960s and upgraded in 1980. The plant currently serves a domestic population of 14,500 with an ADWF of approximately 4.04 ML/d.

Current problems at the plant include:

- Inlet overflow problems during wet weather;
- No on-site sludge handling facilities hence sludge is transferred by road to Ti Tree Bend WWTP; and
- Deterioration of plant and equipment.

The estimated cost to upgrade the Newnham WWTP is $15 million. The high cost is due to the need to upgrade the plant to cope with the hydraulic flow, as well as the need to convert the plant to activated sludge to enable nutrient removal.

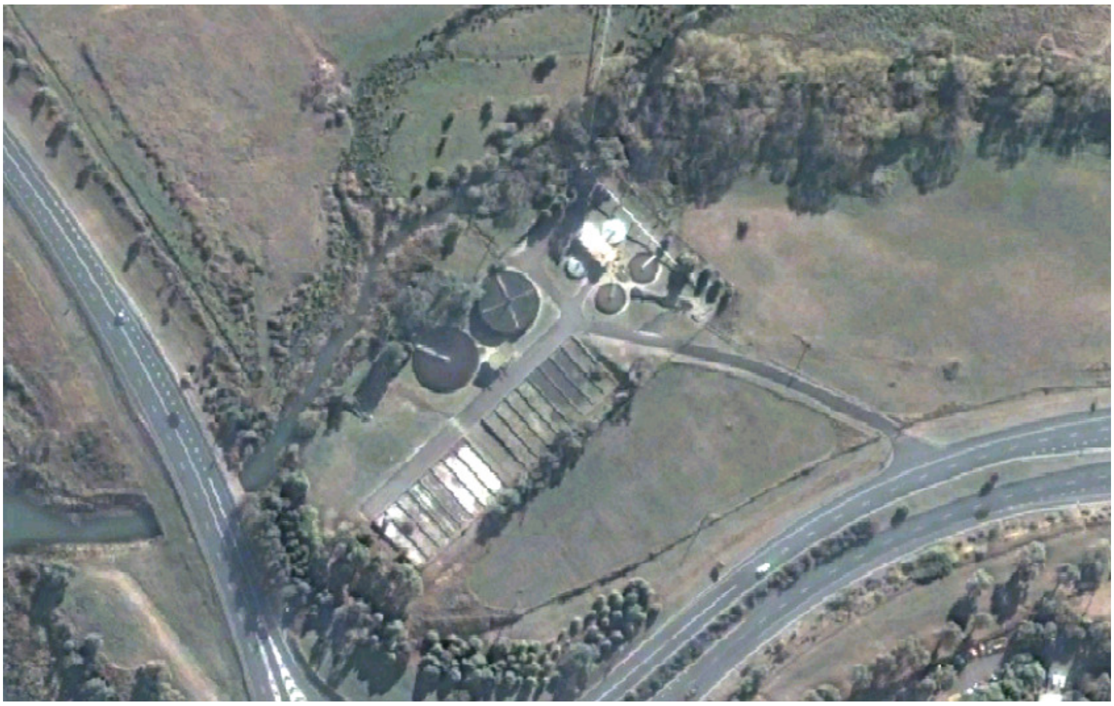


Figure 3 – Aerial photograph of Newnham WWTP

5.2.1.4 Ti Tree Bend

The Ti Tree Bend WWTP was constructed in 1974, with secondary treatment and chlorination/disinfection added in 1983 and 1991. The treatment population is around 45,000, with an ADWF measured at 30 ML/d. Trade waste and dry weather infiltration make up 16.7ML/d.

Known problems at the plant include:

- Odour problems;
- Overflow of partially treated sewage during high inflows; and
- Poor settleability of Secondary Clarifier sludge.

Overflow of partially treated sewage occurs when flow exceeds 2 x ADWF. Sewage from separated and combined systems is mixed then overflows downstream of the Primary Sedimentation tanks. Peak wet weather flow is approximately 6 x ADWF.

The estimated cost to upgrade the Ti Tree Bend WWTP is $15 million.

Figure 4 – Aerial photograph of Ti Tree Bend WWTP

5.2.1.5 Catchment Alterations

In addition to the treatment plant upgrades, catchment alterations or improvements are necessary if this option is adopted. The work required includes:

- Rehabilitation of the existing 375mm diameter rising main between Norwood and Queechy;
- Diversion of catchments TP.1.B, TP.4.B & TP.4.G to the Queechy pump station; and
- Construction of a new pump station to replace the existing Queechy pump station.

The above catchments to be diverted to Queechy pump station are separated catchments. It is desirable to divert them at this point to prevent them from merging into the combined system further downstream and contributing to overflows. This diversion would increase the ADWF flow at Norwood (for the present population) to 4.27 ML/d.

The major part of the rising main rehabilitation work is the replacement of a 400 metre section. The estimated cost of these works is of the order of $2.76 million.

Table 2 - Summary - Option (a)

Location	Catchment Population		ADWF (ML/d)	
	2003	2025	2003	2025
Norwood	16,336	19,970	3.53	5.00
Hoblers Bridge	9,117 + Trade Waste	11,124 + Trade Waste	2.44	3.92
Newnham	14,450	17,632	4.04	4.41
Ti Tree Bend	44,217	53,954	30.00	33.49

Note:

1) The flowrates in the above table assume that sub-catchments TP.1.B, TP.4.B and T.4.G are diverted from the Ti Tree Bend catchment into the Norwood catchment via the Queechy pump station.
2) The adopted trade waste flow at Hoblers Bridge is 1.14 ML/d over a 10 hour period. This amount is included in the 2025 ADWF figure.

Table 3 - Capital Costs – Option (a)

Location	Upgrade Cost $M	Collection Cost $M	Total Cost $M
Norwood	4.10	2.76	6.86
Hoblers Bridge	6.90	-	6.90
Newnham	15.00	-	15.00
Ti Tree Bend	16.00	-	16.00
Total	**42.00**	**2.76**	**44.76**

Table 4 - Operating and 30 year total costs – Option (a)

Location	Annual Operating Cost $M	30 year Operating Cost $M	Total 30 year Cost $M
Norwood	0.269	8.07	14.93
Hoblers Bridge	0.500	15.00	21.90
Newnham	0.200	6.00	21.00
Ti Tree Bend	1.300	39.00	55.00
Total	**2.269**	**68.07**	**112.83**

5.2.2 Option (b) Upgrade Hoblers Bridge WWTP and Ti Tree Bend WWTP

This option would see the Hoblers Bridge WWTP upgraded to treat flows from the Norwood catchment, and the Ti Tree Bend WWTP upgraded to treat flows from the Newnham, Prospect and Riverside catchments.

5.2.2.1 Hoblers Bridge

The Hoblers Bridge WWTP requires various works in order to overcome the current problems, improve the standard of treatment, and increase the capacity to treat the anticipated future flows from the Hoblers Bridge and Norwood catchments. The works include:

- Construction of a 5.7 ML storage basin;
- Replacing the existing inlet works to accommodate up to 615 litres per second;
- Replacing the existing grit washer and drum screen;
- Constructing an additional primary clarifier, and a transfer pump station;
- Constructing a 5,000m^3 bioreactor;
- Installation of 5 surface aerators;
- Installation of 2 WAS pumps;
- Installation of an alum dosing facility;
- Installation of a-recycle pumps;
- Expansion of the chlorine contact tank to 900m^3;
- Upgrading the power supply, instrumentation and controls;
- Installation of rotary screw thickeners and two centrifuges; and
- Construction of a new 1,900m^3 anaerobic digester.

