Economics Work Package 11: SRL1: The Urban Intervention Options Work Brief

Deliverable 2: Summary of life cycle costs for wastewater infrastructure solutions

Prepared by Sue Ira, Koru Environmental Consultants Ltd on behalf of Greater Wellington Regional Council

Te Awarua-o-Porirua Collaborative Modelling Project

23 June 2017

Koru Environmental Consultants Ltd

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Report prepared for Greater Wellington Regional Council.

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Disclaimer:
Whilst every effort has been made to ensure the integrity of the data collected and its application through the COSTnz Model, the author does not give any warranty as to the accuracy, completeness, currency or reliability of the information made available in this report and expressly disclaims (to the maximum extent permitted by law) all liability for any damage or loss resulting from the use of, or reliance on the LCC models or the information or graphs provided through them.

Costs presented in this report are based on current available information and should be read in the context of the assumptions presented in this report. Cost information has been gathered and modelled in order to gain an understanding of the relative difference in cost between different solutions, not the actual cost of each solution.

Any decision that is made after using this data must be based solely on the decision-makers own evaluation of the information available to them, their circumstances and objectives.

1 Introduction

1.1 Purpose and scope

The purpose of the project is to collaboratively generate information and knowledge to support the Te Awarua-o-Porirua Whaitua Committee make recommendations for land and water management in the Whaitua. The project will produce modelling outputs and knowledge describing the current environmental, social, cultural and economic conditions in TAoP Whaitua, as well as potential future outcomes that might result under urban and rural land and water management scenarios.

This work forms part of the Urban Intervention Work Brief and is one component of the overall economics work brief that addresses the decision making needs of the Whaitua Committee. This report follows-on from the Deliverable 1 Report "Summary of potential solutions available for stormwater, wastewater and water supply provision". The Deliverable 1 report documented potential solutions available to facilitate an operational focus towards water quality treatment, stormwater reuse and source control. Additionally, the report documented potential solutions available and currently being used to support water supply and wastewater infrastructure needs. Coupled with a decision-support matrix, a full range of solutions was presented, along with the applicability of their use and cost information, as documented in national and international literature.

Deliverable 2 of the Urban Intervention Work Brief requires the development of a cost 'reference library' for the different solutions. The costs need to be provided as estimates of the undiscounted life cycle costs in NZ$2017. This report provides a description of the modelling work that was undertaken and the life cycle costs for those wastewater solutions where cost data is available.

1.2 Life cycle costing

A life cycle costing (LCC) approach has been previously used to assess costs associated with stormwater devices in Australia, the United States of America (USA) and the United Kingdom (UK) (Vesely *et al.*, 2006[1]). The Australian/New Zealand Standard 4536:1999[2] defines LCC as the process of assessing the cost of a product over its life cycle or portion thereof. The life cycle cost is the sum of the acquisition and ownership costs of an asset over its life cycle from design, manufacturing, usage, and maintenance through to disposal. The consideration of revenues is excluded from LCC. A cradle-to-grave time frame is warranted because future costs associated with the use and ownership of an asset are often greater than the initial acquisition cost and may vary significantly between alternative solutions to a given operational need (Australian National Audit Office, 2001[3]).

LCC has a number of benefits and supports a number of applications and analyses (Lampe *et al* 2005[4]):

- it allows for an improved understanding of long-term investment requirements;
- it helps decision-makers make more cost-effective choices at the project scoping phase;
- it provides for an explicit assessment of long-term risk;

[1] Vesely, E-T., Arnold, G., Ira, S. and Krausse, M. (2006). *Costing of Stormwater Devices in the Auckland Region.* NZWWA Stormwater Conference.

[2] Australian/New Zealand Standard. (1999). Life Cycle Costing: An Application Guide, AS/NZ 4536:1999. Standards Australia, Homebush, NSW, Australia and Standards New Zealand, Wellington, NZ.

[3] Australian National Audit Office. (2001). Life Cycle Costing: Better Practice Guide. Canberra, Commonwealth of Australia.

[4] Lampe, L., Barrett, M., Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Hollon, M. (2005). Performance and Whole Life Costs of Best Management Practices and Sustainable Urban Drainage Systems. WERF Report Number 01-CTS-21T.

- it reduces uncertainties and helps local authorities determine appropriate development contributions; and
- it assists local authorities in their budgeting, reporting and auditing processes.

Decision-making on the use and upgrade of wastewater infrastructure needs quality data on the technical and financial performance of these devices. The financial performance will depend on the sum and distribution over the life cycle of the device of costs associated with design, construction, use, maintenance, and disposal. LCC can be used for structuring and analysing this financial information. A LCC approach has been used in this project to quantify, where possible, the cost implications of wastewater infrastructure.

