HARRISON GRIERSON

GREATER WELLINGTON REGIONAL COUNCIL

Rainwater Tank Investigation

Rainwater Tank Analysis Report for Upper Hutt

January 2011
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HARRISON GRIERSON CONSULTANTS LIMITED

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EXECUTIVE SUMMARY

Harrison Grierson was commissioned by Greater Wellington Regional Council (Greater Wellington) to develop a model of rainwater tanks in the urban environment for the cities in the Wellington region; Lower Hutt, Upper Hutt, Porirua and Wellington. This report presents the findings for Upper Hutt and discusses the costs of installing rainwater tanks.

The model is set up to calculate the volume of water in the tank each day using the rainfall over the roof area as the flow into the tank and the household demand as the flow out of the tank. The tank was assumed to supply only outdoor usage and toilet flushing.

Nine runs were set up in the model to look at 3 occupancy rates, 2, 3 and 4 people per house and 3 roof sizes, 100, 150, 200 m². The model was also run for 5,000 L and 10,000 L tanks and a dry and average summer.

The model was used to calculate the total amount of rainwater supplied to the house and the total volume of mains supply used to top up the tank. Using these outputs and a water cost of $\$1.41/m^3$, the savings to each household through water charges reduction was calculated. The installation cost of the rainwater tank systems were also considered in order to compare the savings in water charges with the capital costs.

Through analysis of the 9 runs of the model for the two tank sizes and two years of data, the following conclusions can be drawn for Upper Hutt:

- The total yearly demand for flushing and outdoor usage is 51,603 L, 77,405 L and 103,207 L for a 2, 3 and 4 person household respectively.

- The maximum yearly saving which can be found through using rainwater for outdoor use and toilet flushing is $72.76, $109.14 and $145.52 for a 2, 3 and 4 person house respectively, with a 10,000 L rainwater tank.

- The average saving found from rainwater tank use is approximately $102.62/year for a 5,000 L tank system and $107.72/year for a 10,000 L tank system.

- With an installation cost of $7,500 for a 5,000 L rainwater tank system, the minimum interest charged will be $525 per annum. As the interest is significantly higher than the maximum achievable savings of $135.34 for a 5,000 L tank, the tank system will never pay for itself through savings in water charges.

- With 14,253 properties in Upper Hutt and an expected engagement of 25% of householders, approximately 3,563 rainwater tanks would be installed at a total cost, less savings over a 5 year period, of approximately $30 million.

1.0 INTRODUCTION

Harrison Grierson has been commissioned by Greater Wellington to perform an analysis of rainwater tanks in the urban environment. The aim of the project was to investigate the viability of urban rainwater tanks for the four cities in the region. The four cities analysed were Lower Hutt, Upper Hutt, Porirua and Wellington. This report details the analysis of Upper Hutt only.

The aim of the project was to model the volume of water in the tank over three years of rainfall data (July to June).

Rainfall data for a dry and average summer for each city was provided by Greater Wellington. This rainfall data formed the basis of the analysis; the set of data used for Upper Hutt is provided in Appendix 1.

1.1 VARIABLES

Through consultation with Greater Wellington it was agreed that the model would be run for 9 different scenarios with the following inputs:

Table 1: Summary of Run Variables

Run Number	Occupancy (People per House)	Roof Area (m^2)
1	2	200
2	2	150
3	2	100
4	3	200
5	3	150
6	3	100
7	4	200
8	4	150
9	4	100

Greater Wellington also requested that a 5,000 L and a 10,000 L tank should be analysed giving a total of 18 runs for each city.

1.2 MODEL OUTPUTS

The rainwater tank model plots the volume in the tank, using the rainfall data and demand statistics to calculate the flow in and out each day. The tank has a minimum allowable volume of 10%. If the tank falls below this level it is refilled to 10% using the mains supply.

The outputs from the model discussed in this report are;

- The total volume of rainwater captured and supplied to the household by the rainwater tank
- The total volume of water used from the mains to maintain the tank at 10%

Other outputs such as number of non-supply days, max number of non-supply days in a row, spillage from the tank and minimum required tank volumes are discussed in the Rainwater Tank Model Analysis Report (July 2010).

1.3 COST ANALYSIS BASIS

Greater Wellington also requested that a simple cost analysis be performed over the 5 years following installation of a rainwater tank. A period of 5 years is seen as a reasonable time for a householder to expect to see a return from the installation of a rainwater tank.

The cost analysis takes into consideration the cost of installing the tank system, the cost of installing a water meter and manifold on the water main if required and the reduction in water charges from the use of rainwater over a 5 year period.

The rainwater supplied by the tank is used to calculate the reduction in water charges for the household, with water rates at $1.41/m^3 for Upper Hutt as specified by Greater Wellington. As detailed in the quote supplied in Appendix 2, installing a 4,500 L tank system for garden irrigation and toilet use was estimated to cost approximately $6,300. Connecting up the downpipes from the entire roof to the tank system would be a variable cost depending on the house layout and could cost between $1,500 and $2,000 per house. It is therefore assumed that a 5,000 L tank system would cost approximately $7,500 to install. As a 25,000 L tank system is assumed to cost $11,000 to install it is estimated that a 10,000 L tank system will cost $8,500, or $10,000 including downpipe connections. As this quote was received in 2007, these figures are considered to be conservative estimates.

