Chapter 11
Rainwater tanks
design, construction and maintenance

11.1 Introduction

Rainwater tanks are primarily water quantity management devices. There are minor water quality benefits, depending on the amount of atmospheric deposition in a given area, but their primary function is for quantity management and to supply on-site water use.

Rainwater tanks are not a stand alone solution for quality and quantity issues in a catchment, but they can be implemented as a part of an integrated approach for reducing:

> stormwater volumes entering the receiving waters, through the use of stormwater captured and used on-site
> flows into downstream stormwater treatment practices or if roof runoff is separated from ground runoff
> peak stormwater flows from the sub-catchment by providing permanent or temporary storage
> sanitary sewer overflows by reducing the rates and volumes of stormwater that enters directly or indirectly into sanitary sewers
> roof-generated contaminants entering water bodies
> demand from mains water supply leading to more effective use of water resources,

Peak runoff reduction is limited to any sub-catchment for which tanks are specifically designed. Depending on the rate of slow release and their relative position in a catchment, all devices that store and release stormwater at a slower rate from a selected sub-catchment.have the potential to increase the peak flow rate further downstream.

A catchment-wide approach is essential to verify the effects of flow retarding devices in a sub-catchment (on downstream catchment areas). This is particularly important for catchments with existing and potential downstream flooding issues.

Rainwater tanks have been in use for centuries for supplying household and agricultural water. With the emergence of high quality, low cost community water supply systems, rainwater tank systems became limited to non-urban areas. In recent years, however, there has been a greater interest in rainwater harvesting in urban areas with wider recognition of their environmental and infrastructural benefits.

These guidelines deal only with non-potable use of rainwater.

Plate 11-1: Rainwater tank on a residential property

If potable use of rainwater is intended, several health and safety related issues are involved, including treating and disinfecting the rainwater to appropriate water standards and avoiding cross connections. Professional advice is required for this.

11.2 Limitations of tanks for stormwater quantity management

As with all stormwater practices, rainwater tanks have some limitations in some situations. Their primary limitations relate to their effectiveness for water quantity management, although they have some water quality applications.

The current perception is that roof runoff is relatively clean. Historic approaches have tended to treat runoff from impervious surfaces other than roofs, allowing roof runoff to bypassing treatment systems. Future research will provide better information on roof runoff, but water quality limitations on tank water use cannot be established until there is more information on the need for roof runoff treatment.

What is clear is that particulates from roof runoff are extremely small and sedimentation may not be an effective removal process. Use of roof runoff for domestic non-potable use will reduce contaminant discharge into receiving waters because whatever contaminants are present, some of the runoff will enter wastewater treatment systems or be discharged on to permeable surfaces such as lawn or garden.

This chapter discusses the water quantity benefits of roof water tanks. It does not promote the blanket use of water tanks throughout a catchment, because the timing of storm flows through the catchment when the tanks are primarily used as detention tanks may result in potential increases downstream. A catchment-wide analysis of the sensitivity of timing may need to be done in some catchments but general guidelines may also provide assistance in the absence of a catchment plan.

This chapter allows the roof area to compensate, from a water quantity perspective, for other small impervious surfaces. Roof areas cannot compensate for too many additional impervious surfaces.

The issue is further complicated by household water use. Using roof water for partial water supply (i.e.. non-potable water uses such as laundry and toilet) reduces the total volume of runoff that may be discharged during a storm event compared with use for total water supply (both non-potable and potable water uses), because tanks are more likely to be emptier at the start of a storm. .

Water tank limitations for water quantity management include:

> the catchment time of concentration to the point where the water tank discharges to the receiving system cannot exceed 20 minutes

> tanks cannot compensate forother impervious areas exceeding 120 m^2

> flows from water tanks will bypass downstream treatment systems

> where there are documented downstream flooding problems, only partial credit should be given to use of water tanks, as follows:

- partial use systems (approximately 300 l/day) will receive a credit for up to 150 square metres of impervious surfaces, including roof areas
- full use systems (potable and non-potable - approximately 500-600 l/day) will receive a credit for up to 250 square metres of impervious surfaces (including roof areas)

11.3 Performance

11.3.1 Water quality credit through water use

When tank water is used for non-potable purposes, the contaminants in roof runoff are redirected to sanitary sewers and planted areas, accordingly reducing the load entering receiving environments. The percentage contaminant reduction depends on the percentage of water captured for use.

Reduced runoff volumes may also decrease stream channel erosion, conferring additional water quality benefits (Tremain 2001). These additional channel erosion water quality benefits have not been quantified or included in the water quality credit given in this chapter.

Table 11-1 compares typical roof runoff contaminant concentrations with the relevant water quality guidelines for protection of aquatic ecosystems.

Table 11-1
Typical roof runoff quality

Parameter	Typical levels in roof runoff	Water quality guidelines	Reference
pH	6.7	6.5 – 9.0	ANZECC 1992
Suspended solids (g/m^3)	29	-	-
Cadmium (mg/m^3)	0.26	2.2*	USEPA 1999
Copper (mg/m^3)	25	9.0*	USEPA 1999
Lead (mg/m^3)	17.6	2.5*	USEPA 1999
Zinc (mg/m^3)	315	120*	USEPA 1999
Faecal coliforms (cfu/100mL)	2	200	DoH 1992
Enterococci (cfu/100mL)	15	35	MoH 1999

* at hardness of 100 g/m^3

Source Gadd et al (2001)

It is very difficult to quantify water quality benefits of roof runoff capture as contaminant vary according to geography and roofing materials. Any benefits will largely depend on whether water is used for on-site purposes or whether the tank functions primarily as a peak control device.

Airborne sediments deposited on roofs are extremely small, and will not settle out in the tank.