1.3 Caveat and limitations

Unlike the stormwater life cycle costing models, this is the first project which has attempted to collect cost data and quantify life cycle costs of wastewater infrastructure. The wide variety of wastewater infrastructure solutions, along with their "site specific" implementation, means that obtaining standardized cost data which can be used in costing models is exceptionally challenging. A study undertaken by the Water Environment Research Foundation (WERF - UK) and the AWWA Research Foundation (USA) (Lampe *et al*, 2005[4]) confirmed that both construction and maintenance cost data are notoriously difficult to obtain due to the 'financial sensitivity' of the information and the large number of variables involved in the construction and maintenance processes of some of the devices. In addition, it is an exceptionally time consuming process to collect cost data and, in many instances, data collected is not comparable or suitable for use within a model. Whilst significant effort was placed on collecting wastewater cost data, no "actual" maintenance data was obtained from existing maintenance operations on wastewater infrastructure. Maintenance contractors were approached for cost information, but many refused to provide data. Their reasons ranged from financial sensitivities, to not having data in a meaningful form (many maintenance contracts are lump sums for maintenance based on areas rather than itemised maintenance), and variability of size making it too difficult to cost. Some contractors did assist by providing information around the likely maintenance activities that could occur, along with potential frequencies and costs. Due to the lack of maintenance cost data, and as shown in the table below, LCC models could not be developed for many of the wastewater infrastructure solutions.

Solution	Costing Approach
Wastewater treatment plants	Replacement value $ per person Maintenance activity schedule
On-site wastewater disposal	Rural/ rural urban device – not costed through the urban economics work brief. Raw cost data provided in Section 5.
Hydrocarbon interceptor units	Not costed – too many variants and unlikely to be used as a standalone option. Raw cost data provided in Section 5.
Grease traps	Not costed - too many different types to develop any meaningful costs and would not be likely to form part of a public network. Raw cost data provided in Section 5.
Wastewater pump stations	$ per L/s pumped total acquisition cost Maintenance activity schedule and replacement costs
Wastewater pipes	Life cycle costs have been modelled
Other fittings (including grease traps and APIs above)	Schedule of TAC can be provided based on WW data.

For those infrastructure solutions where LCC models could be developed, the data used to develop the models is based on the best available cost information at the time of writing this report and professional judgement. However, cost information is notoriously variable, and whilst every effort has been made to ensure the consistency and integrity of the data collected, reliance should not be placed on the actual costing figures. Significant work would be needed to collect additional cost and maintenance data in order to further refine the models. Decision-makers should rather use the life cycle costing information to understand the potential relative difference between the different management solutions.

2 Life cycle costing models and cost data

The Landcare Research COSTnz Model[5] has been used to determine life cycle cost information for the Porirua Whaitua. COSTnz is a site-specific model and requires a good understanding of the local site conditions, contaminant inputs and infrastructure solution design. In general, the life cycle costs are assessed using a unit-based approach. Whilst COSTnz is a LCC model which is focussed on stormwater infrastructure, it does include a "Generic" module which can be tailored to any type of "hard" infrastructure. The "Generic" module was modified and used to model wastewater infrastructure life cycle costs for those solutions where sufficient maintenance data was available.

Cost data for the wastewater models was obtained from a number of sources. Wellington Water provided a significant amount of construction and installation cost data for the wastewater infrastructure which they operate. In addition, wastewater cost information was obtained from Wellington Water and WaterCare Asset Management Plans (AMPs), as well as "on-the-ground" subdivisions undertaken in the Auckland Region and from wastewater contractors.

3 Life cycle costing assumptions

All models have the same life cycle costing assumptions, as follows:

- The base year for the COSTnz model is 2007. As a result, all costs were inflated to a base year of 2017 using a 2.8% inflation rate. Any other data received was also inflated to a base year of 2017 in order to ensure all data was comparable and had the same base date in the models.
- A life cycle analysis period and life span of 50 years was used for all model runs.
- A discount rate of 3.5% was used for the discounted life cycle costs (however, as required in the scope of works, only undiscounted life cycle costs are presented in this report).
- Decommissioning costs were not included in the models as none of the solutions would be decommissioned after 50 years.

4. Model assumptions for individual solutions

The following section describes the total acquisition cost (TAC) and maintenance cost (MC) assumptions, as well as any specific design assumptions or cost limitations, for each wastewater solution.

It should be noted that, where possible, a range of costs (from low to high) has been provided. Providing a range of costs assists in addressing uncertainty in the cost estimates. In addition, this

[5] Ira, S. J. T., Vesely, E-T., McDowell, C and Krausse, M. 2009. *COSTnz – A Practical Life Cycle Costing Model for New Zealand*. NZWWA Conference, Auckland.

range helps to remind users that the value of these life cycle costs lies in their ability to provide a relative comparison of costs between different solutions, rather than the actual cost itself.

4.1 Wastewater Treatment Plants

Construction and maintenance costs of wastewater treatment plants (WWTP) are highly variable depending on the size of the plant, population treated, environment in which it is built, and the desired/ required level of wastewater treatment. Based on the Wellington Water and WaterCare AMPs, the replacement cost[6] of a WWTP varies from $690 - $710 per person treated.

Wellington Water have recently undertaken an analysis of potential upgrade options for the Porirua WWTP and associated wastewater network. This study also involved investigating the total acquisition costs (TAC) of each option, and the costing results are summarized in **Appendix A**.

It is recommended that these options be compared with the technical options which are being modelled through the Porirua Whaitua project and used to inform the Committee of likely changes in TAC of the wastewater network as a result of the upgrades. On-going maintenance costs of the upgraded system were not investigated as part of their study.

Maintenance activity, frequency and cost information for WWTPs was obtained from one Auckland source and no maintenance cost data was provided by Wellington Water. The source provided information based on his professional judgement and made the assumption that it was for a large scale WWTP. The table below summarises this information.