The estimated cost to upgrade the Hoblers Bridge WWTP is $13.5 million.

5.2.2.2 Ti Tree Bend

The Ti Tree Bend WWTP requires various works in order to overcome the current problems, improve the standard of treatment, and increase the capacity to treat the anticipated future flows from the Ti Tree Bend, Newnham, Prospect and Riverside catchments. The works include:

- Construction of an overflow storage system;
- Provision of additional:
  - aeration tanks
  - primary sedimentation tanks
  - secondary sedimentation tanks
  - chlorination tanks
- Construction of a new sludge digester; and
- Construction of a nutrient reduction facility.

The estimated cost to upgrade Ti Tree Bend WWTP is $21.5 million.

5.2.2.3 Catchment Alterations

In addition to the treatment plant upgrades, catchment alterations or improvements are necessary if this option is adopted. The work required includes:

Norwood/Hoblers Bridge

- Converting Norwood WWTP to a pump station, including 4.2 ML buffer storage;
- Rehabilitation and reuse of the existing 375mm diameter rising main between Norwood and Queechy;
- Diverting catchments TP.1.B, TP.4.B & TP.4.G to the Queechy pump station;
- Constructing a new pump station to replace the existing Queechy pump station; and
- Constructing a new rising main from Queechy to Hoblers Bridge WWTP.

Estimated cost: $4.40M

Newnham/Ti Tree Bend

- Reconstruct Newnham WWTP as a pump station, including 5ML buffer storage; and
- Construct a new rising main to Ti Tree Bend WWTP.

The new rising main may need to be of sufficient capacity to accommodate flows from Hope Street, Mowbray Street and Lytton Street pump stations.

Estimated cost: $4.55M

For the purpose of the report, the rising main has been sized for the Newnham catchment flows only, and the pumping rate of 2 x ADWF has been adopted. For this scenario, a 300mm diameter, 3,400 metre long pipeline would be required.

Table 5 - Summary - Option (b)

Location	Catchment Population		ADWF (ML/d)	
	2003	2025	2003	2025
Hoblers Bridge	27,650 + Trade Waste	33,738 + Trade Waste	7.85	9.57
Ti Tree Bend	67,382	82,281	33.54	40.58

Notes:

1) The flowrates in the above table assume that sub-catchments TP.1.B, TP.4.B, TP.4.A and T.4.G are diverted from the Ti Tree Bend catchment into the Hoblers Bridge catchment via the Queechy or Birch Avenue pump stations.
2) The adopted trade waste flow at Hoblers Bridge is 1.14 ML/d over a 10 hour period. This amount is included in the 2025 ADWF figure.
3) The population and flow figures for Ti Tree Bend allow for treatment of wastewater from Newnham, Prospect and Riverside.
4) The 2003 flowrate for Ti Tree Bend is determined as the theoretical domestic flowrate, plus the trade waste and dry weather infiltration determined to be 16.7 ML/d from previous flow monitoring.

Table 6 - Capital Costs – Option (b)

Location	Upgrade Cost $M	Collection Cost $M	Total Cost $M
Hoblers Bridge	13.50	4.40	17.90
Ti Tree Bend	21.50	4.55	26.05
Total	**35.00**	**8.95**	**43.95**

Table 7 - Operating and 30 year total costs – Option (b)

Location	Annual Operating Cost $M	30 year Operating Cost $M	Total 30 year Cost $M
Hoblers Bridge	0.669	20.07	37.97
Ti Tree Bend	1.461	43.83	69.88
Total	**2.130**	**63.90**	**107.85**

5.2.3 Option (c) Upgrade Ti Tree Bend to treat all sewage flows

If this option was adopted, all wastewater flows from the Ti Tree Bend, Newnham, Prospect, Riverside, Hoblers Bridge and Norwood catchments would be treated at Ti Tree Bend.

5.2.3.1 Ti Tree Bend

The Ti Tree Bend WWTP requires various works in order to overcome the current problems, improve the standard of treatment, and increase the capacity to treat the anticipated future flows. The works include:

- Construction of an overflow storage system;
- Provision of a new screw pump;
- Provision of additional:
  - aeration tanks
  - primary sedimentation tanks
  - secondary sedimentation tanks
  - chlorination tanks
- Construction of two (2) new sludge digesters; and
- Nutrient reduction facilities.

The estimated cost to upgrade Ti Tree Bend WWTP is $33.07 million.

5.2.3.2 Catchment Alterations

To enable wastewater to be treated at only the Ti Tree Bend treatment plant, it will be necessary to transfer wastewater from the catchments of the redundant treatment plants to the upgraded treatment plant. The infrastructure additional to Option (b) will be conversion of Hoblers Bridge to a pump station and construction of a new rising main to Ti Tree Bend. One of the options proposed is to incorporate a five megalitre buffer storage at the Hoblers Bridge pump station. This would allow a moderate pumping rate of 2 x ADWF, which in turn would enable smaller, and hence lower cost pumps and rising main to be used. It is anticipated that the rising main would be 5.5 kilometres in length, and that a 450mm diameter pipe would give adequate capacity and a velocity of 1.0 m/s.

The estimated cost of the catchment alterations and construction of new pump stations is of the order of $4.4 million for Norwood - Hoblers Bridge, $7.46 million for Hoblers Bridge pump station and Hoblers–Ti Tree Bend rising main, and $4.6 million for the Newnham-Ti Tree Bend catchment. The latter includes the cost of upgrades at Ti Tree Bend to accommodate flows from Prospect and Riverside. As with Option (b), the Meander Valley and West Tamar Councils would be expected to contribute toward the cost of upgrading and operating Ti Tree Bend if this option was adopted.

Table 8 - Summary - Option (c)

Location	Catchment Population		ADWF (ML/d)	
	2003	2025	2003	2025
Ti Tree Bend	95,032	116,019	42.08	51.15

Table 9 - Capital Costs – Option (c)

Location	Upgrade Cost $M	Collection Cost $M	Total Cost $M
Ti Tree Bend	33.07	16.5	49.57

Table 10 - Operating and 30 year total costs – Option (c)

Location	Annual Operating Cost $M	30 year Operating Cost $M	Total 30 year Cost $M
Ti Tree Bend	1.982	59.46	109.03

5.2.4 Cost Comparison – all options proposed by Consultant

Table 11 - Predicted costs for 30 year lifespan

Rationalisation Option	Capital Costs $M	Annual Operating Cost $M	30 year Operating Cost $M	Total 30 year Cost $M
(a) Upgrade existing	44.76	2.269	68.07	112.83
(b) Upgrade Hoblers Bridge & Ti Tree Bend	43.95	2.130	63.90	107.85
(c) Upgrade Ti Tree Bend	49.57	1.982	59.46	109.03

Table 11 above shows the expected operating and overall costs of each option if adopted for a 30 year period. This design period has been included for the purpose of comparing with options proposed by Council officers.

Table 12 - Predicted costs for 20 year lifespan

Rationalisation Option	Capital Costs $M	Annual Operating Cost $M	20 year Operating Cost $M	Total 20 year Cost $M
(a) Upgrade existing	44.76	2.269	45.38	90.14
(b) Upgrade Hoblers Bridge & Ti Tree Bend	43.95	2.130	42.60	86.55
(c) Upgrade Ti Tree Bend	49.57	1.982	39.64	89.21

Table 12 (previous page) shows the expected operating and overall costs of each option if adopted for a 20 year period. This was the design period intended by GHD.