An installation cost of $127 for a manifold water meter was provided by Greater Wellington. This is the cost to install a water meter on an existing manifold. If a new manifold needs to be installed, the total cost would be $480. These figures assume no installation complications, use of compression fittings and no long travel distances.

2.0 MODEL SET-UP

2.1 INFLOW

The inflow into the tank over a day is taken to be the roof area used multiplied by the total rainfall for that day. As agreed with Greater Wellington, it is assumed that the first 1 mm of rainfall will not be collected due to the 1st flush diverter, the potential for leaking spouting, inefficient collection and roof area restrictions. It is also assumed that rainfall from the entire roof area will be collected. For this reason the roof area used is the effective roof area.

The flow into the tank is given by the equation 1 below:

$$Flow_{IN} = (RF - RF_{LOSS}) \times RA \qquad (1)$$

Where:

RF - Rainfall – for that day (mm)

RF_{LOSS} - Losses = 1 mm

RA - Roof Area – 100 m^2, 150 m^2 or 200 m^2

2.2 OUTFLOW

It is assumed that the tank will be used solely for toilet flushing and outdoor usage. Greater Wellington provided statistics for toilet flushing and outdoor usage demand over the summer and winter months. These were given as a percentage of the total demand and are presented in the table below:

Table 2: Rainwater Tank Usage (RTU) rates for each season

Season	Toilet Flushing (% of DD)	Outdoor Usage (% of DD)	Total RTU (% of DD)
Spring / Summer	17.5%	17%	34.5%
Autumn / Winter	18.5%	6%	24.5%

Greater Wellington provided the average daily demand for each city and the variation in demand over the year. For Upper Hutt the average was 240 L/person/day, with monthly variation as shown in table 3.

Table 3: Monthly Demand Variations (MDV)

Month	Daily Demand Variation (% of DD)	Monthly Rainwater Tank Usage (% of DD)	Daily Demand (L/person/day)
January	107%	34.5%	88.60
February	111%	34.5%	91.91
March	105%	24.5%	61.74

Table 3: Monthly Demand Variations (MDV)

Month	Daily Demand Variation (% of DD)	Monthly Rainwater Tank Usage (% of DD)	Daily Demand (L/person/day)
April	98%	24.5%	57.62
May	96%	24.5%	56.45
June	95%	24.5%	55.86
July	95%	24.5%	55.86
August	95%	24.5%	55.86
September	95%	34.5%	78.66
October	96%	34.5%	79.49
November	102%	34.5%	84.46
December	101%	34.5%	83.63

Using the daily demand per person (DD) for each city, the monthly demand variation (MDV) and the varying rainwater tank usage (RTU) the flow out of the rainwater tank is given by the equation below:

$$Flow_{OUT} = DD_{CITY} \times MDV_{MONTH} \times RTU_{SEASON} \times OCC \quad (2)$$

Where:

DD - Daily Demand – 240 L/person/day

MDV - Monthly Demand Variation – for a specific month (% of DD)

RTU - Rainwater Tank Usage – for a specific season (% of DD)

OCC - Occupancy rate – 2, 3 or 4 people/house (p/h)

The governing equation for the model as presented below is assumed to be the previous day's volume, plus the inflow (rainfall), minus the outflow (demand):

$$V_{TANK} = V_{PREVIOUS} + Flow_{IN} - Flow_{OUT} \quad (3)$$

Where:

V_{TANK} - Current Tank Volume (L)

$V_{PREVIOUS}$ - Previous Day's Tank Volume (L)

If the total rainfall for one day is less than the minimum harvest (1mm) then it is assumed no water is collected for the rainwater tank (i.e. $Flow_{IN}$ cannot be negative). It is also assumed that the tank starts at 20% full on the 1st of July, i.e. the initial volume of the 10,000L tank is 2,000 L and the initial volume of the 5,000 L tank is 1,000 L.

The current tank volume is calculated for each consecutive day using equation 3 above. Each day the specific rainfall data for that day and the specific demand for that month and season are used.

A 10% buffer volume was incorporated into the model. This was to represent the scenario where the mains water supply would be used to top up the tank when it reached a low level. This meant that if the tank volume is calculated to be below 10%, the volume is returned to 10% and the difference is recorded as "mains supply volume".

Of interest to Greater Wellington was the volume of water used from the tank which was supplied by the collected rain and not the mains top-up. This was calculated as the total demand from the tank minus the mains supply volume and was recorded as "rainwater supply". This rainwater supply will be equivalent to the cost savings for the household.

3.0 UPPER HUTT RESULTS – SUMMARY

The following tables show the total rainwater used, the total mains supply top-up (to maintain the tank at 10%) and the equivalent saving through reduction in water charges for each household over year 1 (average summer) and year 2 (dry summer). The total annual water demand for a 2, 3 or 4 person household is on average 175,200 L, 262,800 L and 350,400 L respectively. The total annual demand for outdoor use and toilet flushing for a 2, 3 or 4 person household is on average 51,603 L, 77,405 L and 103,207 L respectively.