Maintenance Activity	Frequency	Unit	Cost
Routine Maintenance			
Automated Electronic monitoring	Once	per plant	approx $4000-$5000
Check pumps, lift lid, hose down walls (2 technicians, two hours)	Weekly	per hour	$ 75.00
General maintenance for a plant handling 1000 cubic metres a day	Daily	per plant	$ 680.00
General maintenance for a plant handling 600 cubic metres a day	Daily	per plant	$ 85.00
Service for a plant handling 3 cubic metres a day	Every 3 months	per hour	$ 85.00
Corrective Maintenance			
Technician inspection	as required	per hour	$ 85.00
Wastewater labourer	as required	per hour	$ 65.00

[6] Replacement cost is defined as the measured fair value of an asset less depreciation. http://www.aucklandcouncil.govt.nz/Plans/LongTermPlan/VolumeThree/section_s1341978107152.html Accessed on 12/6/2017

Recommendations (to allow a LCC model to be built):
Additional maintenance activity, frequency and cost data should be collected from the Porirua WWTP in order to refine the proposed maintenance schedule and costs above. Potentially a monthly maintenance schedule with associated costs could be developed, which could then be used in a life cycle costing model. Corrective maintenance costs could then be identified through historic records for the WWTP. These costs could be modelled and converted to a $ per person treated to complement the existing TAC information.

4.2 Wastewater Pump Stations

Total acquisition costs:
The construction and installation cost of wastewater pump stations was estimated from actual pump stations constructed in Auckland, as well as cost data provided by Wellington Water. As recommended by Wellington Water, an additional cost of 55% of the construction and installation cost was added onto this cost to account for planning, design, preliminary and general, fees and contingencies. The cost data received was based on pump stations ranging from 18 L/s to 1700 L/s

The TAC for wastewater pump stations was determined to be:

Low TAC (cost per L/s)	Mean TAC (cost per L/s)	High TAC (cost per L/s)
$3,800	$9,500	$28,800
[>1000 L/s pump capacity]	*[300 – 900 L/s pump capacity]*	*[<300 L/s pump capacity]*

Based on the dataset and pumping rate (L/s), pump stations with greater pump capacity rates (i.e. high L/s rate) have the lowest TAC, whilst smaller pump stations with smaller pump capacity rates have higher TACs (as shown by the indicative pump capacity guidance in row 3).

Maintenance Costs
Maintenance activity, frequency and cost information for wastewater pump stations was obtained from one Auckland source and no maintenance cost data was provided by Wellington Water. The source provided information based on his professional judgement and made the assumption that it was for a large scale, high loading pump station. The maintenance contractor stated that, over the course of 10 years, the amount spent on repairs to the pump station each year would likely equate to the total pump value. The table below summarises this information.

Maintenance Activity	Frequency	Unit	Cost
Routine Maintenance			
Chamber lid replacement	Within 25 years	per lid	$ 3,000.00
General maintenance/inspections of pumps	Every 10 years, although possibly every 5 years if close to a daycare, school or	per pump	total replacement cost of pump
Pump station inspection (usually 4 hours per month)	weekly-fortnightly	per hour	$ 85.00
Moving pumps for closer inspection	Every three months	per station	$ 850.00
Corrective Maintenance			
Chamber repairs	Every 25 years	per chamber	Inspection fees ($65-85 per hour), possible repairs needed

As estimated from the Wellington Water and WaterCare AMPs, the replacement cost for wastewater pump stations can vary from $54,600 - $694,000.

Recommendation (to allow a LCC model to be built):
Total Acquisition Costs: more data should be collected from small and medium sized pump stations with pumping rates between 50 L/s and 500L/s to further validate the TAC estimated above.

Maintenance Costs: Additional maintenance activity, frequency and cost data should be collected from existing Porirua pump stations in order to refine the proposed maintenance schedule and costs above. Potentially a monthly maintenance schedule with associated costs could then be developed, which could then be used in a life cycle costing model. Corrective maintenance costs could be identified through historic records for the pump stations, or based on total pump replacement every 10 years, along with a sum for other minor repairs. These costs could then be modelled and converted to a L/s pumping rate to complement the existing TAC information.

4.3 Wastewater Pipes

The COSTnz "generic" model was used to develop life cycle costs for wastewater pipes, and it is based on a similar approach to the stormwater pipe models. In order to generate an appropriate NZ$/m cost for the pipes, 80m sections of pipe were costed. Data from Wellington Water has shown that they service approximately 15699 manholes and a total pipe length of 596km. This equates to, on average, 1 manhole for every 40m of pipe. This spacing falls within the recommendations of the Regional Standard for Water Services in the Wellington Region (November 2012).

Two types of piped systems were costed, namely a gravity-fed wastewater piped network and a pumped wastewater piped network. An 80m section of pipe was costed in order to account for additional infrastructure that would be associated with these 2 piped systems.

As recommended by Wellington Water, an "on-cost factor" of 1.13 (approximately 50% of the installation cost) was added to the installation cost to account for costs incurred through the design, planning and consenting phase, and to account for compliance and management fees during construction. This percentage is relatively consistent with the recommendations Table 6.2 of Chapter 6 of an unnamed/ undated EPA report[7].