The trend evident in Tables 11 and 12 indicates that capital investment in rationalising and upgrading the treatment facilities would be rewarded by lower overall costs. However, at some point the cost of operating and maintaining several pump stations erodes the savings achieved by eliminating one or more of the treatment plants.

In comparison to Option (a), the lower operational costs of Option (c) would mean that the difference in capital cost would be recovered in 16 years. In comparison to Option (b), the higher capital cost, and the similar operating costs mean that the higher capital cost of Option (c) would not be recovered for 38 years.

Though it is clear that Options (b) and (c) are more cost-effective than Option (a), it is important to note that the estimates are only accurate to within 30%. The estimated annual operating costs strongly influence the overall life-cycle cost of each option, and therefore neither Option (b) or (c) can be neglected without more detailed estimation.

5.3 Further Proposals by LCC, Planning and Systems Department

5.3.1 Preliminary Discussion

In August and September 2003, the Planning and Systems Department assessed and reported on rationalisation of wastewater treatment facilities in the Norwood-Hoblers Bridge catchment and the Newnham-Ti Tree Bend catchment.

Several options were proposed and assessed for each catchment. The options included catchment rationalisation as well as changes to the current arrangement for pumping stations.

For both reports, the estimated annual operating costs provided by Council include the annual operating costs of the pump stations and other catchment infrastructure. In comparison, the report produced by GHD does not include those catchment operating costs. In order to make a direct comparison between any combination of options proposed by Council, and the options proposed by GHD, the catchment costs shown in Option 4 of the Norwood – Hoblers Bridge rationalisation, and Option 7 of the Newnham – Ti Tree Bend rationalisation should be deducted from the relevant option being considered.

5.3.2 Norwood–Hoblers Bridge

The cost of upgrading the treatment plants to suit the proposed options was not included in the previous assessment by Council. The cost estimates given in the GHD report were added to the estimates for each of the options proposed by Council. The treatment plant operating costs were determined by dividing the current annual operating budgets by the current annual flowrates of wastewater. This provided a current treatment cost in terms of cents per kilolitre (c/kl) at each of the two existing plants. This treatment cost rate is based on the Average Dry Weather Flow. The figure was subsequently multiplied by the predicted flowrate for 2025 to predict the treatment cost in 2025. The treatment cost at Norwood is currently 16.83 c/kl and at Hoblers Bridge 57.46 c/kl. Because there is such a vast difference, two comparison tables are included. Table 13 shows the predicted cost using the current treatment cost rates. Table 14 shows the costs based on the treatment cost rate at Norwood.

The options proposed are briefly as follows:

Existing
This option involves catchment alterations and the continued use of the existing facilities in their current form. The proposal involves continued operation of the treatment plants using the existing facilities, and no nutrient removal. Catchment modifications include diverting catchments TP.4.B and TP.4.G to Queechy pump station, upgrading Queechy pump station and the rising main to Norwood WWTP, upgrading the pumps and storage at Lewis Street Sewage Pumping Station (SPS). The option is covered for comparison purposes only, as it would not be possible to meet the proposed effluent discharge conditions with the existing facilities.

Option 1
Divert catchments TP.4.B and TP.4.G to Queechy pump station, upgrade Queechy pump station and the rising main to Hoblers Bridge. Convert Norwood WWTP to a pump station, pump wastewater to Hoblers Bridge via a 'common' rising main between Queechy and Hoblers Bridge. Upsize the pumps at the Lewis Street SPS.

Option 2
Divert catchments TP.4.B and TP.4.G to Queechy pump station, upgrade Queechy pump station and construct a new rising main to Killafaddy pump station. Convert Norwood WWTP to a pump station, pump wastewater to Killafaddy pump station. The two rising mains would join to a 'common' rising main prior to crossing the North Esk River. Upgrade Killafaddy pump station and the rising main to Hoblers Bridge WWTP. Upsize the pumps at the Lewis Street SPS.

Option 3
Divert catchments TP.4.B and TP.4.G to Queechy pump station, upgrade Queechy pump station and construct a new 375 dia. rising main to Hoblers Bridge WWTP. Convert Norwood WWTP to a pump station, pump wastewater to Killafaddy pump station. Upgrade Killafaddy pump station and the rising main to Hoblers Bridge WWTP. Upsize the pumps at the Lewis Street SPS.

Option 4
Divert catchments TP.4.B and TP.4.G to Queechy pump station, upgrade Queechy pump station and rehabilitate the existing rising main to Hoblers Bridge. Upsize the pumps at the Lewis Street SPS. The works and hence costs associated with Option 4 are common to all of the other options. These works will be required no matter which option is adopted.

Calculations to support these tables are included in Appendix C.

Table 13 - Summary - Hoblers Bridge treatment costs based on current (high) cost per unit volume at ADWF

Option	ADWF flow at …		Capital Cost		Annual Operating Cost		30 year cost
	Norwood	Hoblers Bridge	Catchment	WWTPs	Catchment	WWTPs	
Existing	3.53	2.44	-	-	$84,000	$727,500	$ 24,345,000
1	-	9.55	$ 2,800,000	$13,500,000	$102,000	$1,307,919	$ 60,487,562
2	-	9.55	$ 4,300,000	$13,500,000	$102,000	$1,307,919	$ 61,987,562
3	-	9.55	$ 3,050,000	$13,500,000	$102,000	$1,307,919	$ 60,737,562
4	5.21	4.34	$ 1,900,000	17,600,000	$78,000	$887,500	$ 44,366,500

Table 14 - Summary - Hoblers Bridge treatment costs reduced to match the current treatment cost per unit volume at ADWF of the Norwood WWTP

Option	ADWF flow at …		Capital Cost		Annual Operating Cost		30 year cost
	Norwood	Hoblers Bridge	Catchment	WWTPs	Catchment	WWTPs	
Existing	3.53	2.44	-	-	$84,000	$366,700	$ 13,521,000
1	-	9.55	$ 2,800,000	$13,500,000	$102,000	$586,600	$ 36,958,000
2	-	9.55	$ 4,300,000	$13,500,000	$102,000	$586,600	$ 38,458,000
3	-	9.55	$ 3,050,000	$13,500,000	$102,000	$586,600	$ 37,208,000
4	5.21	4.34	$ 1,900,000	$17,600,000	$78,000	$586,600	$ 39,438,000

Option 1 was recommended by Council as it is the cheapest long-term option. Also the proposed multiple pump stations, detention storage, and common rising main provides a fairly robust catchment arrangement.

5.3.3 Newnham – Ti Tree Bend

The cost of upgrading the treatment plants to suit the proposed options was not included in the previous assessment by Council. Table 16 'Comparative costs of LCC proposed Options (Newnham–Ti Treed Bend)' following, includes the upgrade costs, as determined in the Regional Wastewater Rationalisation Report. Table 15 following, shows the upgrade and operating cost figures which were added to the infrastructure cost estimates for the options proposed by LCC.