Table 4: Upper Hutt Council Rainwater Tank Model Outputs

Tank Size	Roof Size (m^2)	2 People per House			3 People per House			4 People per House		
		Mains Supply Top-up (L)	Total Rainwater Supply (L)	Reduction In Water Charges	Mains Supply Top-up (L)	Total Rainwater Supply (L)	Reduction In Water Charges	Mains Supply Top-up (L)	Total Rainwater Supply (L)	Reduction In Water Charges
YEAR 1 (average summer)										
5,000L	200	0	51,603	$72.76	2,418	74,987	$105.73	7,837	95,370	$134.47
	150	0	51,603	$72.76	2,503	74,902	$105.61	8,933	94,274	$132.93
	100	0	51,603	$72.76	4,844	72,561	$102.31	13,955	89,251	$125.84
10,000 L	200	0	51,603	$72.76	0	77,405	$109.14	0	103,207	$145.52
	150	0	51,603	$72.76	0	77,405	$109.14	0	103,207	$145.52
	100	0	51,603	$72.76	0	77,405	$109.14	7,774	95,433	$134.56
YEAR 2 (dry summer)										
5,000L	200	1,145	50,642	$71.41	4,367	73,313	$103.37	7,590	95,985	$135.34
	150	1,345	50,442	$71.12	4,567	73,113	$103.09	7,790	95,785	$135.06
	100	1,545	50,242	$70.84	4,767	72,913	$102.81	12,090	91,484	$128.99
10,000 L	200	0	51,787	$73.02	0	77,681	$109.53	3,090	100,485	$141.68
	150	0	51,787	$73.02	67	77,613	$109.43	3,290	100,285	$141.40
	100	0	51,787	$73.02	267	77,413	$109.15	6,156	97,418	$137.36

From the table we can calculate that the average reduction in water charges for a 5,000 L tank is $102.62/year and the average reduction for a 10,000 L tank is $107.71/year. Note that "Total Rainwater Supply" assumes the entire roof area is used for rainwater collection.

4.0 COST ANALYSIS

The total yearly demand for toilet flushing and outdoor usage is 51,603 L, 77,405 L and 103,207 L for a 2, 3 and 4 person household respectively for Upper Hutt City. The maximum water charges reduction of $72.76, $109.14 and $145.52 respectively are achieved with a 10,000L tank.

The lowest cost scenario would be to install a 5000 L tank system with no manifold or water meter required. The cost for this option would be $7,500.

With an interest rate of 7%, the interest charged would be $525 per annum. As this value is much higher than the maximum savings from reduced water charges, the capital would never be paid back through water savings.

If interest is disregarded, the maximum saving that can be earned from rainwater tank use ($135.34 for a 5,000 L tank and $145.52 for a 10,000 L tank), will take 55 years to re-pay the cost of the 5,000 L tank system ($7500) excluding the water meter installation, and 69 years for the 10,000 L tank system ($10,000). This is substantially more than the useful life of the tank system.

In order to evaluate the financial viability of implementing rainwater tanks a simple cost analysis was performed looking at the 5 year period after installation of the tank system. A 5 year period was used as a reasonable period for the consumer to expect a payback from the tank system installation. This analysis weighed the cost of installing the tank system with or without the water meter and manifold against the total reduction in water charges over the 5 year period.

The savings in water charges for a household with a 5,000 L tank system, considering an average yearly saving of $102.62 over a 5 year period:

$$\begin{aligned} Savings &= \$102.62 \times 5\,years \\ &= \$513 \end{aligned}$$

Excluding interest charges, the cost to an average household of installing a 5,000 L tank system, manifold and manifold water meter with $513 saving in water charges over 5 years is shown below. The assumed installation costs are $7,500 for the tank and $480 for the manifold and water meter:

$$\begin{aligned} Total_{Household} &= \$7,500 + \$480 - \$513 \\ &= \$7,467 \end{aligned}$$

Table 5 shows the cost of both 5,000 L and 10,000 L rainwater systems (excluding interest charges) with and without meter and manifold required. The total cost, assuming 25% of the 14,253 properties in Upper Hutt install rainwater systems, is also shown. This is compared with the average total savings from reduced water charges over 5 years.

Table 5: Upper Hutt Rainwater Tanks Cost Analysis Summary

Tank Size	Installation Cost			Total Cost 25% Properties	Total Savings over 5 years
	Tank System	Water Meter	Manifold		
5,000 L	$7,500	-	-	$27 million	$1.8 million
5,000 L	$7,500	$127	-	$27 million	$1.8 million
5,000 L	$7,500	$127	$353	$28 million	$1.8 million
10,000 L	$10,000	-	-	$36 million	$1.9 million
10,000 L	$10,000	$127	-	$36 million	$1.9 million
10,000 L	$10,000	$127	$353	$37 million	$1.9 million
AVERAGE				**$32 million**	**$1.87 million**

5.0 OTHER ISSUES

5.1 STORMWATER ATTENUATION

There is a possibility that the rainwater tanks could also function as a stormwater tank. However the purpose for having a stormwater tank is that it is empty at the start of a storm event so that it can contain the rush of water and release it slowly. Whereas a water supply tank gradually collects water and retains it until it is needed. It is likely that a rainwater tank would be full at the start of a storm event. Additionally, for rainwater tanks to operate effectively as a stormwater control device in an urban environment, stormwater tanks should be implemented as part of an integrated catchment management plan.