Total Acquisition Costs:
The following formula was used to determine the TAC for each scenario:

Gravity-fed pipe LCC model
TAC Cost for 80m of pipe = [(Pipe Installation Cost x 80) + (2 x manhole)] 50% design, planning, supervision & contingency cost*

Pumped pipe LCC model
TAC Cost for 80m of pipe = [(Pipe Installation Cost x 80) + (2 x manhole)+ (1 x connections + valves+ grade change)] 50% design, planning, supervision & contingency cost*

[7] Chapter 6 of an unnamed/ undated US EPA Report: https://www3.epa.gov/npdes/pubs/usw_d.pdf

Pipe installation costs (from Wellington Water, Rawlinsons[8] and AR & Associates)

Pipe Diameter (mm)/ Infrastructure*	Low (NZ$) (greenfield rate) ($/m)	Mid (NZ$) (suburban rate) ($/m)	High (NZ$) (CBD rate) ($/m)
110	248	588	686
160	268	628	732
250	335	715	834
355	425	890	1,038
450	483	1,029	1,201
560	561	1,326	1,547
675	692	1,495	1,742
750	823	1,682	1,963
825	875	1,850	2,159
900	1,013	2,063	2,407
1050	1,350	2,519	2,939
1200	1,487	2,921	3,408
WW Manhole	4,936	5,498	6,600
Valve Connection	580	681	782
Main Valves (sluice/ air/ shut-off/ etc)	2,967	3,844	4,720
Change of direction/ grade	590	693	796

* HDPE SDR17 pipes for under 600mm. Over 600mm are concrete pipe costs. Cover depth of approximately 0.9m.

Maintenance costs:
Since no additional maintenance data was available for wastewater pipes, maintenance activities, frequencies and costs for the low, mid and high scenarios incorporate the same activities as for stormwater pipes. The modelled maintenance spreadsheets are shown below. An increase from 1 to 2-3 hours for CCTV inspection has been allowed for the larger pipe sizes. The pumped pipe model also includes an extra item for replacement of valves.

[8] Rawlinsons New Zealand Construction Handbook (2007)

Gravity-fed pipe LCC model

Low costs

MAINTENANCE COSTS

Routine Maintenance	Frequency (Per Year)	Unit	Costs		Total Cost
	User Defined		Model/ Default	User Defined	
Inspections	2	per device		$162.00	$324.00
Six Monthly Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	2	per device			$0.00
Annual Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	1	per device			$0.00
Minor repairs	1	per device		$450.00	$450.00
Make good following vandalism		per device			$0.00
Other Activities *{please specify}*					$0.00
Traffic Management	2	per device			$0.00
					$0.00
					$0.00
					$0.00
					$0.00
TOTAL ROUTINE MAINTENANCE COSTS [Annual]					**$774.00**

Corrective Maintenance	Frequency (Number of Years)	Unit	Costs		Total Cost
	User Defined		Model/ Default	User Defined	
Replacement of Unit*	15	per device			$0.00
Replacement of parts (grates, outlet structures; other concrete components)	10	per device		$385.00	$385.00
Cleanout of Sediment*	10	m^3			$0.00
Disposal of Sediment	10	m^3			$0.00
Other activities *{please specify}*					
CCTV	25	per hour		$240.00	$240.00
Traffic Management	10	per pipe		$450.00	$450.00
Vacuuming of Pipes	10	per service		$250.00	$250.00
Disposal of Sediment	10	m3		$83.34	$25.00
TOTAL CORRECTIVE MAINTENANCE COSTS					**$1,350.00**

Mid costs

MAINTENANCE COSTS

Routine Maintenance	Frequency (Per Year)	Unit	Costs		Total Cost
	User Defined		Model/ Default	User Defined	
Inspections	2	per device		$179.00	$358.00
Six Monthly Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	2	per device			$0.00
Annual Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	1	per device			$0.00
Minor repairs	1	per device		$580.00	$580.00
Make good following vandalism		per device			$0.00
Other Activities *{please specify}*					$0.00
Traffic Management	2	per device			$0.00
					$0.00
					$0.00
					$0.00
					$0.00
TOTAL ROUTINE MAINTENANCE COSTS [Annual]					**$938.00**

Corrective Maintenance	Frequency (Number of Years)	Unit	Costs		Total Cost
	User Defined		Model/ Default	User Defined	
Replacement of Unit*	15	per device			$0.00
Replacement of parts (grates, outlet structures; other concrete components)	10	per device		$485.00	$485.00
Cleanout of Sediment*	10	m^3			$0.00
Disposal of Sediment	10	m^3			$0.00
Other activities *{please specify}*					
CCTV	25	per hour		$305.00	$305.00
Traffic Management	10	per pipe		$517.00	$517.00
Vacuuming of Pipes	10	per service		$255.00	$255.00
Disposal of Sediment	10	m3		$120.00	$36.00
TOTAL CORRECTIVE MAINTENANCE COSTS					**$1,598.00**