If the tank is used for on-site water use, the actual reduction in contaminant loading will also depend on the percentage of time during the year that the tank is full when a rainfall event occurred. If the tank is full at the start of a rainfall event then none of the rainfall event will be stored (and later used) and hence will confer little water quality benefit. The number of days the tank is full at the start of a rain event is a function of the antecedent rainfall, roof area, tank size and water use.

11.3.2 Water quality credit

For the purposes of estimating the water quality benefits from rainwater tanks, a water quality credit is calculated based on the percentage of water used multiplied by a water quality factor. The percentage of water used is based on Table 11-2 and the water quality factor is taken as 0.75. The water quality factor of 0.75 takes into account the number of rain days that the tank is full at the start of a rainfall event. The water quality credit is not given for other impervious surfaces for which a quantity credit is given. Runoff from non-roof areas must be treated.

Model runs using long-term (up to 20 years) daily rainfall records indicate that the percentage of rain days a tank is full varies from 15% to 35% for a typical range of roof areas and water use rates. The average tank full days is approximately 25%, so the water quality factor of 0.75 has been taken as a value for the Auckland Region.

11.3.3 Peak flow and extended detention attenuation

The degree of peak flow attenuation that can be achieved depends on the roof area, other impervious areas, storm characteristics, tank size and outlet orifice size. Note that the tank can control runoff from the roof catchment area only. If there is an increase in other impervious areas, such as footpaths and paving areas, the roof catchment area needs to be proportionately big enough to compensate for the runoff from those areas. Once paved areas exceed 30% - 60% of the roof area, the incremental increase in roof runoff attenuation storage volumes becomes limted. This contributes to the rationale for the 120 m^2 limitation on non-roof impervious areas.

Rainwater tanks can be designed to perform the following functions (refer Figure 11-1 for commonly used components of a rainwater tank):

- > non-potable water use, with a consequent benefit of quality improvement by reducing contaminant load into receiving waters. This requires long-term storage in the tank supplying the demand points (e.g. toilet flush, garden tap, laundry) either by gravity or via a small pump
- > peak flow attenuation, which requires temporary storage emptied through an orifice that is sized to limit the tank outflow rate to an approved maximum rate. This manual does not encourage providing a rainwater tank solely for the purpose of flow attenuation without a quality improvement component. However, territorial au-

Table 11-2
Percent water capture

150 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Captured from Roof					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	15%	25%	25%	30%	30%	30%
225	20%	35%	45%	45%	50%	50%
325	25%	40%	55%	60%	65%	72%
500	35%	50%	65%	70%	80%	100%
600	40%	50%	70%	75%	95%	100%
1000	45%	55%	75%	80%	100%	100%

200 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Captured from Roof					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	10%	20%	20%	20%	20%	20%
225	20%	25%	35%	35%	35%	35%
325	20%	30%	40%	45%	50%	55%
500	30%	40%	55%	60%	70%	80%
600	30%	45%	60%	65%	75%	85%
1000	35%	45%	65%	70%	80%	90%

250 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Captured from Roof					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	10%	15%	20%	20%	20%	20%
225	10%	20%	30%	30%	30%	30%
325	15%	25%	35%	40%	40%	45%
500	25%	35%	45%	50%	60%	65%
600	35%	40%	50%	55%	65%	80%
1000	40%	40%	55%	60%	70%	85%

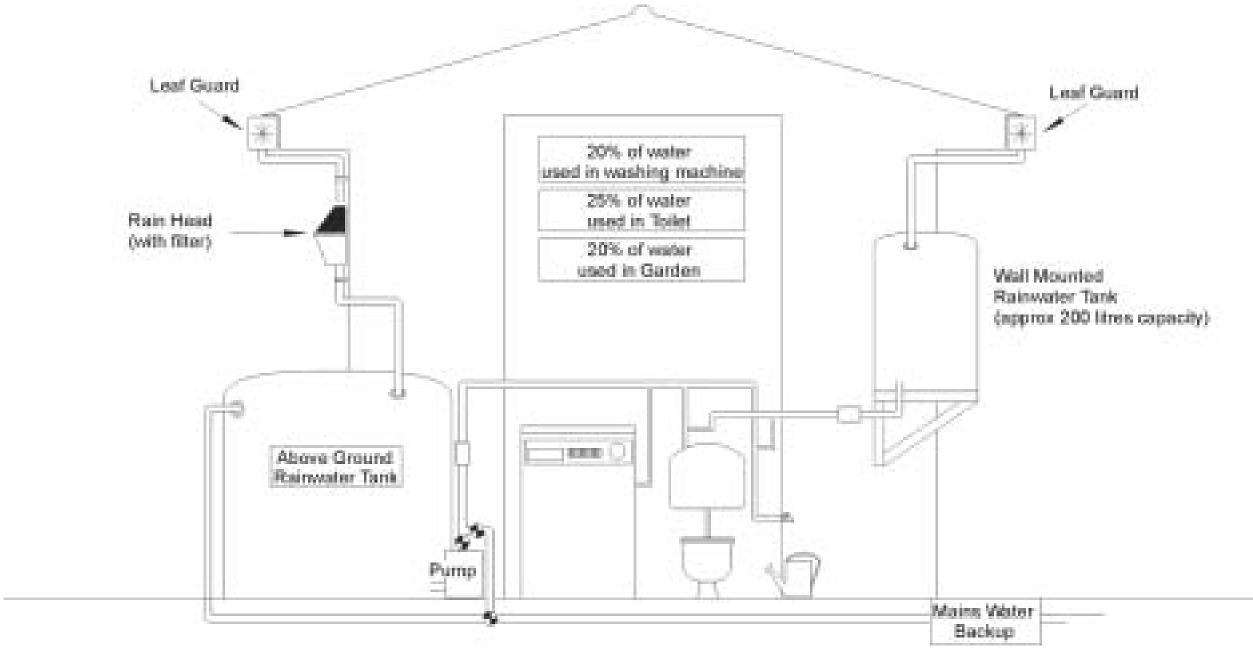
300 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Captured from Roof					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	10%	10%	15%	15%	15%	15%
225	10%	20%	25%	25%	25%	25%
325	15%	20%	30%	35%	35%	35%
500	20%	30%	40%	45%	50%	55%
600	25%	30%	45%	50%	55%	65%
1000	30%	35%	50%	55%	55%	70%