5.2 EMERGENCY SUPPLY

In the event of an emergency, such as an earthquake, where all the water lines are disconnected, then a rainwater tank would prove very effective in assuring that a water supply is available. Whilst at full demand a 5,000 litre tank would provide only 22 man days of supply, it is likely that in this event that consumers would naturally ration water usage. Rainwater tanks can provide an effective emergency supply in the event of a civil defence emergency.

5.3 AVAILABLE SPACE

A major issue in an urban environment is space. Many sections currently being sold have areas less than 500m². With 200m² houses built on 400m² sections, this leaves minimal room to fit a rainwater tank, which can have a diameter in excess of 2.5 m. Options such as under deck tanks, below ground tanks or under eave tanks save a lot of space but come with much more difficult (and expensive) installations. To install a tank under an existing deck the deck would have to be demolished prior to installing the tank and rebuilt after. For installing a tank below ground, a large hole would need to be excavated in order to fit the tank. Having a tank under the eaves of a house would greatly decrease the natural light entering through the windows. On steep sections the installation of rainwater tanks can be difficult and costly. Implementation of rainwater tanks needs to consider the available space.

5.4 EFFECTIVE ROOF AREAS

This report calculates values based on the fact that all the rain landing on the roof area is being transferred into one tank. In reality this would be very difficult. On existing houses, there would have to be extensive changes to the existing gutter system to redirect all the rainwater into one tank. On new houses, it would be a significant design point on which to focus, in order to direct all the rainwater into one tank.

6.0 SUMMARY

Through analysis of the 9 runs of the model for the two tank sizes and two years of data, the following conclusions can be drawn for Upper Hutt:

- The total yearly demand for flushing and outdoor usage is 51,603 L, 77,405 L and 103,207 L for a 2, 3 and 4 person household respectively.
- The maximum yearly saving which can be found through using rainwater for outdoor use and toilet flushing is $72.76, $109.14 and $145.52 for a 2, 3 and 4 person house respectively using a 10,000L rainwater tank.
- The average saving found from rainwater tank use is approximately $102.62/year for a 5,000 L tank system and $107.71/year for a 10,000 L tank system.
- With a minimum installation cost of $7,500 for a 5,000 L rainwater tank system, the minimum interest charged will be $525 per annum. As the interest is significantly higher than the maximum achievable savings of $135.34 for a 5,000 L tank, the tank system will never pay for itself through reduced water charges.

- With 14,253 properties in Upper Hutt and an assumed engagement of 25% of householders, approximately 3,563 rainwater tanks would be installed. The total cost less savings over a 5 year period would be approximately $30 million.

7.0 LIMITATIONS

7.1 GENERAL

This report is for the use by Greater Wellington Regional Council only, and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

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APPENDIX 1

Upper Hutt City Rainfall Data

UHCC Akatarawa Average Year	
Time	Rainfall
1/07/1998	0
2/07/1998	48.7
3/07/1998	67.1
4/07/1998	1.5
5/07/1998	0
6/07/1998	0.5
7/07/1998	0
8/07/1998	1.5
9/07/1998	14.3
10/07/1998	50.7
11/07/1998	10.8
12/07/1998	22
13/07/1998	17.4
14/07/1998	0
15/07/1998	0
16/07/1998	1.5
17/07/1998	2
18/07/1998	2
19/07/1998	0
20/07/1998	0
21/07/1998	0
22/07/1998	2.6
23/07/1998	22.5
24/07/1998	16.9
25/07/1998	0
26/07/1998	0
27/07/1998	0
28/07/1998	0
29/07/1998	0.5
30/07/1998	11.7
31/07/1998	49.3
1/08/1998	1.1
2/08/1998	9.5
3/08/1998	1.1
4/08/1998	0
5/08/1998	0
6/08/1998	0
7/08/1998	5.8
8/08/1998	13.8
9/08/1998	0
10/08/1998	0
11/08/1998	0.5
12/08/1998	9.5
13/08/1998	13.8
14/08/1998	1.6
15/08/1998	2.6
16/08/1998	0
17/08/1998	4.2
18/08/1998	0

UHCC Akatarawa Dry Year	
Time	Rainfall
1/07/2006	0
2/07/2006	0
3/07/2006	0
4/07/2006	0
5/07/2006	17.5
6/07/2006	49.5
7/07/2006	62.5
8/07/2006	11
9/07/2006	0
10/07/2006	0
11/07/2006	0.5
12/07/2006	14
13/07/2006	26
14/07/2006	0
15/07/2006	15.5
16/07/2006	18.5
17/07/2006	3.5
18/07/2006	0
19/07/2006	0
20/07/2006	6
21/07/2006	57
22/07/2006	6.5
23/07/2006	1
24/07/2006	0
25/07/2006	0
26/07/2006	0
27/07/2006	0
28/07/2006	0
29/07/2006	0
30/07/2006	0
31/07/2006	6
1/08/2006	0.5
2/08/2006	0.5
3/08/2006	18
4/08/2006	29
5/08/2006	1
6/08/2006	0
7/08/2006	18
8/08/2006	12.5
9/08/2006	10.5
10/08/2006	3
11/08/2006	0
12/08/2006	0
13/08/2006	1.5
14/08/2006	0
15/08/2006	16.5
16/08/2006	4
17/08/2006	0
18/08/2006	0