High costs

MAINTENANCE COSTS

Routine Maintenance	Frequency (Per Year) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Inspections	2	per device		$196.17	$392.34
Six Monthly Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	2	per device			$0.00
Annual Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	1	per device			$0.00
Minor repairs	1	per device		$715.00	$715.00
Make good following vandalism		per device			$0.00
Other Activities *{please specify}*					$0.00
Traffic Management	2	per device			$0.00
					$0.00
					$0.00
					$0.00
					$0.00
TOTAL ROUTINE MAINTENANCE COSTS [Annual]					**$1,107.34**

Corrective Maintenance	Frequency (Number of Years) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Replacement of Unit*	15	per device			$0.00
Replacement of parts (grates, outlet structures; other concrete components)	10	per device		$585.00	$585.00
Cleanout of Sediment*	10	m^3			$0.00
Disposal of Sediment	10	m^3			$0.00
Other activities *{please specify}*					
CCTV	25	per hour		$370.00	$370.00
Traffic Management	10	per pipe		$585.00	$585.00
Vacuuming of Pipes	10	per service		$260.00	$260.00
Disposal of Sediment	10	m3		$157.70	$47.31
TOTAL CORRECTIVE MAINTENANCE COSTS					**$1,847.31**

Pumped pipe LCC model

Low costs

MAINTENANCE COSTS

Routine Maintenance	Frequency (Per Year) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Inspections	2	per device		$162.00	$324.00
Six Monthly Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	2	per device			$0.00
Annual Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	1	per device			$0.00
Minor repairs	1	per device		$450.00	$450.00
Make good following vandalism		per device			$0.00
Other Activities *{please specify}*					$0.00
Traffic Management	2	per device			$0.00
					$0.00
					$0.00
					$0.00
					$0.00
TOTAL ROUTINE MAINTENANCE COSTS [Annual]					**$774.00**

Corrective Maintenance	Frequency (Number of Years) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Replacement of Unit*	15	per device			$0.00
Replacement of parts (1x manhole cover +1x valve replacement)	10	per device		$3,352.00	$3,352.00
Cleanout of Sediment*	10	m^3			$0.00
Disposal of Sediment	10	m^3			$0.00
Other activities *{please specify}*					
CCTV	25	per hour		$240.00	$240.00
Traffic Management	10	per pipe		$450.00	$450.00
Vacuuming of Pipes	10	per service		$250.00	$250.00
Disposal of Sediment	10	m3		$83.34	$25.00
TOTAL CORRECTIVE MAINTENANCE COSTS					**$4,317.00**

Mid costs

MAINTENANCE COSTS

Routine Maintenance	Frequency (Per Year) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Inspections	2	per device		$179.00	$358.00
Six Monthly Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	2	per device			$0.00
Annual Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	1	per device			$0.00
Minor repairs	1	per device		$580.00	$580.00
Make good following vandalism		per device			$0.00
Other Activities *{please specify}*					$0.00
Traffic Management	2	per device			$0.00
					$0.00
					$0.00
					$0.00
					$0.00
TOTAL ROUTINE MAINTENANCE COSTS [Annual]					**$938.00**

Corrective Maintenance	Frequency (Number of Years) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Replacement of Unit*	15	per device			$0.00
Replacement of parts (1x manhole cover +1x valve replacement)	10	per device		$4,329.00	$4,329.00
Cleanout of Sediment*	10	m^3			$0.00
Disposal of Sediment	10	m^3			$0.00
Other activities *{please specify}*					
CCTV	25	per hour		$305.00	$305.00
Traffic Management	10	per pipe		$517.00	$517.00
Vacuuming of Pipes	10	per service		$255.00	$255.00
Disposal of Sediment	10	m3		$120.00	$36.00
TOTAL CORRECTIVE MAINTENANCE COSTS					**$5,442.00**

High costs

MAINTENANCE COSTS

Routine Maintenance	Frequency (Per Year) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Inspections	2	per device		$196.17	$392.34
Six Monthly Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	2	per device			$0.00
Annual Service (inspection of operating unit and clearing debris from inlets; outlets; replacement of filters/ cartridges/ bags, etc)	1	per device			$0.00
Minor repairs	1	per device		$715.00	$715.00
Make good following vandalism		per device			$0.00
Other Activities *{please specify}*					$0.00
Traffic Management	2	per device			$0.00
					$0.00
					$0.00
					$0.00
					$0.00
TOTAL ROUTINE MAINTENANCE COSTS [Annual]					**$1,107.34**

Corrective Maintenance	Frequency (Number of Years) User Defined	Unit	Costs Model/ Default	Costs User Defined	Total Cost
Replacement of Unit*	15	per device			$0.00
Replacement of parts (1x valve + 1x manhole cover)	10	per device		$5,305.00	$5,305.00
Cleanout of Sediment*	10	m^3			$0.00
Disposal of Sediment	10	m^3			$0.00
Other activities *{please specify}*					
CCTV	25	per hour		$370.00	$370.00
Traffic Management	10	per pipe		$585.00	$585.00
Vacuuming of Pipes	10	per service		$260.00	$260.00
Disposal of Sediment	10	m3		$157.70	$47.31
TOTAL CORRECTIVE MAINTENANCE COSTS					**$6,567.31**

4.4 General Wastewater cost/ model exclusions and notes

- Consistent pipe material assumed (HDPE SDR17 pipes for under 600mm. Over 600mm are concrete pipe costs. Cover depth of approximately 0.9m).
- The models do not include connections to private lots/ houses (i.e. plumbing to house, etc).
- The models do not include monitoring of flows or metering.
- All costs are a mix of engineers estimates, quotes and guesstimates, and are based on the assumptions detailed in this document.
- Maintenance costs and schedules are rough estimates/ guesstimates based on “best available data” at this time.
- Local cost information has been used where it is available.