500 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Captured from Roof					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	5%	5%	5%	5%	5%	5%
225	5%	10%	10%	10%	15%	15%
325	10%	15%	15%	20%	20%	20%
500	10%	15%	15%	20%	25%	30%
600	15%	20%	25%	30%	35%	40%
1000	20%	25%	35%	40%	50%	60%

Figure 11-1
Commonly used components of a water tank



thorities may allow or require such tanks in order to manage existing stormwater network capacity

> combined water use and peak flow attenuation, which require long-term storage capacity in the lower part of tank and a temporary storage capacity in the upper part of the tank

For peak discharge control:

> in areas with stormwater reticulation, select 1 in 10 year 24 hour storm as defined by TP 108. This Annual Recurrence Interval (ARI) is chosen for reticulated systems because the infrastructure management objective in this case is to manage stormwater within the existing system capacity, and the majority of the existing systems in the region were designed for 1 in 10 year stormwater service level.

> in areas with no stormwater reticulation, select 1 in 2 year 24 hour storm as defined by TP 108. This ARI is chosen to control intermediate sized storms.

For downstream channel protection:

> Partial credit for control and release of 34.5 mm of rainfall over a 24 hour period is provided by using both of the following equations.

Volume adjustment = 0.5 (storage tank size (m^3))
Volume adjustment = 7.5 (daily use (m^3))

Use the smaller of the two calculated volumes for the volume credit

The individual volume calculated for each roof is then summed to obtain the total rain tank volume credit for all of the houses on the site. This volume is then subtracted from the total site extended detention volume requirement to calculate the storage volume needed.

The temporary storage for 2 year ARI is generally larger than that for 10 year ARI, for two reasons:

> the outlet orifice of the former is smaller

> the percentage increase of peak from pre-developed to developed is greater for 2 year event than for 10 year event (ARC, 2000)

11.4 Design approach

11.4.1 Objectives

Rainwater tanks should be designed to achieve the following objectives:

> a percentage rainwater capture through water use agreed with the TA or the ARC, as appropriate. The percentage water capture depends on several variables including:

- catchment roof area
- water use rate
- tank capacity
- long-term rainfall characteristics of the area

> temporary runoff storage of a target level should be agreed with the TA or the ARC, as appropriate. The level of required storage depends on several variables including:

- impervious areas,
- tank capacity, and
- storm characteristics of the area.

The default value is either 1 in 10 year ARI or 1 in 2 year ARI for the selected sub-catchment (e.g. a property, a subdivision), depending on whether it is served by a reticulated or stream system.

11.4.2 Applicability

Rainwater tanks can be used in residential, commercial and industrial developments. The applications include the following:

> with water use, to treat roof runoff and accordingly reduce the size of the downstream treatment devices. In this case, the roof runoff, after storage in the tank system, would enter the receiving waters separately, while the ground runoff would be routed via the downstream treatment practice. Examples include industrial or commercial sites where the roofs are treated by tanks while parking areas are treated by rain gardens or swales or high-density subdivisions where roofs are addressed by tanks and the rest of the area treated by wetlands

> in infill developments for managing stormwater within existing system capacity (e.g. existing 1 in 10 year capacity). There are different types of rainwater tanks to suit the available space and required volume, as shown in plate 11-2

> in conjunction with other practices, in order to work towards hydrological neutrality in order to mitigate adverse effects of a development

Plate 11-2: Different types of rainwater tanks

> as multipurpose devices to provide treatment, peak attenuation and non-potable water supply benefits. They become financially self-supporting for reasonably large non-potable water demands when coupled with adequate roof areas

This chapter covers roof areas of up to 500 m^2 and paved areas of up to 120 m^2. The 120 m^2 area is the maximum allowed additional area at this time unless a specific situation warrants an increase. Also, limitations are provided on maximum impervious areas for partial (150 m^2) or full water use (250 m^2)

11.5 Design procedure

11.5.1 Water quality credit through water use

Water quality benefits from rainwater tanks have been based on the water quality credit derived from volume reduction through using the water as a non-potable water source rather than conventional stormwater quality treatment technologies.

Step 1: Determine required percentage runoff capture

The required percentage runoff capture is a function of the required percentage water quality treatment (this should be determined in consultation with the TA or ARC). As shown in Table 11-3, if the total required treatment couldn't be achieved by the tank then a proportionate roof area should be included in the catchment area of downstream treatment devices, based on the following table.

Table 11-3
Proportionate roof area to be treated by downstream treatment devices

% Roof Runoff Captured by Tank System	% Roof Area to be included in the Catchment Area of the Downstream Treatment Devices(1)
90%	33%
75%	44%
50%	63%
40%	70%
30%	78%
20%	85%
10%	93%
0%	100%

Note (1): % Roof Area to be included is calculated based on a "water quality factor" of 0.75 (refer Performance section). For instance, if 40% of roof runoff is captured by the tank, then the water quality credit is equal to 40% times 0.75 (water quality factor) = 30%, therefore 70% (i.e. 100% - 30%) of roof area should be included in calculations for downstream devices.

Step 2: Assess non-potable water demand

If used for non-potable household uses like toilet, laundry and gardening, rainwater needs little or no treatment at all. As shown in Table 11-4, approximately 65 % of household water demand can be met from rainwater collected from roofs. Based on a total water demand of 500 l/d, an average 3-member household would be able to use 325 l/d of rainwater.