Table 15 - WWTP Upgrade & operating costs added to LCC estimates

Option	Location	Upgrade Cost $M	Annual Operating Cost $M	Total 30 year Cost $M
(a)	Newnham	15.00	0.200	21.00
	Ti Tree Bend	16.00	1.300	55.00
(b)	Ti Tree Bend	21.50	1.461	65.33

Table 16 - Comparative costs of LCC proposed Options (Newnham–Ti Tree Bend)

Option	Description	Capital Cost $M	Annual Operating Cost $M	30 Year Cost $M
1	Transfer of flow by gravity to Ti Tree Bend	28.69	1.442	71.968
2	Transfer of flow by pumping to Ti Tree Bend	27.90	1.468	71.965
3	Transfer of flow by gravity to Hope Street	28.49	1.430	72.560
4	Transfer of flow by pumping to Hope Street	29.50	1.440	75.250
5	Transfer of flow by gravity to Clyde Street	28.49	1.456	72.190
6	Transfer of flow by pumping to Clyde Street	29.50	1.624	78.231
7	Upgrade of both treatment plants	34.30	1.500	79.300

The cost estimates produced by the Council engineers did not include the capital and operating costs of the treatment plant upgrades because estimates were not available at the time the report was produced. Also the catchment infrastructure operating costs for Options 3 and 4 were not included. A reason for this is not given or evident. For the purposes of this comparison, the same assumptions and figures as used by GHD in the 'Rationalisation Option Report' have been used. That is to say that the operating costs estimated for Queechy and Newnham have been applied to the Council's proposals for Hope Street and Newnham pump stations. The GHD proposal was for a rising main from Newnham to Ti Tree Bend. The LCC proposal was for a rising main to Hope Street pump station. Therefore, the electricity costs of Newnham have been reduced to 80% of the estimate to account for the reduced pumping distance.

The Council report recommended that Option 5 be adopted. The 30 year cost estimate is only marginally higher than the cheapest options which were Options 1 and 2. The investigation included estimates of capital and operational costs for each option. Option 5 was recommended at a predicted 30 year cost of $5,890,000.

Option 5 features minor works at the Newnham Treatment Plant, construction of a 750mm diameter gravity sewer to Clyde Street, construction of a new pump station at Clyde Street and rising main to Ti Tree Bend WWTP. This option also includes constructing gravity sewers from Bank and Plumer Streets and connecting into the Newnham - Clyde Street gravity sewer. The current sewerage system at Bank and Plumer Streets is individual septic tanks. These streets have been an environmental health issue to Council for some time due to the lack of a cost-effective sewerage option. The work also involves construction of gravity sewers to Clyde Street which would make the Mowbray Street and Lytton Street pump stations redundant. The Hope Street pump station would also be upgraded to reduce the frequency of overflows.

The predicted 30 year cost of Options 1 and 2 is approximately $200,000 cheaper than Option 5. However, Option 5 is preferable to Option 1 for two reasons. One of the reasons is that Lytton Street pump station can be diverted to Clyde Street, and subsequently made redundant. The other benefit is that the rising main of Option 5 can be laid at a relatively shallow depth in comparison to a gravity sewer which would need to be 8.0 metres deep at Ti Tree Bend, and would also require a lift station at the inlet to Ti Tree Bend.

The disadvantages of Option 2 are firstly, as for Option 1, Lytton Street cannot be made redundant, and secondly the detention time in the rising main would frequently be four hours. This may see the need for an oxygen injection station to avoid odour problems.

5.4 Comparison of Council and GHD proposals

The purpose of this section is to compare the separate proposals to rationalise the wastewater treatment to two plants. The options being considered and compared are:

- By LCC Planning & Systems:
  - Norwood – Hoblers Bridge, Option 1 in conjunction with
  - Newnham – Ti Tree Bend, Option 5.

  From this point on, this option is known as Option (d).

- By GHD:
  - Option (b).

Table 17 - Comparative costs of proposed Options - Rationalisation to 2 WWTPs

	Catchment	Option	Capital Cost		Annual Operating Cost		30 year cost
			Catchment	WWTPs	Catchment	WWTPs	
LCC	Norwood – Hoblers Bridge	1	$2,800,000		$102,000		$ 36,958,000
		4	$1,900,000		$78,000		$ 39,438,000
		Net	$900,000	$13,500,000	$24,000	$586,600	$ 36,818,000
	Newnham – Ti Tree Bend	5	$7,490,000		$112,666		$76,200,000
		7	$3,300,000		$56,000		$80,980,000
		Net	$4,190,000	$21,500,000	$56,666	$1,461,000	$71,219,980
	Total	(d)	$5,090,000	$35,000,000	$80,666	$2,047,600	$103,937,980
GHD	Norwood – Hoblers Bridge	(b)	$4,400,000	$13,500,000	$130,000	$586,600	$39,398,000
	Newnham – Ti Tree Bend	(b)	$4,550,000	$21,500,000	-	$1,461,000	$69,880,000
	Total		$8,950,000	$35,000,000	$130,000	$2,047,600	$109,278,000

5.5 Impact of Riverside and Prospect Catchments

Table 18 - Catchment populations and flows

Catchment	Population		Flow	
	2003	2025	2003	2025
Newnham	14,450	17,632	4.04	4.41
Ti Tree Bend	44,217	53,954	30.00	33.49
Sub total	58,667	71,586	**34.04**	**37.90**
Norwood	16,336	19,970	3.53	5.00
Hoblers Bridge	9,117 + TW	11,124 + TW	2.44	3.92
Sub total	25,453	31,094	5.97	8.92
Total for LCC Catchments	84,120	102,680	**40.01**	**46.82**
Riverside	8,000	9,800	2.10	2.45
Prospect	5,800	7,100	1.55	1.78
Sub total	13,800	16,900	3.65	4.23
Regional Total	97,920	119,580	**43.66**	**51.05**

As can be seen by the bold figures in the two columns toward the right hand side of Table 18, diverting the Riverside and Prospect catchments to Ti Tree Bend will not have a significant impact. If Option (b) or (d) was adopted, the increase in flow would equate to approximately 11% if wastewater from Riverside and Prospect was treated at Ti Tree Bend. Similarly, if Option (c) was adopted, the difference would be approximately 9%.

If the diversion is agreed to, there should be no reason why increased capacity cannot be achieved.

5.6 Summary and Discussion

The estimated 30 year costs for the options proposed by GHD, and the most suitable options proposed by Launceston City Council are summarised in Table 19 below.

Table 19 - Summary of options & costs

	Option	Description	30 year cost*
GHD	(a)	Upgrade the existing wastewater treatment plants at the existing locations	$113M
	(b)	Upgrade Hoblers Bridge WWTP and Ti Tree Bend WWTP	$108M
	(c)	Upgrade Ti Tree Bend WWTP and divert all sewage flows to Ti Tree Bend	$109M
LCC	(d)	Upgrade Hoblers Bridge WWTP and Ti Tree Bend WWTP	$104M

* 30 year operating cost rounded to nearest million dollars

As can be seen in Table 19 above, Option (a) is the most expensive option. The estimates for the rationalisation proposals vary by less than 5%. GHD do not warrant the accuracy of the figures included in their report as being better than +/- 30%, therefore the cost comparison alone does not exclude any of the options. However, if Option (a) was adopted, Launceston City Council would still need to address the existing deficiencies in the catchment networks. Options (b), (c), and particularly Option (d) include works which will eliminate or resolve the existing deficiencies.

Options (b) and (d) are both based on abandoning the Norwood and Newnham WWTPs, and upgrading the Hoblers Bridge and Ti Tree Bend plants. Option (d) has lower operating costs, and potentially greater reliability than Option (b) because it proposes a gravity main between Newnham and Clyde Street, whereas Option (b) proposes a rising main.

If the Newnham – Ti Tree Bend catchment alterations proposed by LCC can be incorporated into the Option (c), the predicted 30 year cost may be more comparable to Option (d). This would also provide the catchment benefits of Option (d).