- It is recommended that the Wellington Water wastewater scenario modelling work be used to estimate costs of upgrades where possible.

5. Summary of undiscounted life cycle costs

5.1 Results

The table below and series of graphs provide a summary of the undiscounted $/year (2017) life cycle costs (based on a 50 year analysis period) for the gravity-fed and pumped wastewater piped systems.

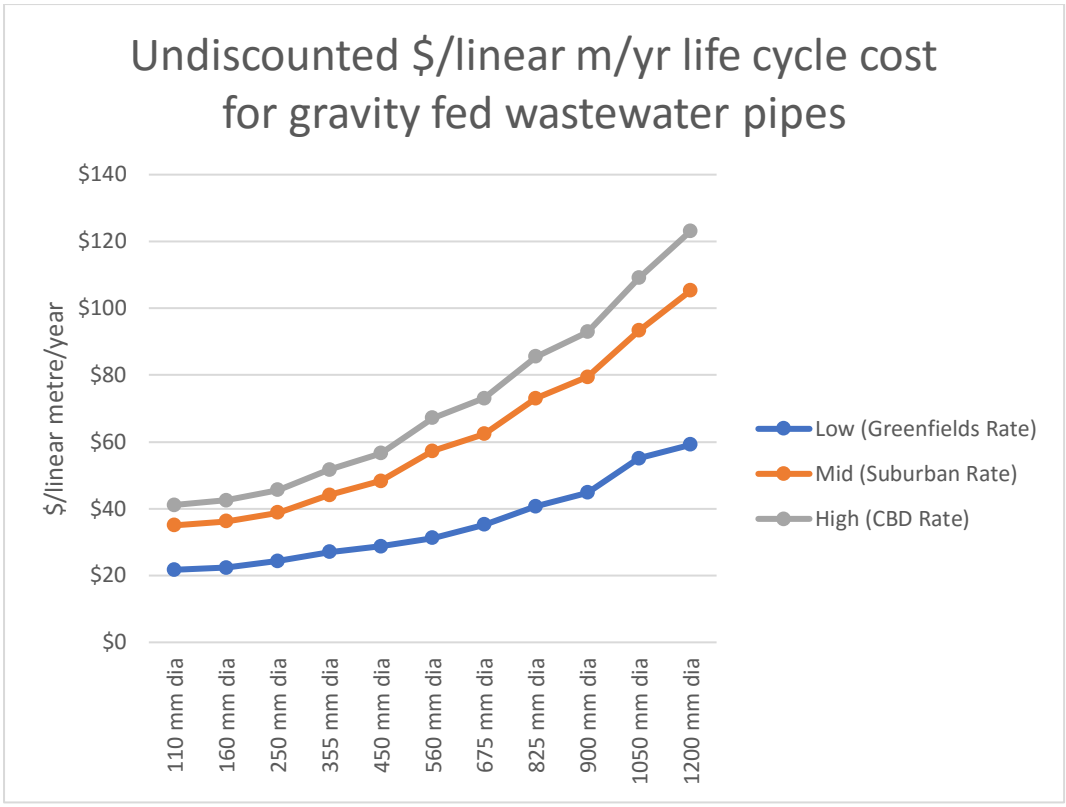
Summary of undiscounted life cycle costs ($/ linear metre/ year):