UHCC Akatarawa Average Year	
Time	Rainfall
19/08/1998	0.5
20/08/1998	0.5
21/08/1998	3.2
22/08/1998	0.5
23/08/1998	0
24/08/1998	0
25/08/1998	1.1
26/08/1998	18.5
27/08/1998	0.5
28/08/1998	10.1
29/08/1998	0
30/08/1998	0
31/08/1998	3.2
1/09/1998	0
2/09/1998	0.5
3/09/1998	0.5
4/09/1998	32.3
5/09/1998	1.6
6/09/1998	0
7/09/1998	32.3
8/09/1998	0.5
9/09/1998	0
10/09/1998	0
11/09/1998	0
12/09/1998	0
13/09/1998	0
14/09/1998	0
15/09/1998	0
16/09/1998	24.2
17/09/1998	34.1
18/09/1998	6.6
19/09/1998	16.5
20/09/1998	0
21/09/1998	0
22/09/1998	6.6
23/09/1998	0
24/09/1998	0
25/09/1998	0
26/09/1998	0
27/09/1998	0
28/09/1998	8.2
29/09/1998	0.5
30/09/1998	0
1/10/1998	0
2/10/1998	6.6
3/10/1998	5.5
4/10/1998	0
5/10/1998	1.1
6/10/1998	0

UHCC Akatarawa Dry Year	
Time	Rainfall
19/08/2006	0
20/08/2006	4
21/08/2006	1.5
22/08/2006	8.5
23/08/2006	3
24/08/2006	0
25/08/2006	1.5
26/08/2006	3.5
27/08/2006	111
28/08/2006	0
29/08/2006	0
30/08/2006	0
31/08/2006	0
1/09/2006	0
2/09/2006	0
3/09/2006	0.5
4/09/2006	0.5
5/09/2006	16
6/09/2006	1.5
7/09/2006	15.5
8/09/2006	0.5
9/09/2006	0.5
10/09/2006	0
11/09/2006	0
12/09/2006	0
13/09/2006	0
14/09/2006	0.5
15/09/2006	0
16/09/2006	0
17/09/2006	0
18/09/2006	0
19/09/2006	0
20/09/2006	13
21/09/2006	0
22/09/2006	1
23/09/2006	6
24/09/2006	0
25/09/2006	0
26/09/2006	0
27/09/2006	6
28/09/2006	8
29/09/2006	3
30/09/2006	2.5
1/10/2006	4
2/10/2006	1.5
3/10/2006	15
4/10/2006	4.5
5/10/2006	11
6/10/2006	4.5

UHCC Akatarawa Average Year	
Time	Rainfall
7/10/1998	0
8/10/1998	0
9/10/1998	13.7
10/10/1998	36.8
11/10/1998	39.6
12/10/1998	8.2
13/10/1998	13.7
14/10/1998	33.5
15/10/1998	0
16/10/1998	23
17/10/1998	2
18/10/1998	1
19/10/1998	0
20/10/1998	38.5
21/10/1998	85
22/10/1998	28
23/10/1998	0
24/10/1998	0
25/10/1998	0
26/10/1998	0
27/10/1998	0
28/10/1998	47.5
29/10/1998	107
30/10/1998	16.5
31/10/1998	1.5
1/11/1998	0
2/11/1998	0
3/11/1998	2
4/11/1998	18.5
5/11/1998	6
6/11/1998	0
7/11/1998	0
8/11/1998	0
9/11/1998	0
10/11/1998	0
11/11/1998	0
12/11/1998	0
13/11/1998	0
14/11/1998	0
15/11/1998	0
16/11/1998	0
17/11/1998	0
18/11/1998	0
19/11/1998	0
20/11/1998	0
21/11/1998	0
22/11/1998	0
23/11/1998	0
24/11/1998	0

UHCC Akatarawa Dry Year	
Time	Rainfall
7/10/2006	1.5
8/10/2006	0
9/10/2006	0
10/10/2006	18.5
11/10/2006	2
12/10/2006	0
13/10/2006	0
14/10/2006	1
15/10/2006	3
16/10/2006	4.5
17/10/2006	6
18/10/2006	4.5
19/10/2006	0
20/10/2006	15.5
21/10/2006	0.5
22/10/2006	0.5
23/10/2006	31.5
24/10/2006	16.5
25/10/2006	29
26/10/2006	1
27/10/2006	0
28/10/2006	8
29/10/2006	0
30/10/2006	53
31/10/2006	9.5
1/11/2006	0
2/11/2006	0.5
3/11/2006	0
4/11/2006	0
5/11/2006	0
6/11/2006	0
7/11/2006	0
8/11/2006	0
9/11/2006	6
10/11/2006	11
11/11/2006	0
12/11/2006	5.5
13/11/2006	7.5
14/11/2006	2
15/11/2006	22.5
16/11/2006	20
17/11/2006	20.5
18/11/2006	87
19/11/2006	39.5
20/11/2006	7.5
21/11/2006	0
22/11/2006	0
23/11/2006	0
24/11/2006	6.5