6 Pulp Mill

The Tasmanian timber company, Gunns Limited, this year announced plans to construct a pulp mill at Long Reach on the eastern bank of the Tamar River. Long Reach is approximately 50 kilometres North of Launceston. Once established, the mill will likely require in the order of 70-75 megalitres of water per day. The Tamar River adjacent to the proposed site is saline so the water would either need to be supplied from an upstream location, or a desalination plant would need to be constructed and operated.

Gunns Limited have recently negotiated with Tasmanian electricity suppliers, Hydro Tasmania to purchase freshwater from the Trevallyn Dam. The Trevallyn Dam is located on the western fringe of Launceston. Water from the dam travels through tunnels and pipelines to the power station at Riverside before it is discharged into the Tamar River. Gunns Limited will take water prior to the turbines and pump it to the pulp mill. To balance the water drawn from the reservoir, Gunns Limited will trade water stored on properties within their control upstream of Trevallyn.

Even though Hydro Tasmania and Gunns Limited have reached a trading agreement, another option which may also be beneficial to Launceston, Hydro Tasmania, and Gunns Limited is the transfer of Launceston's wastewater to the pulp mill for use in the production process.

At the present time, Launceston generates between 43 and 45 megalitres of wastewater per day. Assuming a population growth of 1% per annum, the average dry weather wastewater production by Launceston would approach 50 megalitres per day. The expected demand for water by the mill is 70–75 megalitres per day so there will still be a shortfall of approximately 30 megalitres per day which would most likely need to be sourced from Trevallyn Dam.

Providing that raw or partially treated wastewater is acceptable for use at the pulp mill, this option is environmentally sensible for two reasons. Firstly, it will reduce the demand for freshwater from Trevallyn Dam, leaving the water available to generate power, or to continue the natural course through the Cataract Gorge to the Tamar River. Secondly, because the proposed location of the mill is closer to the sea, and subject to greater flow and tidal influence, the effluent could be discharged with lesser environmental impact than if discharged to the river at Launceston.

Siltation is an ongoing problem in the upper reaches of the Tamar River, and a dredging program is in place to keep the river navigable. An increase in flow through the gorge would reduce the salinity and the combination of increased velocity and reduced salinity would reduce the tendency for silt to settle out.

Further investigations are needed to determine the water quality requirements of the proposed pulp mill and the extent of pre-treatment that would be required. The research required to develop a scheme such as this would be significant, however, if such a scheme is feasible and the parties are agreeable it is likely to be eligible for assistance from the state government.

7 Conclusion

Based on cost differences, and the additional benefits provided by the other options, Option (a) can be disregarded at this stage. The most economical wastewater treatment solution for the Launceston region will involve rationalisation as per either Option (b), (c) or (d). In any case, inclusion of the Prospect and Riverside catchments should be possible and economical, providing agreement is reached prior to design and construction. At this stage, the costs of the various options cannot be estimated with sufficient accuracy to determine which of the above options should be adopted.

Due to the proposed gravity main from Newnham to Clyde Street and other catchment benefits, Option (d) is preferred to Option (b). As eluded to in Section 5.6, Option (c) may also be modified to incorporate the same wastewater transfer arrangement proposed for the Newnham–Ti Tree Bend catchment.

Options (c) and (d), and the abovementioned variation to Option (c) warrant more detailed design and cost estimation. Option (c) relies heavily on the Hoblers Bridge pumping station and Ti Tree Bend treatment plant. Council will need to evaluate both cost differences and risk differences between these two options.

8 Recommendations & Further Research

As discussed in Section 7, Options (c) and (d) cannot be disregarded at this stage and both warrant further investigation. In order to proceed, it is recommended that Council:

- Conduct an environmental investigation and liaise with DPIWE to determine the 'Protected Environmental Values' of the Tamar River Estuary and agree on the emission limits for treated effluent discharge;

- Investigate and assess emerging and alternative treatment technologies;

- Liaise with the West Tamar and Meander Valley Councils to establish agreements for future wastewater treatment;

- Conduct more detailed concepts and estimates of Option (c) and Option (d), including:
  - varying Option (c) as discussed in Section 5.6;
  - consideration of new treatment technologies;

- Evaluate the benefits and risks associated with relying on Ti Tree Bend WWTP;

- Construct pipelines to transfer sewage from separated areas directly to the relevant WWTP inlet without merging with the combined system; and

- Develop a strategy to transition from the existing arrangement to the adopted option.

List of References

1. Title: Launceston City Council
   Report on Upgrading of Major Plants to Reduce Nitrogen and Phosphorous Levels in the Final Effluent
   Author: GHD
   Date: March 1990

2. Title: Review and Update of 1991 Report on Nutrient Removal
   Author: GHD
   Date: September 1999

3. Title: Launceston City Council, Ti Tree Bend WWTP
   Report on Centralised Sludge Handling Facility, Preliminary Design
   Author: GHD
   Date: April 2003

4. Title: Norwood Sewage Treatment Plant Upgrade:
   Nutrient Removal Options
   Author: Jonathan Haines (Final year Environmental Technology Project, University of Tasmania)
   Date: February 2000

5. Title: Newnham/Ti Tree Bend Wastewater Treatment Plant Rationalisation
   Author: Grant Henderson (LCC Planning & Systems Department)
   Date: September 2003

6. Title: Norwood/Hoblers Bridge Wastewater Treatment Plant Rationalisation
   Author: Grant Henderson (LCC Planning & Systems Department)
   Date: September 2003

7. Title: State Policy on Water Quality Management
   Author: Tasmanian Department of Primary Industries, Water and Environment
   Date: 1997

8. Title: Emission Limit Guidelines for sewage treatment plants that discharge pollutants into fresh and marine waters
   Author: Tasmanian Department of Primary Industries, Water and Environment
   Date: June 2001

9. Title: Wastewater Engineering, Treatment and Re-use, fourth edition
   Author: Metcalf & Eddy

Appendix A

Project Specification – Draft B, 29 September 2005

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG 4111/4112 Research Project

PROJECT SPECIFICATION

FOR:	*Glenn Crouch*
TOPIC:	*Rationalisation of wastewater treatment plants in Launceston*
SUPERVISORS:	Dr Ernest Yoong (USQ) Mr Steve Ratcliffe (LCC)
SPONSORSHIP:	*Launceston City Council*
BACKGROUND:	Launceston City Council currently operates 4 sewage treatment facilities providing primary and secondary treatment prior to discharge to the environment. Changes to environmental laws mean that Council is required to actively improve the standard of treated effluent. Rather than spend large amounts of money to upgrade the four separate treatment facilities, Councils Infrastructure Division engaged a consultant to investigate various rationalisation options in conjunction with treatment facility upgrades. The consultant has recently completed investigations and submitted a draft report to Council on the various rationalisation options available to council. It is likely that rationalisation will require considerable civil works including construction of: pipelines, pump stations, and detention storage facilities.
PROJECT AIM:	This project seeks to establish the most economical means of providing wastewater for the City of Launceston.

PROGRAM: Issue B, 29 September 2005 (1st draft)

1. Undertake a literature review of the report titled 'Launceston Regional Wastewater Rationalisation Strategy' by GHD Consulting Engineers (draft dated January 2005), including:
   - Review the supporting documents such as previous reports
   - Review the evaluations of the various options outlined in the report
   - Speculate on the findings of the report and potentially suggest additional options or variations to the proposed options including alternative treatment technologies.
2. Determine the rationalisation option most likely to give the best outcome for the City of Launceston.