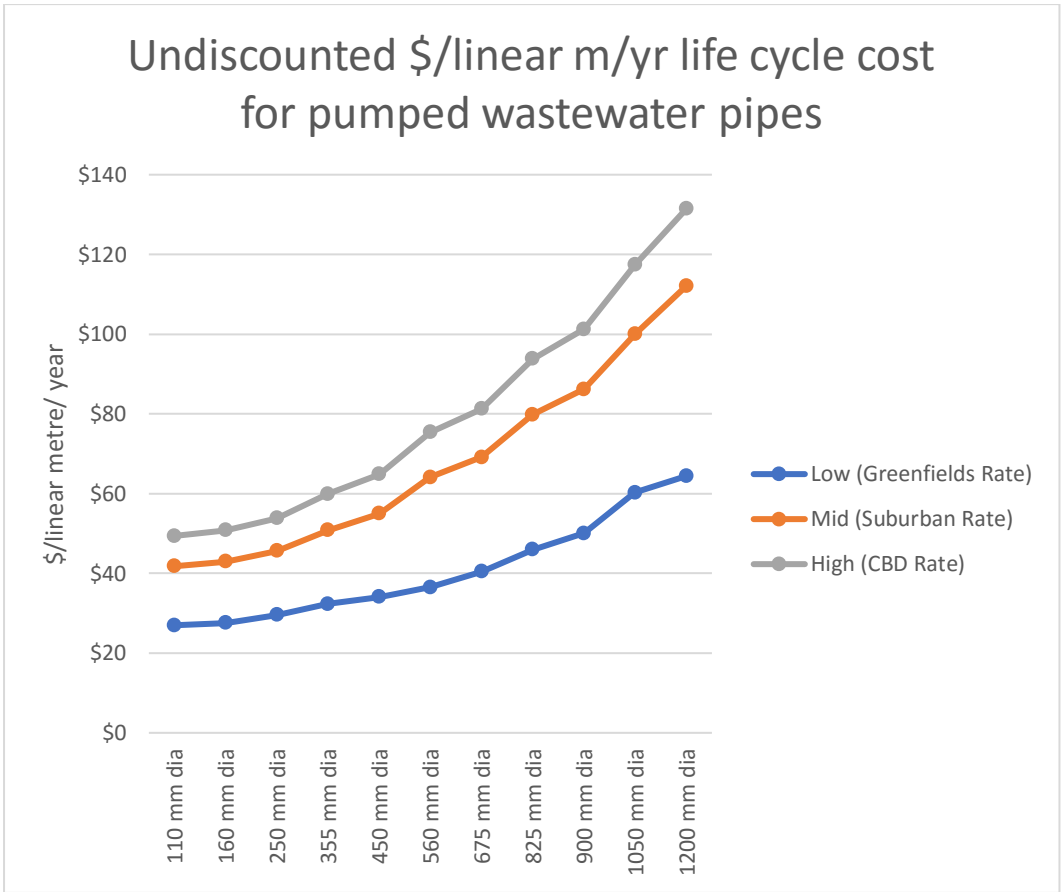
Gravity fed wastewater pipe costs

$/m/yr	Low (Greenfields Rate)	Mid (Suburban Rate)	High (CBD Rate)
110 mm dia	$22	$35	$41
160 mm dia	$22	$36	$43
250 mm dia	$24	$39	$46
355 mm dia	$27	$44	$52
450 mm dia	$29	$48	$57
560 mm dia	$31	$57	$67
675 mm dia	$35	$62	$73
825 mm dia	$41	$73	$86
900 mm dia	$45	$79	$93
1050 mm dia	$55	$93	$109
1200 mm dia	$59	$105	$123

Pumped wastewater pipe costs

$/m/yr	Low (Greenfields Rate)	Mid (Suburban Rate)	High (CBD Rate)
110 mm dia	$27	$42	$49
160 mm dia	$28	$43	$51
250 mm dia	$30	$46	$54
355 mm dia	$32	$51	$60
450 mm dia	$34	$55	$65
560 mm dia	$36	$64	$75
675 mm dia	$40	$69	$81
825 mm dia	$46	$80	$94
900 mm dia	$50	$86	$101
1050 mm dia	$60	$100	$117
1200 mm dia	$64	$112	$131


Undiscounted $/linear m/yr life cycle cost for gravity fed wastewater pipes
$/linear metre/year
$140
$120
$100
$80
$60
$40
$20
$0
110 mm dia
160 mm dia
250 mm dia
355 mm dia
450 mm dia
560 mm dia
675 mm dia
825 mm dia
900 mm dia
1050 mm dia
1200 mm dia
Low (Greenfields Rate)
Mid (Suburban Rate)
High (CBD Rate)


Undiscounted $/linear m/yr life cycle cost for pumped wastewater pipes
$/linear metre/ year
$140
$120
$100
$80
$60
$40
$20
$0
110 mm dia
160 mm dia
250 mm dia
355 mm dia
450 mm dia
560 mm dia
675 mm dia
825 mm dia
900 mm dia
1050 mm dia
1200 mm dia
Low (Greenfields Rate)
Mid (Suburban Rate)
High (CBD Rate)

5.2 Other costs

5.2.1 Land costs

COSTnz does not include land costs in the total life cycle analysis. Therefore, in order to generate an accurate catchment-scale LCC, land costs need to be accounted for. Modelling work was undertaken as part of the UPSW stormwater cost model in an attempt to determine whether or not a land cost factor could be used to account for land costs in the different types of development scenarios (i.e. greenfield vs retrofit development). This information was presented in the report entitled "*Deliverable 2: Summary of life cycle costs for stormwater infrastructure solutions*". The land cost factors are applied through the UPSW stormwater cost model relate to $/ha/ yr life cycle costs and therefore cannot be directly applied to the wastewater pipe model costs. In the absence of further research and guidance, and given that the pipes are underground, it is recommended that the pipe models do not include a factor for land costs.

Further work is needed to validate this assumption and to determine what the land cost may be for other wastewater solutions such as wastewater treatment plants and pump stations.

5.2.2 Construction costs

A list of itemised construction costs (relating to earthworking and concreting) is provided in the report "*Deliverable 2: Summary of life cycle costs for stormwater infrastructure solutions*".

5.2.3 "Other Fitting" and "on-site solutions" costs

To further supplement the "library" of wastewater infrastructure costs, a list of costs obtained through the data collection process is provided below. The costs only encompass construction and installation costs, and do not include design, planning, preliminary and general or site supervision costs.