UHCC Akatarawa Average Year	
Time	Rainfall
25/11/1998	5.1
26/11/1998	16.4
27/11/1998	1.1
28/11/1998	0
29/11/1998	0
30/11/1998	4.8
1/12/1998	9.5
2/12/1998	0.5
3/12/1998	2.1
4/12/1998	0
5/12/1998	15.9
6/12/1998	1.6
7/12/1998	2.6
8/12/1998	2.1
9/12/1998	1.6
10/12/1998	0
11/12/1998	0
12/12/1998	0
13/12/1998	0
14/12/1998	0
15/12/1998	4.2
16/12/1998	0
17/12/1998	0
18/12/1998	0
19/12/1998	12.7
20/12/1998	33.9
21/12/1998	0
22/12/1998	2.1
23/12/1998	1.6
24/12/1998	0
25/12/1998	0
26/12/1998	0
27/12/1998	0
28/12/1998	0
29/12/1998	0
30/12/1998	0
31/12/1998	0
1/01/1999	0
2/01/1999	0
3/01/1999	0
4/01/1999	0
5/01/1999	0
6/01/1999	0
7/01/1999	0
8/01/1999	0
9/01/1999	0.5
10/01/1999	0
11/01/1999	0
12/01/1999	0

UHCC Akatarawa Dry Year	
Time	Rainfall
25/11/2006	19
26/11/2006	0
27/11/2006	14
28/11/2006	3.5
29/11/2006	0
30/11/2006	0
1/12/2006	48.5
2/12/2006	0.5
3/12/2006	0
4/12/2006	0
5/12/2006	1.5
6/12/2006	0
7/12/2006	0
8/12/2006	0
9/12/2006	34.5
10/12/2006	3.5
11/12/2006	1
12/12/2006	0
13/12/2006	0
14/12/2006	7.5
15/12/2006	0
16/12/2006	0
17/12/2006	0
18/12/2006	27.5
19/12/2006	0
20/12/2006	0.5
21/12/2006	23
22/12/2006	2
23/12/2006	2
24/12/2006	0
25/12/2006	0.5
26/12/2006	0.5
27/12/2006	0
28/12/2006	8
29/12/2006	5
30/12/2006	0
31/12/2006	11
1/01/2007	0.5
2/01/2007	1
3/01/2007	5.5
4/01/2007	0
5/01/2007	0
6/01/2007	0
7/01/2007	0
8/01/2007	0
9/01/2007	0
10/01/2007	1.5
11/01/2007	14
12/01/2007	0

UHCC Akatarawa Average Year	
Time	Rainfall
13/01/1999	0
14/01/1999	0
15/01/1999	47.6
16/01/1999	23.3
17/01/1999	0
18/01/1999	3.7
19/01/1999	3.2
20/01/1999	0
21/01/1999	0
22/01/1999	0
23/01/1999	0
24/01/1999	0
25/01/1999	0
26/01/1999	0
27/01/1999	0
28/01/1999	0
29/01/1999	0
30/01/1999	0
31/01/1999	0
1/02/1999	27.5
2/02/1999	3.2
3/02/1999	0
4/02/1999	0
5/02/1999	0
6/02/1999	0
7/02/1999	0
8/02/1999	0
9/02/1999	0
10/02/1999	0
11/02/1999	0
12/02/1999	0
13/02/1999	0
14/02/1999	0
15/02/1999	0
16/02/1999	0
17/02/1999	0
18/02/1999	0
19/02/1999	0
20/02/1999	0
21/02/1999	28.8
22/02/1999	0
23/02/1999	0
24/02/1999	0
25/02/1999	0
26/02/1999	0.5
27/02/1999	12.1
28/02/1999	25.2
1/03/1999	0
2/03/1999	0

UHCC Akatarawa Dry Year	
Time	Rainfall
13/01/2007	11
14/01/2007	0
15/01/2007	8
16/01/2007	0
17/01/2007	0
18/01/2007	0
19/01/2007	0
20/01/2007	0
21/01/2007	0
22/01/2007	0
23/01/2007	0
24/01/2007	6.5
25/01/2007	0
26/01/2007	0
27/01/2007	0
28/01/2007	1
29/01/2007	12
30/01/2007	31
31/01/2007	2.5
1/02/2007	0
2/02/2007	19
3/02/2007	0
4/02/2007	0
5/02/2007	0
6/02/2007	0
7/02/2007	0
8/02/2007	0
9/02/2007	0
10/02/2007	0
11/02/2007	0
12/02/2007	0.5
13/02/2007	0
14/02/2007	0
15/02/2007	0
16/02/2007	0
17/02/2007	3
18/02/2007	0
19/02/2007	0
20/02/2007	0
21/02/2007	0
22/02/2007	0
23/02/2007	0
24/02/2007	0
25/02/2007	0
26/02/2007	0
27/02/2007	0
28/02/2007	0
1/03/2007	0
2/03/2007	0