As time permits:

3. For the preferred rationalisation option undertake preliminary design and costing of the necessary infrastructure (i.e. pipelines, pump stations, detention storage facilities)

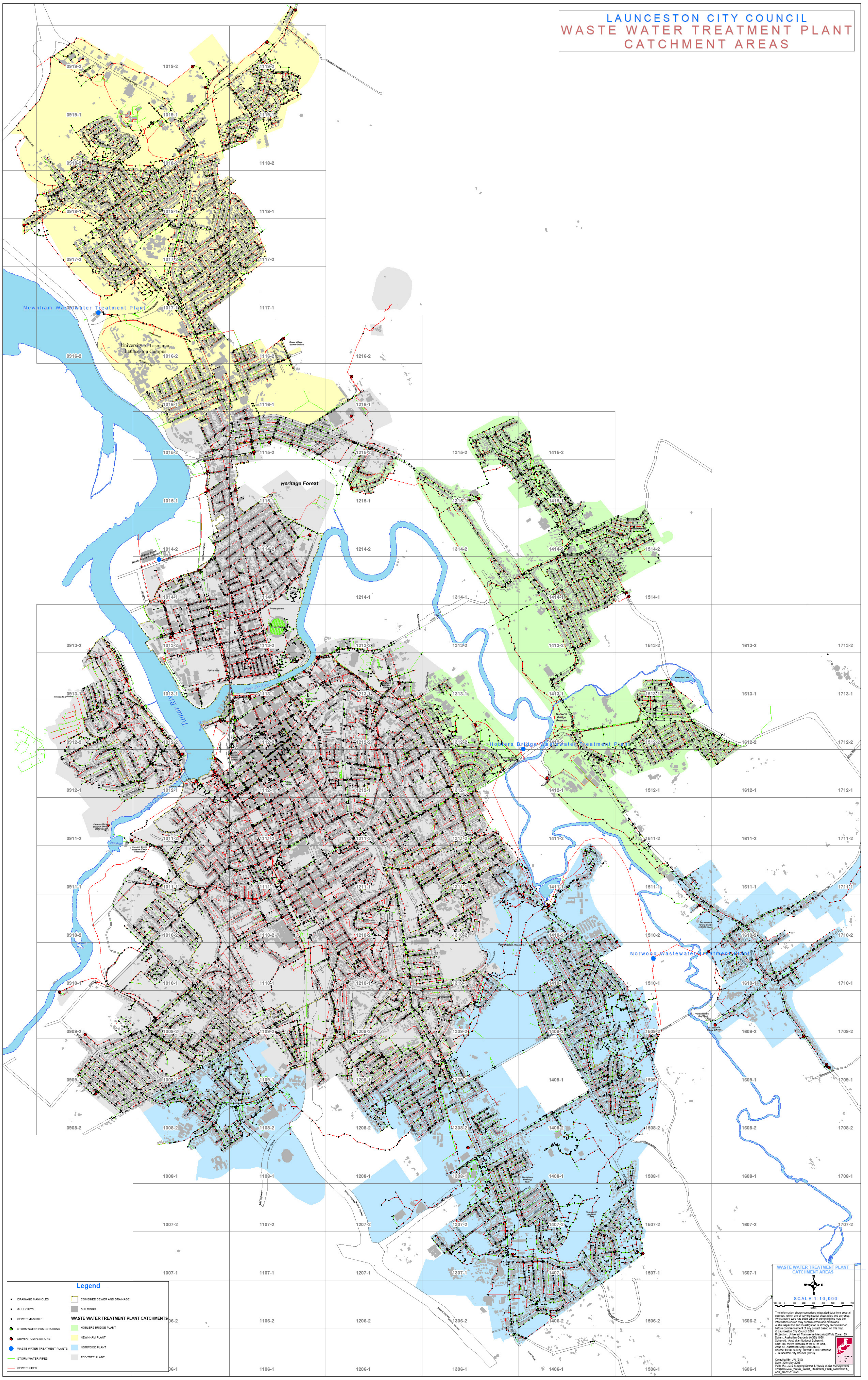
Agreed

__________________________ (Student) __________ (date)

__________________________ (Supervisor) __________ (date)

Appendix B

Launceston City Council Wastewater Catchment Plan


LAUNCESTON CITY COUNCIL
WASTE WATER TREATMENT PLANT CATCHMENT AREAS
Newnham Wastewater Treatment Plant
Heritage Forest
Hoblers Bridge Wastewater Treatment Plant
Norwood Wastewater Treatment Plant
Legend
DRAINAGE MANHOLES
GULLY PITS
SEWER MANHOLE
STORMWATER PUMPSTATIONS
SEWER PUMPSTATIONS
WASTE WATER TREATMENT PLANTS
STORM WATER PIPES
SEWER PIPES
COMBINED SEWER AND DRAINAGE
BUILDINGS
WASTE WATER TREATMENT PLANT CATCHMENTS
HOBLERS BRIDGE PLANT
NEWNHAM PLANT
NORWOOD PLANT
TEE-TREE PLANT
WASTE WATER TREATMENT PLANT
CATCHMENT AREAS
N
S
E
W
SCALE:1:10,000
Meters
The information shown comprises integrated data from several sources, which are of varying spatial accuracies and currency. Whilst every care has been taken in compiling the map the information shown may contain errors and omissions.
A site inspection and investigation is strongly recommended before commencement of any project based on this map.
© Launceston City Council 2004
Projection: Universal Transverse Mercator(UTM), Zone: 55.
Datum: Australian Geodetic (AGD) 1966.
Spheroid: Australian National Spheroid.
Grid: 500 metre intervals of the UTM Grid, Zone 55, Australian Map Grid (AMG).
Source: Detail Survey, DPIWE, LCC Database - Launceston City Council (2005).
Compiled By: JW (SIS)
Date: 30th May 2005
Path: R:\...\GIS Mapping\Sewer & Waste Water Management\Projects\LCC_Waste_Water_Treatment_Plant_Catchments_A0P_20-02-01.mxd

Appendix C

Hydraulic Flows and Cost Estimates – Norwood/Hoblers Bridge

Comparison of costs for the Norwood-Hoblers Bridge options proposed in the report titled 'Norwood/Hoblers Bridge Wastewater Treatment Plant Rationalisation' dated 8th August 2003

Note the following points

1) Capital costs for pumping station and pipeline upgrades are as estimated by Council officers
2) Capital costs for treatment plant upgrades are as estimated by GHD
3) Operating costs for small pumping stations is as noted by LCC in the Newnham - Ti Tree Bend WWTP Rationalisation report, September 2003.
4) Operating costs for small pumping stations is estimated at $12,000 as per note 3, operating costs for intermediate and larger pump stations factored up in approximate proportion to ADWF.
5) Operating costs for treatment plants is purely a ratio of predicted flow / current flow, multiplied by the current operating budget. The figures do not include allowance for additional treatment expenses due to the proposed nutrient removal processes, nor any allowance for depreciation or equipment replacement.
6) Based on the current daily flowrates and operating budgets, the treatment cost per unit of volume treated at Hoblers Bridge WWTP is 340% of the treatment cost at Norwood. Summary (2) below uses the Norwood treatment cost to predict the treatment cost of Hoblers Bridge WWTP when upgraded.