For industrial and commercial developments, it would be necessary to assess the non-potable water demand on a case by case basis. Non-potable water usage in some in-

Table 11-4
Estimated typical household water demand based on a total of 500 litres/day for a 3 member household

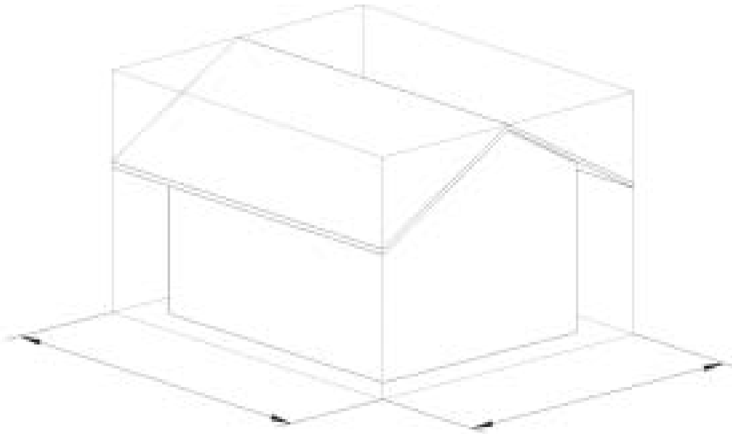
Water Use	Average litres/day
Bathroom	125
Toilet	125
Laundry	100
Gardening	100
Kitchen	50
Total	**500**

dustries and for floor and vehicle washing can be estimated from water audits, where available for similar activities, and by consulting the process engineers of the industry for which the rainwater tanks are to be designed.

Step 3: Measure roof catchment area

Roof catchment area is the plan area of the roofs that are to be drained to the tanks, for example:

Figure 11-2
Method to calculate roof catchment area



When figuring catchment area, measure at ground level below edges of the roof, including eaves

> for existing roofs, measure the plan (horizontal) area of the roof at ground level below the edges of the roof (including eaves)

> for proposed buildings this area can be calculated from the architectural plans. Figure 11-2 provides detail on calculating catchment area.

Step 4: Use design tables given in this Chapter

Use Tables 11-2 and 11-5 to determine tank size, percentage runoff capture and percentage water supplied.

These Tables were developed using a computerised model that uses long-term (up to 20 years) daily rainfall records to perform water balance analysis.

One point that must be stressed is that water use in litres/day is really "anticipated" water use as opposed to "actual".

Worked examples are given at the end of the chapter to illustrate the use of these Tables.

If percentage water supplied is estimated to be less than 100%, this means the system is unable to supply the full non-potable water demand throughout the year. Augmentation from mains water would be needed to meet the deficit. Even if the percentage water supplied is estimated to be 100%, it is recommended that mains water be available as a stand-by to counter any problems.

Step 5: Multiply by the factor for the area

For a given roof area and percentage capture, required tank size varies around the Auckland Region, reflecting variations in rainfall. Tank sizes were therefore estimated for three locations; Warkworth (northern extremity), North Shore (central) and Pukekohe (southern extremity). The variations between these three locations were < 10% and did not merit the development of separate Tables for each location. The variations were minor (≤10%), which is within the error margin of the modelling carried out to prepare the Charts. Comparisons of % water captured and % water supplied for Warkworth, Pukekohe, Henderson and the Waitakere Foothills are summarised in Figure 11-3, Comparison for 150 m^2 Roof and Figure 11-4, Comparison for 300 m^2 Roof.

<u>11.5.2</u> <u>Peak flow attenuation</u>

Step 1: Determine required ARI

> for areas where tanks overflow into reticulated stormwater systems, the 1 in 10 year rainfall is to be used

> for areas where tanks overflow to stream, the 1 in 2 year rainfall is to be used.

> Where a reticulated system drains into a stream without flow restriction prior to entry into the stream, criteria should be based on 1 in 2 year ARI.

Step 2: Measure roof catchment area and other impervious areas

The roof catchment area is measured similar to Step 3 for water quality.

The other impervious areas include roof areas that are not connected to the tank and paved areas such as driveways and carparks. Off-site impervious surfaces cannot be included.

Step 3: Use design charts given in this chapter

The next step is to use Figure 11-5 Charts 1 or 2 and Charts 3 or 4 or Charts 5 and 6 to determine tank size, outlet orifice size, and the remainder of any impervious area that would not be mitigated by the tank system.

These Charts for 2.2 m diameter and 3.4 m diameter tanks were developed using the reservoir function of the HEC-HMS Version 2.0.3 and runoff assessment guidelines contained in TP 108. Worked examples are given at the end of the Chapter to illustrate the use of these Charts.

11.5.3 Combined quality and attenuation

It is anticipated that combined quality and peak attenuation tanks would be the most preferred because they provide highest value for money in terms of environmental and water use benefits. Combined tanks also encourage regular homeowner maintenance as they are using the tanks for water supply.

Table 11-5
Percent water supplied

150 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Supplied					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	50%	80%	95%	100%	100%	100%
225	40%	65%	85%	90%	100%	100%
325	35%	50%	70%	80%	90%	100%
500	25%	40%	55%	60%	70%	75%
600	25%	35%	50%	50%	60%	60%
1000	20%	30%	35%	35%	50%	55%

200 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Supplied					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	55%	85%	95%	100%	100%	100%
225	40%	65%	85%	95%	100%	100%
325	35%	55%	75%	85%	95%	100%
500	25%	45%	60%	65%	80%	90%
600	25%	40%	50%	60%	70%	80%
1000	20%	30%	40%	40%	50%	60%

250 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Supplied					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	55%	85%	100%	100%	100%	100%
225	40%	65%	90%	95%	100%	100%
325	35%	60%	80%	85%	95%	100%
500	25%	45%	65%	70%	85%	95%
600	25%	45%	60%	65%	75%	90%
1000	20%	35%	45%	50%	60%	70%