UHCC Akatarawa Average Year		UHCC Akatarawa Dry Year	
Time	Rainfall	Time	Rainfall
3/03/1999	0	3/03/2007	0
4/03/1999	0	4/03/2007	0
5/03/1999	0	5/03/2007	0
6/03/1999	0	6/03/2007	0
7/03/1999	4.7	7/03/2007	0
8/03/1999	5.2	8/03/2007	3
9/03/1999	0	9/03/2007	0
10/03/1999	3.1	10/03/2007	0
11/03/1999	0.5	11/03/2007	0
12/03/1999	0	12/03/2007	0
13/03/1999	2.6	13/03/2007	0
14/03/1999	13.6	14/03/2007	11
15/03/1999	7.3	15/03/2007	28.5
16/03/1999	0.5	16/03/2007	0.5
17/03/1999	0	17/03/2007	0
18/03/1999	0	18/03/2007	28
19/03/1999	0	19/03/2007	14
20/03/1999	0	20/03/2007	0
21/03/1999	0	21/03/2007	0
22/03/1999	0	22/03/2007	0
23/03/1999	0	23/03/2007	0
24/03/1999	1.6	24/03/2007	0
25/03/1999	68.7	25/03/2007	0
26/03/1999	0	26/03/2007	0
27/03/1999	0	27/03/2007	0
28/03/1999	0	28/03/2007	0
29/03/1999	0	29/03/2007	0
30/03/1999	0	30/03/2007	0
31/03/1999	16.8	31/03/2007	2.5
1/04/1999	3.7	1/04/2007	7.5
2/04/1999	0	2/04/2007	0
3/04/1999	0	3/04/2007	0
4/04/1999	0	4/04/2007	0
5/04/1999	0	5/04/2007	8.5
6/04/1999	0	6/04/2007	0
7/04/1999	0	7/04/2007	0
8/04/1999	4.2	8/04/2007	0
9/04/1999	11.9	9/04/2007	0
10/04/1999	0	10/04/2007	0
11/04/1999	1	11/04/2007	0
12/04/1999	0	12/04/2007	2.5
13/04/1999	0	13/04/2007	16.5
14/04/1999	0	14/04/2007	3.5
15/04/1999	0	15/04/2007	0
16/04/1999	38.9	16/04/2007	0.5
17/04/1999	14	17/04/2007	0
18/04/1999	22.3	18/04/2007	0
19/04/1999	0	19/04/2007	0.5
20/04/1999	0	20/04/2007	0

UHCC Akatarawa Average Year	
Time	Rainfall
21/04/1999	0
22/04/1999	0
23/04/1999	0
24/04/1999	0
25/04/1999	4.2
26/04/1999	1
27/04/1999	0
28/04/1999	0
29/04/1999	0
30/04/1999	0
1/05/1999	0
2/05/1999	1
3/05/1999	6.2
4/05/1999	6.2
5/05/1999	1.6
6/05/1999	13
7/05/1999	25.4
8/05/1999	3.1
9/05/1999	0
10/05/1999	0
11/05/1999	0
12/05/1999	0
13/05/1999	0
14/05/1999	0
15/05/1999	0
16/05/1999	0
17/05/1999	12.5
18/05/1999	0.5
19/05/1999	0
20/05/1999	0
21/05/1999	0
22/05/1999	0
23/05/1999	0
24/05/1999	0
25/05/1999	0
26/05/1999	0
27/05/1999	22.5
28/05/1999	32.5
29/05/1999	49.5
30/05/1999	0
31/05/1999	18.5
1/06/1999	0
2/06/1999	2.5
3/06/1999	15.5
4/06/1999	0
5/06/1999	3.5
6/06/1999	0
7/06/1999	0
8/06/1999	0

UHCC Akatarawa Dry Year	
Time	Rainfall
21/04/2007	0
22/04/2007	0
23/04/2007	0
24/04/2007	0
25/04/2007	0
26/04/2007	0
27/04/2007	0
28/04/2007	1
29/04/2007	9.5
30/04/2007	0.5
1/05/2007	5.5
2/05/2007	3
3/05/2007	20.5
4/05/2007	5
5/05/2007	0
6/05/2007	0
7/05/2007	0
8/05/2007	6
9/05/2007	0
10/05/2007	0
11/05/2007	19
12/05/2007	4
13/05/2007	0
14/05/2007	0
15/05/2007	0
16/05/2007	0
17/05/2007	0
18/05/2007	0
19/05/2007	0
20/05/2007	0
21/05/2007	0.5
22/05/2007	22
23/05/2007	0
24/05/2007	5.5
25/05/2007	0
26/05/2007	0
27/05/2007	0
28/05/2007	0
29/05/2007	0
30/05/2007	0
31/05/2007	0
1/06/2007	0
2/06/2007	9.5
3/06/2007	21
4/06/2007	0
5/06/2007	0
6/06/2007	0
7/06/2007	0
8/06/2007	0