Annual operating budgets/maintenance costs - Circa 2003 - 2005

Small sewage pump station

Lewis St, Station Rd etc.	$ 12,000	(LCC, Newnham - Ti Tree Rationalisation, Sept 2003)

Treatment plants

Norwood	$ 216,500	L'ton Regional Wastewater Strategy, GHD, May 2005
Hoblers Bridge	$ 511,000	

	Without catchment rationalisation			With catchment rationalisation		
	2003 ADWF (L/s)	2003 ADWF (ML/day)	2025 ADWF (ML/day)	2003 ADWF (L/s)	2003 ADWF (ML/day)	2025 ADWF (ML/day)
Norwood	40.8	3.53	4.1	49.4	4.27	5.21
Hoblers Bridge	28.2	2.44	3.92	41.2	3.56	4.34

	2003 ADWF (ML/day)	Average treatment cost (c/Kl)
Norwood	3.53	16.83
Hoblers Bridge	2.44	57.46

Summary

Option	ADWF flow at ...		Capital Cost	Annual Operating Cost	30 year cost
	Norwood	Hoblers Bridge			
Existing	3.53	2.44	-	$ 799,500	$ 23,985,000
1	-	9.55	$ 16,300,000	$ 1,472,919	$ 60,487,562
2	-	9.55	$ 17,800,000	$ 1,472,919	$ 61,987,562
3	-	9.55	$ 16,550,000	$ 1,472,919	$ 60,737,562
4	5.21	4.34	$ 19,500,000	$ 965,550	$ 44,366,500

Summary (2) - Hoblers Bridge treatment costs reduced to match those of Norwood WWTP

Option	ADWF flow at ...		Capital Cost	Annual Operating Cost	30 year cost
	Norwood	Hoblers Bridge			
Existing	3.53	2.44	-	$ 468,140	$14,044,191
1	-	9.55	$ 16,300,000	$ 688,524	$36,955,719
2	-	9.55	$ 17,800,000	$ 688,524	$38,455,719
3	-	9.55	$ 16,550,000	$ 688,524	$37,205,719
4	5.21	4.34	$ 19,500,000	$ 664,524	$39,435,719

Option 1			
Capital			
Item	**Work required**	**Estimate**	Estimate (GHD)
Lewis Street PS	upsize pumps	$ 50,000	
Norwood WWTP	convert to pump station	$ 500,000	$ 150,000
Norwood - Queechy Rising Main	slipline with 300 dia.	$ 300,000	$ 125,000
Queechy - HB Rising Main	relay in 450 dia. poly	$ 450,000	$ 1,100,000
Queechy Pump Station	replace	$ 1,250,000	$ 2,000,000
South Launceston TM	divert TP.4.B & TP.4.G to Queechy PS	$ 250,000	
Engineering @ 10%			$ 337,500
Contingency @ 20%			$ 675,000
		$ 2,800,000	$ 4,387,500
Upgrade at Hoblers Bridge WWTP			$ 13,500,000
Current ADWF (ML/day)	3.56		
2025 flow - rationalised, Option 1	9.55		
Increase factor	2.68		
Operating			
Lewis St SPS		$ 12,000	
Station Road SPS		$ 12,000	
Norwood SPS		$ 18,000	
Queechy SPS		$ 24,000	
Hoblers Bridge SPS		$ 12,000	
Birch Ave SPS		$ 12,000	
Killafaddy SPS		$ 12,000	
Hoblers Bridge WWTP		$ 1,370,919	
		$ 1,472,919	
30 year cost		**$ 60,487,562**	

Option 2			
Capital			
Item	**Work required**	**Estimate**	Estimate (GHD)
Lewis Street PS	upsize pumps	$ 50,000	
Norwood WWTP	convert to pump station	$ 500,000	
Norwood - river crossing RM	rehabilitate existing 375mm	$ 250,000	
South Launceston TM	divert TP.4.B & TP.4.G to Queechy PS	$ 250,000	
Queechy Pump Station	replace	$ 1,000,000	
Queechy - river crossing RM	250mm poly	$ 250,000	
diversion to river crossing		$ 200,000	
river crossing		$ 150,000	
pipeline to Killafaddy PS		$ 350,000	
Killafaddy PS	upgrade to 500 L/s plus storage	$ 1,000,000	
Killafaddy PS - Hoblers Bridge TP RM	upsize to 450mm	$ 300,000	
Engineering @ 10%			
Contingency @ 20%			
		$ 4,300,000	
Upgrade at Hoblers Bridge WWTP			$ 13,500,000
Current ADWF (ML/day)	3.56		
2025 flow - rationalised, Option 2	9.55		
Increase factor	2.68		
Operating			
Lewis Street SPS		$ 12,000	
Station Road SPS		$ 12,000	
Norwood SPS		$ 18,000	
Queechy SPS		$ 12,000	
Hoblers Bridge SPS		$ 12,000	
Birch Avenue SPS		$ 12,000	
Killafaddy SPS		$ 24,000	
Hoblers Bridge WWTP		$ 1,370,919	
		$ 1,472,919	
30 year cost		**$ 61,987,562**	

Option 3			
Capital			
Item	**Work required**	**Estimate**	Estimate (GHD)
Lewis Street PS	upsize pumps	$ 50,000	
Norwood WWTP	convert to pump station	$ 500,000	
Norwood - river crossing RM	replace with 250mm	$ 250,000	
river crossing		$ 100,000	
pipeline to Killafaddy PS	gravity from river to Killafaddy PS	$ 300,000	
Killafaddy PS	upgrade to 150 L/s plus storage	$ 200,000	
South Launceston TM	divert TP.4.B & TP.4.G to Queechy PS	$ 250,000	
Queechy Pump Station	replace	$ 1,000,000	
Queechy - HB Rising Main	relay in 375 dia. poly	$ 400,000	$ 1,100,000
Engineering @ 10%			
Contingency @ 20%			
		$ 3,050,000	
Upgrade at Hoblers Bridge WWTP			$ 13,500,000
Current ADWF (ML/day)	3.56		
2025 flow - rationalised, Option 3	9.55		
Increase factor	2.68		
Operating			
Lewis Street SPS		$ 12,000	
Station Road SPS		$ 12,000	
Norwood SPS		$ 18,000	
Queechy SPS		$ 18,000	
Hoblers Bridge SPS		$ 12,000	
Birch Avenue SPS		$ 12,000	
Killafaddy SPS		$ 18,000	
Hoblers Bridge WWTP		$ 1,370,919	
		$ 1,472,919	
30 year cost		**$ 60,737,562**	

Option 4			
Capital			
Item	**Work required**	**Estimate**	Estimate (GHD)
Lewis Street PS	upsize pumps	$ 50,000	
South Launceston TM	divert TP.4.B & TP.4.G to Queechy PS	$ 250,000	
Queechy Pump Station	replace	$ 1,000,000	
Queechy - Norwood WWTP Rising Main	replace existing	$ 600,000	$ 1,100,000
Engineering @ 10%			
Contingency @ 20%			
		$ 1,900,000	
Upgrade at Norwood WWTP			$ 4,100,000
Current ADWF (ML/day)	4.27		
2025 flow - rationalised, Option 4	5.21		
Increase factor	1.22		
Upgrade at Hoblers Bridge WWTP			$ 13,500,000
Current ADWF (ML/day)	3.56		
2025 flow - rationalised, Option 4	4.34		
Increase factor	1.22		
Operating			
Lewis Street SPS		$ 12,000	
Station Road SPS		$ 12,000	
Queechy SPS		$ 18,000	
Hoblers Bridge SPS		$ 12,000	
Birch Avenue SPS		$ 12,000	
Killafaddy SPS		$ 12,000	
Norwood WWTP		$ 264,130	
Hoblers Bridge WWTP		$ 623,420	
		$ 965,550	
30 year cost		**$ 44,366,500**	