Fitting Type	2017 Unit Rate ($/ fitting)*
Valve Connection	$782
WW Chamber	$782
WW Chamber Balancing	$1,348
WW Chamber Grit	$15,979
WW Chamber Large	$9,979
WW Change of Direction	$796
WW Change of Grade	$796
WW Change of Pipe Type	$796
WW Dead End	$796
WW Junction	$796
WW Lamphole	$1,605
WW Manhole	$4,396
WW Overflow Outlet	$782
WW Vent Column	$1,578
WW flow monitors	$15,615

Fitting Type	2017 Unit Rate ($/ fitting)*
WW level sensors	$15,615

* Costs presented are construction and installation costs only. They do not include design, planning, preliminary and general or site supervision costs (on-costs of 1.13 should be added onto the rates to include these items).
* Source of data: Wellington Water

On-site WW Solutions	Cost per unit/ system*		
	Low	Mean	High
Interceptor Units (2,000 - 3,000 L unit)	$4,600	$8,050	$11,500
Grease Traps (surface mounted - 1,200 - 5000 L unit)	$4,000	$6,250	$8,500
On-Site Disposal Systems	$8,500	$11,750	$15,000

* Costs presented are construction and installation costs only. They do not include design, planning, preliminary and general or site supervision costs (on-costs of 1.13 should be added onto the rates to include these items).
* Source of data: Auckland-based cost data received from supplier quotes/ websites.

Maintenance costs

Maintenance cost data was collected for the on-site solutions, however, the information was very variable, especially in relation to the size of the unit. The tables below provide a summary of the maintenance activity, frequency and cost information that was obtained.

Interceptor Units

Maintenance Activity	Frequency	Unit	Cost (excl GST)
Routine Maintenance			
Cleaning debris and pooled oil from interceptor	6-monthly	per interceptor	$ 1,500.00
Cleaning debris and pooled oil from interceptor	6-monthly	per interceptor	$0.26 per kg removed, $265 per hour for disposal truck, + labour costs
Corrective Maintenance			
Storm inspection	Whenever there is greater than 25mm of rain over a 24 hour period	per unit	$ 1,500.00

[Data source: Auckland based cost information – contractor estimates from 3 sources]

Grease Traps

Maintenance Activity	Frequency	Unit	Cost (excl GST)
Routine Maintenance			
Cleaning services	Every 13 weeks	per trap	$0.20 AUD per litre
Yearly grease trap maintenance	Annual	per trap	$300-$400 USD (for a small restaurant serving 100 meals a day)
Standard internal grease trap cleaning	6-monthly	per trap	$ 450.00
Standard internal grease trap cleaning	(depends on trap)	per hour	$373 minimum, plus $0.3 per litre over the minimum litre
Corrective Maintenance			
None is usually required as long as grease trap is cleaned regularly			

[Data source: Auckland based cost information – contractor estimates from 4 sources and 1 professional guesstimate]

On-site disposal systems

Maintenance Activity	Frequency	Unit	Cost (excl GST)
Routine Maintenance			
Routine Maintenance and inspections	6 monthly	per inspection	$60-90
Daily running costs	daily	per system	$0.5-$0.75
Mandatory system service		per system	$123 (inlcuding GST)
Fibreglass tank servicing	6 monthly	per system	$ 185.00
Corrective Maintenance			
Minor repairs	5 yearly	per system	

[Data source: Auckland based cost information – contractor estimates/ guesstimates from 4]

6 Conclusions

This report has provided an overview of the method and assumptions used in the life cycle costing process, along with the results of this analysis. Only full LCC models could be developed for gravity-fed and pumped wastewater piped systems. This is mainly due to the fact that, despite significant effort being placed on collecting wastewater cost data, no "actual" maintenance data was obtained from existing maintenance operations on wastewater infrastructure. The report presents LCC for piped wastewater networks, and also provides a series of total acquisition costs for other wastewater infrastructure solutions. Where available, maintenance cost information has also been provided.

Significant further work would be needed to collect additional TAC and maintenance cost data in order to create LCC models for WWTP, pump stations and some of the "on-site" wastewater devices, and to further refine the wastewater pipe models.

It is recommended that, with respect to maintenance costs, the maintenance cost data collection protocols provided in this report be expanded and used to accurately and consistently capture maintenance cost data. Additional maintenance activity, frequency and cost data could then be collected from existing Porirua wastewater networks in order to refine the proposed maintenance schedules and costs. Potentially a monthly maintenance schedule with associated costs could then be developed, which could be used in a life cycle costing model. Corrective maintenance costs could be identified through historic maintenance records.

Appendix A – Summary of TAC for Wellington Water WWTP Upgrade Options

SCHEDULE OF TAC WWTP UPGRADE OPTIONS (DRAFT)				
SUMMARY MATRIX*				
	Option			
ARI	**1**	**2**	**3**	**4**
3 months	$ 76,250,931	$ 97,587,547	$ 72,663,074	$ 82,018,316
6 months	$ 77,446,988	$ 99,928,667	$ 73,892,844	$ 86,001,134
1 year	$ 79,980,603	$ 101,237,735	$ 76,302,970	$ 92,182,379
2 years	$ 84,005,550	$ 106,004,295	$ 81,500,027	$ 99,560,394
5 years	$ 86,951,728	$ 108,146,132	$ 83,192,363	$ 105,671,486
*All costs exclusive of GST				
Costs listed in the Matrix above include the following allowances, as a proportion of Physical Works:				
Preliminaries and Pre-construction Set-up		10%		
Risk and Contingency		30%		
Project and Contract Management		5%		
Consultancy Fees		10%		
TOTAL		55%