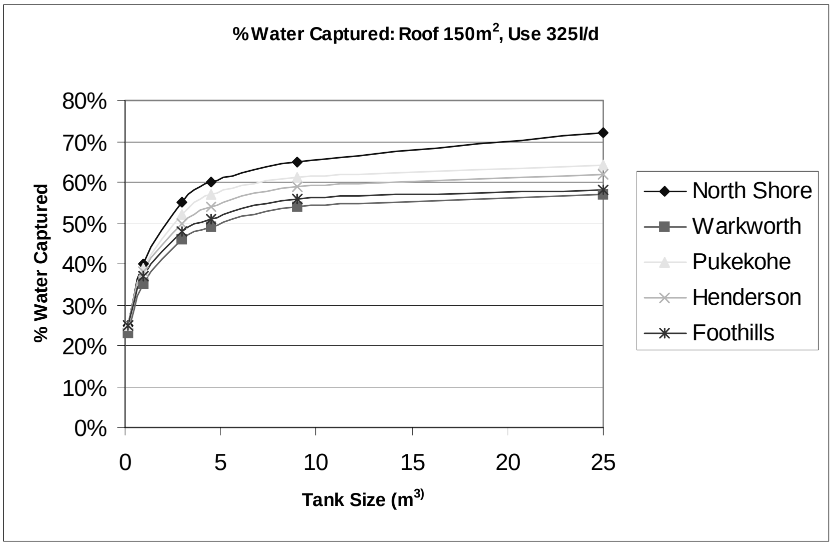
300 m^2 Roof Area

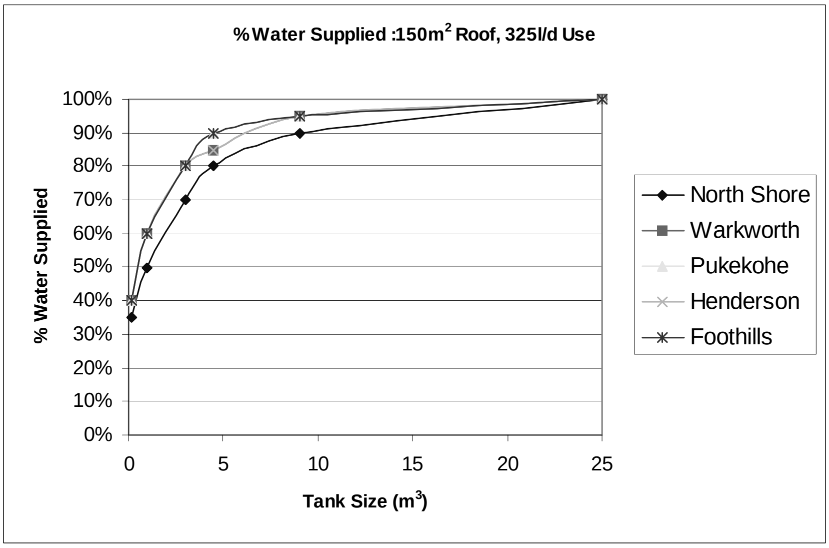
Water use in litres per day	Average Yearly % of Water Supplied					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	55%	85%	100%	100%	100%	100%
225	40%	70%	90%	95%	100%	100%
325	35%	60%	80%	90%	95%	100%
500	25%	45%	70%	75%	85%	95%
600	25%	45%	60%	70%	80%	95%
1000	20%	35%	55%	60%	65%	70%

500 m^2 Roof Area

Water use in litres per day	Average Yearly % of Water Supplied					
	Rain Tank Capacity (Litres)					
	200	1000	3000	4500	9000	25000
125	55%	85%	100%	100%	100%	100%
225	45%	85%	90%	95%	100%	100%
325	40%	75%	85%	90%	95%	100%
500	30%	55%	75%	80%	90%	95%
600	30%	45%	65%	75%	85%	95%
1000	25%	35%	55%	60%	75%	85%

Figure 11-3
Comparison for 150 m² roof





Step 1: Assess the water quality credit volume

The water quality credit volume is assessed using the methodology described in Section 11.5.1.

Step 2: Assess attenuation volume

The attenuation volume is assessed using the methodology described in Section 11.5.2.

Step 3: Assess combined volume

Combined volume is the arithmetical sum of quality and attenuation volumes.

Combined volume = Quality (water use) volume + Attenuation volume

Quality (water use) volume would occupy the lower part of the tank, which is connected via a pump or by gravity (depending on the elevation) to non-potable water demand points.

Attenuation volume should occupy the upper part of the tank, with its outlet orifice placed immediately above the quality (water use) volume.