	Flowrate ADWF (L/s)	
Existing Catchment and treatment scenario	**2003**	**2025**
Station Road	11.8	14.4
Lewis Street	5.1	6.2
Queechy Road	23.9	29.2
Norwood WWTP	**40.8**	**49.8**
Hoblers Bridge	19.5	23.8
Killafaddy	5.8	7.1
Birch Avenue	2.9	3.5
Hoblers Bridge WWTP	**28.2**	**34.4**
Megalitres per day flow at Norwood WWTP	**3.53**	**4.30**
Megalitres per day flow at Hoblers Bridge WWTP	**2.44**	**2.97**

	Flowrate ADWF (L/s)	
Option 1	**2003**	**2025**
Station Road	11.8	14.4
Lewis Street	5.1	6.2
New Norwood	16.9	20.6
Queechy Road	49.4	60.3
Hoblers Bridge	19.5	23.8
Killafaddy	5.8	7.1
Birch Avenue	15.9	19.4
Hoblers Bridge WWTP	**90.6**	**110.5**
Megalitres per day flow at Hoblers Bridge WWTP	**7.83**	**9.55**

1) Station Road & Lewis Street pump to New Norwood
2) New Norwood pumps to Queechy
3) Divert TP.4.B & TP.4.G to Queechy PS (5.2 + 3.4 = 8.6 L/s)
4) Queechy has ADWF flow of 23.9 L/s
5) Queechy pumps direct to Hoblers Bridge TP
6) TP.4.A, TP.4.C, TP.4.D diverted to Birch Ave (6.9 + 4.0 + 2.1 = 13.0 L/s)
7) Birch Avenue has ADWF of 2.9 L/s, 2.9 + 13 = 15.9 L/s.
8) Total design ADWF arriving at Hoblers Bridge WWTP = 90.6 L/s

	Flowrate ADWF (L/s)	
Option 2	**2003**	**2025**
Station Road	11.8	14.4
Lewis Street	5.1	6.2
New Norwood	16.9	20.6
Queechy Road	32.5	39.7
Hoblers Bridge	19.5	23.8
Killafaddy	55.2	67.3
Birch Avenue	15.9	19.4
Hoblers Bridge WWTP	**90.6**	**110.5**
Megalitres per day flow at Hoblers Bridge WWTP	**7.83**	**9.55**

1) Station Road & Lewis Street pump to New Norwood
2) New Norwood pumps to Killafaddy
3) Divert TP.4.B & TP.4.G to Queechy PS (5.2 + 3.4 = 8.6 L/s
4) Queechy has ADWF flow of 23.9 L/s
5) Queechy pumps to Killafaddy
6) Killafaddy has ADWF of 5.8 L/s, add New Norwood and Queechy = 55.2
7) TP.4.A, TP.4.C, TP.4.D diverted to Birch Ave (6.9 + 4.0 + 2.1 = 13.0 L/s)
8) Birch Avenue has ADWF of 2.9 L/s, 2.9 + 13 = 15.9 L/s.
9) Total design ADWF arriving at Hoblers Bridge WWTP = 90.6 L/s

	Flowrate ADWF (L/s)	
Option 3	**2003**	**2025**
Station Road	11.8	14.4
Lewis Street	5.1	6.2
New Norwood	16.9	20.6
Queechy Road	32.5	39.7
Hoblers Bridge	19.5	23.8
Killafaddy	22.7	27.7
Birch Avenue	15.9	19.4
Hoblers Bridge WWTP	**90.6**	**110.5**
Megalitres per day flow at Hoblers Bridge WWTP	**7.83**	**9.55**

1) Station Road & Lewis Street pump to New Norwood
2) New Norwood pumps to Killafaddy
3) Divert TP.4.B & TP.4.G to Queechy PS (5.2 + 3.4 = 8.6 L/s
4) Queechy has ADWF flow of 23.9 L/s
5) Queechy pumps direct to Hoblers Bridge TP
6) Killafaddy has ADWF of 5.8 L/s, add New Norwood = 22.7
7) TP.4.A, TP.4.C, TP.4.D diverted to Birch Ave (6.9 + 4.0 + 2.1 = 13.0 L/s)
8) Birch Avenue has ADWF of 2.9 L/s, 2.9 + 13 = 15.9 L/s.
9) Total design ADWF arriving at Hoblers Bridge WWTP = 90.6 L/s

	Flowrate ADWF (L/s)	
Option 4	**2003**	**2025**
Station Road	11.8	14.4
Lewis Street	5.1	6.2
Queechy Road	32.5	39.7
Norwood WWTP	**49.4**	**60.3**
Hoblers Bridge	19.5	23.8
Killafaddy	5.8	7.1
Birch Avenue	15.9	19.4
Hoblers Bridge WWTP	**41.2**	**50.3**
Rationalised flow in megalitres per day at Norwood WWTP	**4.27**	**5.21**
Rationalised flow in megalitres per day at Hoblers Bridge WWTP	**3.56**	**4.34**

1) Station Road & Lewis Street pump to Norwood
2) Divert TP.4.B & TP.4.G to Queechy PS (5.2 + 3.4 = 8.6 L/s)
3) Queechy has ADWF flow of 23.9 L/s
4) Queechy pumps back to Norwood
5) Norwood TP upgraded to treat 2025 loads
6) TP.4.A, TP.4.C, TP.4.D diverted to Birch Ave (6.9 + 4.0 + 2.1 = 13.0 L/s)
7) Birch Avenue has ADWF of 2.9 L/s, 2.9 + 13 = 15.9 L/s.

Appendix D

Cost Estimates – Newnham/Ti Tree Bend

LCC Newnham - Ti Tree Bend rationalisation proposals cost estimates								
		Option No.						
		1	2	3	4	5	6	7
Capital Costs	Infrastructure	7,690,000	6,900,000	7,490,000	8,500,000	7,490,000	8,500,000	3,300,000
	Newnham WWTP Upgrade	0	0	0	0	0	0	15,000,000
	Ti Tree Bend WWTP Upgrade	21,000,000	21,000,000	21,000,000	21,000,000	21,000,000	21,000,000	16,000,000
		28,690,000	27,900,000	28,490,000	29,500,000	28,490,000	29,500,000	34,300,000
Annual Operating Costs	Infrastructure	42,600	68,833	69,000	125,000	56,667	224,367	0
	Newnham WWTP	0	0	0	0	0	0	200,000
	Ti Tree Bend WWTP	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,300,000
		43,278,000	44,065,000	44,070,000	45,750,000	43,700,000	48,731,000	45,000,000
Total 30 year cost		**$71,968,000**	**$71,965,000**	**$72,560,000**	**$75,250,000**	**$72,190,000**	**$78,231,000**	**$79,300,000**

Notes:
Information sourced from table 1 'Newnham/Ti Tree Bend Wastewater Treatment Plant Rationalisation - LCC September 2003
Annual infrastructure operating costs for Options 3 and 4 were not included in the LCC report, therefore the figures calculated by GHD for Queechy and Newnham pump stations have been substituted into these calculations as follows.

	Option 3		Option 4	
	Queechy (Hope)	Newnham	Queechy (Hope)	Newnham
Attendance	30000	0	30000	30000
Maintenance	9000	0	9000	6000
Electricity	30000	0	30000	20000
Total	69000	0	69000	56000

Electricity costs for Newnham reduced to 80% of the GHD figure, LCC proposal only pumps as far as Hope St SPS.
Includes costs of relevant treatment plant upgrades and operating costs, including costs of major pumping stations.
Operating costs of minor pump stations is not included.