UHCC Akatarawa Average Year	
Time	Rainfall
9/06/1999	7
10/06/1999	8.5
11/06/1999	0
12/06/1999	0
13/06/1999	0.5
14/06/1999	6.5
15/06/1999	8
16/06/1999	29.8
17/06/1999	15.2
18/06/1999	8.4
19/06/1999	0
20/06/1999	0.5
21/06/1999	0
22/06/1999	2.1
23/06/1999	0.5
24/06/1999	0
25/06/1999	0
26/06/1999	0
27/06/1999	0.5
28/06/1999	1.1
29/06/1999	1.1
30/06/1999	0

UHCC Akatarawa Dry Year	
Time	Rainfall
9/06/2007	0
10/06/2007	0
11/06/2007	0
12/06/2007	1
13/06/2007	0
14/06/2007	0
15/06/2007	0
16/06/2007	0.5
17/06/2007	1.5
18/06/2007	2
19/06/2007	0
20/06/2007	0
21/06/2007	5
22/06/2007	12.5
23/06/2007	7
24/06/2007	0
25/06/2007	0
26/06/2007	3.5
27/06/2007	1
28/06/2007	0.5
29/06/2007	0
30/06/2007	1

APPENDIX 2

AJ Withrington Plumbers Ltd
Water Tank System Installation Quote

A J Withrington Plumbers Limited

P O Box 635
Warkworth

Phone: 09-425-8413
Mobile: 021-735-206
Fax: 09-425-9783
AJW.PLUMBERS@xtra.co.nz

Fax

To:	Iain Rabbits	**From:**	Tony Withrington
Fax	09-917-5001	**Pages:**	3
Phone:		**Date:**	16 April 2007
Re:	Estimated costings re water tanks	**CC:**	

☐ **Urgent** x **For Review** ☐ **Please Comment** ☐ **Please Reply** ☐ **Please Recycle**

Iain – to follow costings as discussed.

Regards

Tony Withrington

A J Withrington Plumbers Limited

P O Box 635
Warkworth

Phone: 09-425-8413
Mobile: 021-735-206
Fax: 09-425-9783
AJW.PLUMBERS@xtra.co.nz

16 April 2007

Harrison Grierson Consultants Ltd
P O Box 5760
Wellesley St
Auckland

Attn: Iain Rabbitts – Senior Process Engineer

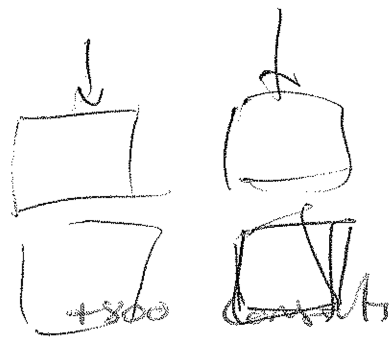
Dear Iain

Re: Estimated costings for rainwater installations – as instructed

First installation for garden irrigation

To supply and fit:

- D1000 (4500L) water tank
- Tank base/crushed fines (metal)
- First Flush diverter
- Strainer on pump
- PFI-30 pressure pump (electric)
- Associated valves and fittings
- Excavation of tank
- No electrical allowance



Estimated cost $3,667.35 excluding GST

Second installation for garden irrigation and toilet use

To supply and fit:

- D1000 (4500L) water tank
- Tank base/crushed fines (metal)
- First Flush diverter
- Strainer on pump
- PFI-30 pressure pump (electric)
- Associated valves and fittings
- Excavation of tank
- No electrical allowance
- Reinstatement of walls – estimated $500.00 excluding GST included in price below

+800 Contents

Estimated cost $6,327.35 excluding GST

A J Withrington Plumbers Limited

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Third installation for entire house usage

To supply & fit:

- D5500 (25000L) water tank
- Tank base/crushed fines (metal)
- First Flush diverter
- Leave diverter
- Strainer on pump
- Associated valves and fittings
- CH2-40PC pressure pump (suit average house 1 x bathroom, 1 x ensuite)
- Filters and UV
- No electrical allowance

Estimated cost $11,016.13 excluding GST

Note: All material prices included in each costing are retail figures. Labour costings on installation 1 is based on one days labour for two men – approx $900-$1000 excluding GST.

Installation 2 labour costing is based on 1.5 days for two men – approx $2800-$2900 excluding GST.

Installation 3 labour costing is based on two full days for two men – approx $3800-$3900 excluding GST.

On installation 3 it would be near impossible to cost out the gathering of d/pipes to be diverted into the bigger 25000L water tank which would be required for entire household usage due to different house designs (dug under d/ways, footpaths, under decks etc and more than three d/pipes). If I had to estimate this based on a three bedroom house with up to three d/pipes and a reasonable accessible location and dug to tank, an additional cost of $1500-$2000 excluding GST would be reasonable.

Each job and all of these prices might vary due to location of d/pipes, land gradients, accessibility of services etc, so I would take these costings as a reasonable indicative average cost per household unit based on current material costings and labour rates.

I hope this is helpful to you. Please do not hesitate to contact me to discuss this matter further.

Yours faithfully

A J Withrington