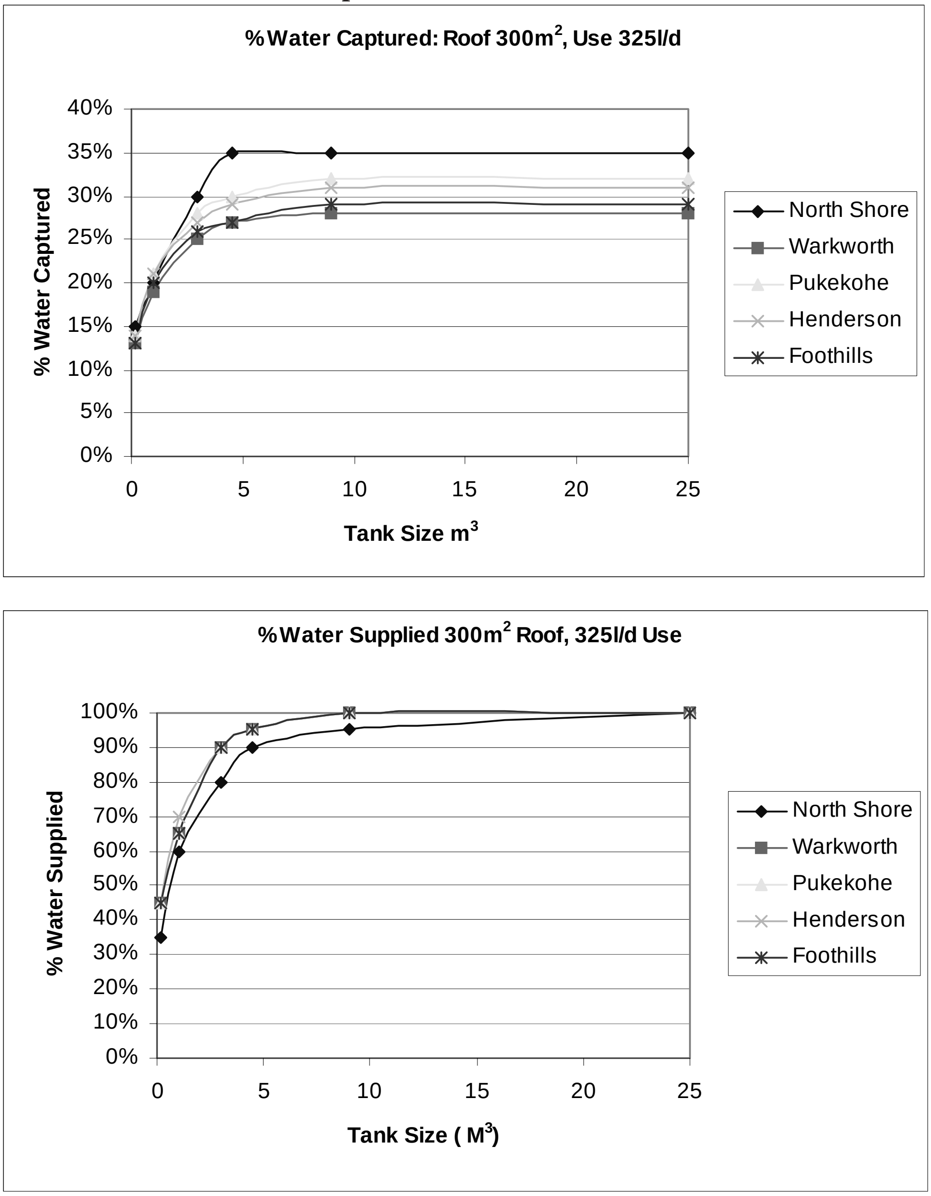
It is possible that the combined tanks would provide more benefit than estimated. For example, a higher level of attenuation may be achieved, in some instances, when the tank water level is lower than the orifice level, water use, at the start of a storm. These benefits are difficult to estimate and are therefore ignored. This does, however, ensure a conservative design.

It is also possible that the water level in the tank is higher than the orifice level when the critical storm starts, due to a previous storm or a multi-peak storm, resulting in lower than anticipated attenuation. This possibility is considered low, given that the storm pattern of TP 108 is specifically developed for the Auckland Region to represent the most critical case in terms of peak flows.

11.5.4 Aesthetics and optimum use of space

Rainwater tanks, along with other stormwater management needs, should be considered at the conceptual stage of a development project. This would enable the optimum use of space and an aesthetically co-ordinated overall design. Tanks need to be included in this in order to minimise visual intrusion and unnecessary use of space.

Figure 11-4
Comparison for 300 m² roof



There are various types of tanks for installation above or below ground or wall mounted mini tanks just under the gutter for gravity feeding demand points.

For retrofits the space for the tank and the type of the tank should be selected to minimise visual impact and space use. As in the case of new developments, major refurbishments should consider rainwater tanks at the conceptual stage.

11.5.5 Other design considerations

These include:

> roofing materials
> gutters and downspouts
> Primary screening
> Water treatment for non-potable use

Roofing materials

Metal roofing, clay tiles or slates are appropriate for quality rainwater harvesting. No lead or copper is to be used as roof flashing or as gutter solder as the slightly acidic quality of rain can dissolve the lead or copper and contaminate water supply. Composite asphalt, shingles and some painted concrete tile roofs can leach contaminants into the rainwater affecting quality, colour and taste.

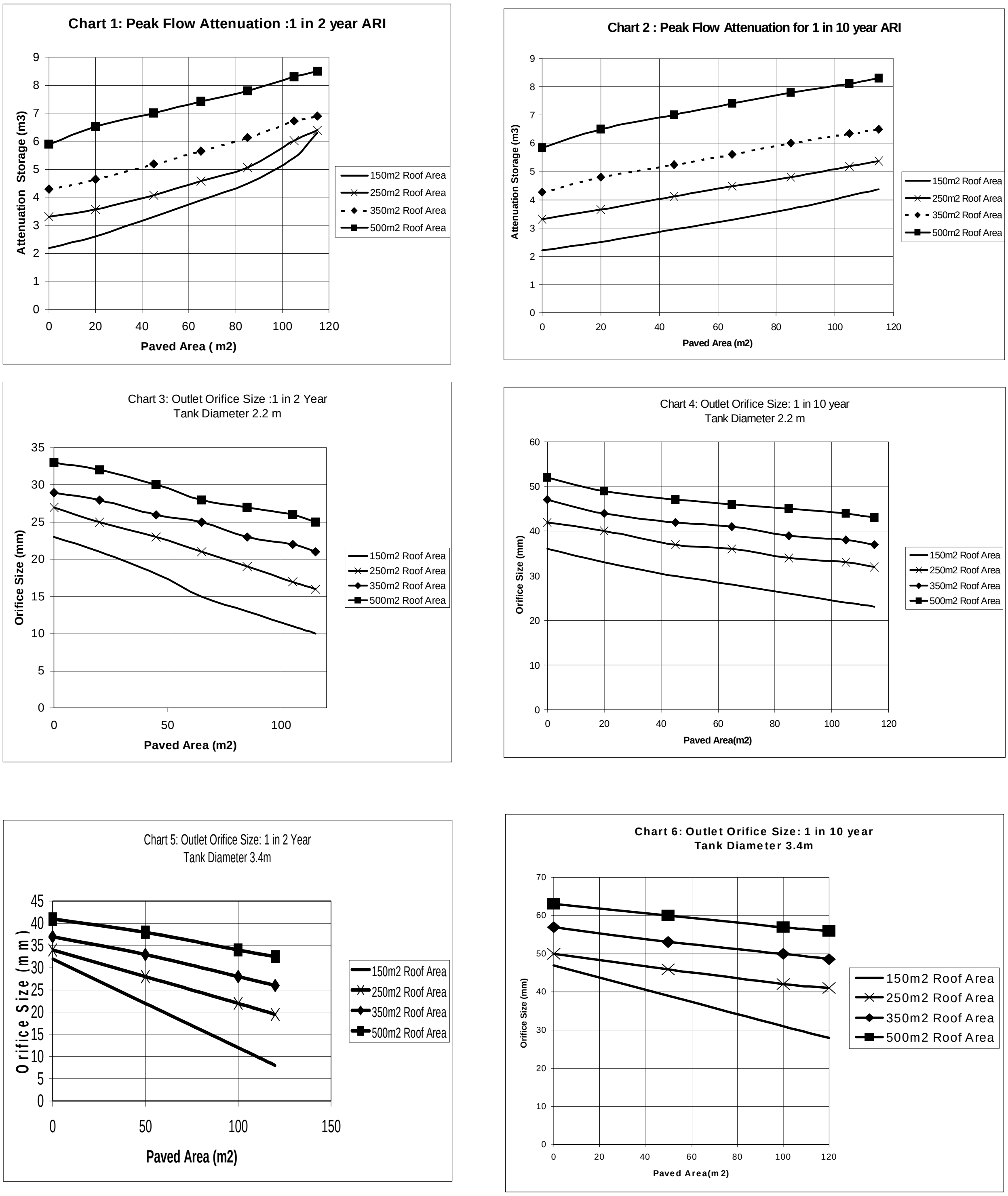
Gutters and downspouts

Seamless extruded aluminium, galvanised steel or PVC are the commonly recommended material for gutters and downspouts. The roofing and gutter material should not contain substances that impair water or are hazardous to health (e.g. asbestos, solder, lead-based paint). Gutters and downspouts must be properly sized, sloped and installed to maximise the quantity of harvested rain. The connection between the downspout and the storage tank is generally constructed of an appropriate grade of PVC pipe.

Primary screening and first flush diverters

Primary screening devices are used to prevent leaves and other debris from entering the tank. Typical primary screening devices are shown below in Figure 11-6. First flush devices are designed to divert the first part of the rainfall that picks up most of the dirt and debris away from the rain tank.

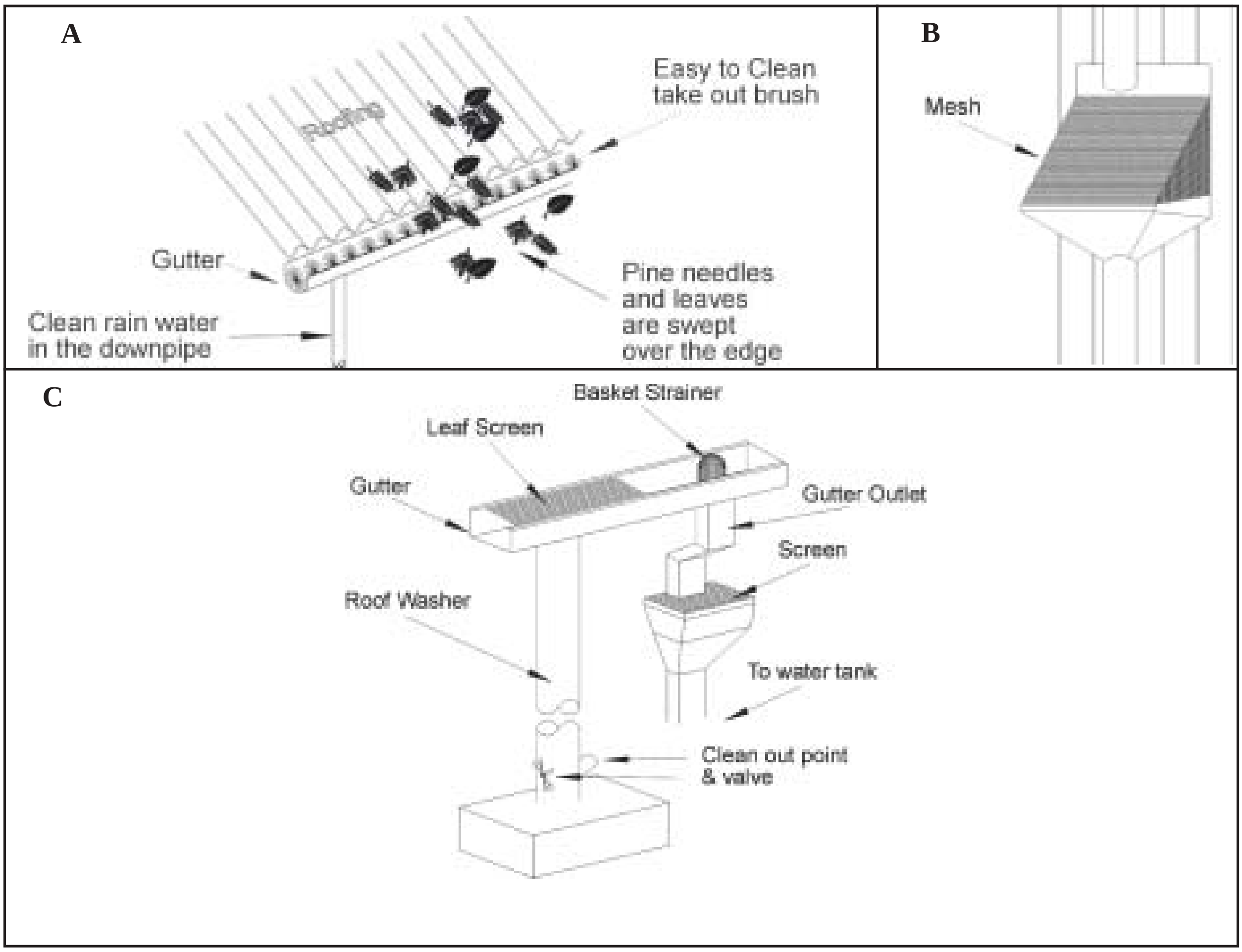
Figure 11-5
Design charts



Primary screening devices often have a 6 mm wire mesh leaf screen in a metal (or plastic) frame installed near the downspout. If there are trees nearby and leaves pose a problem, a leaf screen may be installed along the entire length of the gutter.

The first flush picks up most of the dirt, debris, and contaminants (e.g. bird droppings) that collect on the roof after each storm. The system is commonly designed so that at least the first 40 litres of roof runoff are diverted into a separate small chamber for every 100 m^2 of roof area. Once the chamber has filled, the rest of the water flows to the downspout connected to the rainwater tank. The chamber has a small tube at the

Figure 11-6
Screening devices and first flush diversion

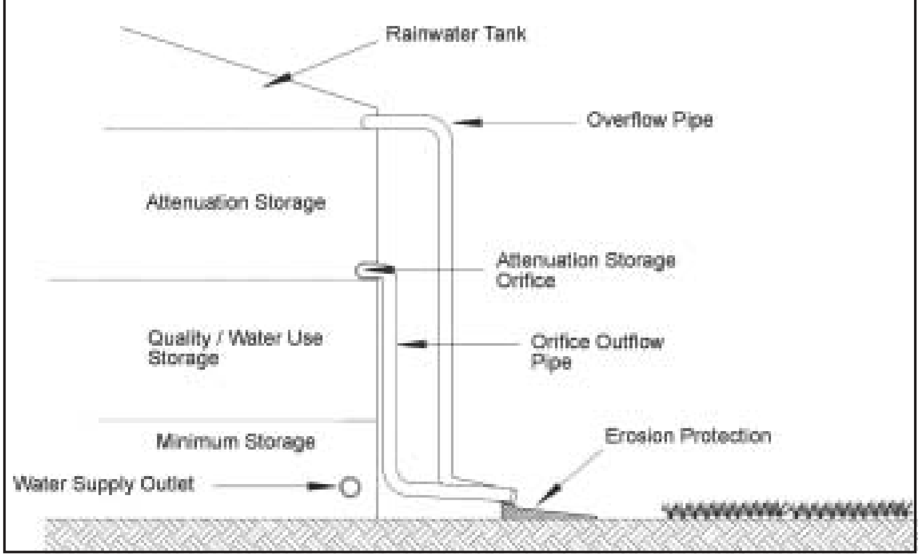


bottom that empties on to the ground after a storm event so it is empty before the next rain event. Figure 11-7 shows a typical first flush device.

Water treatment for non-potable use

Dirt, rust, scale, bird and rodent faeces and airborne bacteria may still enter the tank even when primary screener and first flush diverters are in place. Water can also be unsatisfactory without being unsafe. Although there is some sedimentation of suspended solids inside the tank, even for non-drinking uses, further filtration is often a good idea. Cartridge filters or those used for domestic swimming pools or spa pools may be used (e.g. 50 micron washable filters or similar).

Figure 11-7
Schematic arrangement at the attenuation storage orifice



11.6 Construction

11.6.1 Storage tanks

The tank should have a durable, watertight, opaque exterior and a clean, smooth interior. Available tank materials include plastic, steel, concrete and fibreglass.

A tight fitting top cover is necessary to prevent evaporation, mosquito breeding and to keep insects, rodents, birds and children from entering or falling into tanks. The tank should be located in a cool place and sunlight should not penetrate to prevent growth of algae.

Tanks, as shown in Figure 11-8, should have a suitable overflow outlet or outlets and should be able to be easily cleaned. Erosion protection measures for the overflow should be provided as necessary.

The tank should be placed high enough for gravity feed or pumped to convey water supply.

11.6.2 Attenuation storage outlet

For the controlled emptying of the temporary attenuation storage, an orifice should be drilled immediately above the long-term storage (quality/water use) volume. The edges of the orifice should be strengthened to prevent fraying. A pipe from the orifice should lead the outflow to a swale or a pipeline. Erosion protection measures should be provided as necessary.

11.6.3 Conveying

Poor plumbing can lead to inefficient collection and low water quality due to high loss and debris or pollutants getting into the tank. It may also result in contamination of individual household or mains water supply (e.g. if debris are not diverted or backflow preventers are not installed). Therefore, all plumbing should be done by a qualified plumber certified / registered by the TA. All plumbing work must conform to the relevant NZ standards including AS/NZS 3500.5:2000, and Building Industry Authority (BIA) approved documents G10, G12, and G14.

11.6.4 Backflow prevention

Backflow preventers must be installed to prevent possible mains water contamination.

11.6.5 Minimum water level

It is possible to provide a mains connection to the rainwater tank to maintain a minimum water level during prolonged dry spells. Such connection should have a 25 mm minimum air-gap separation to the maximum overflow water level of the tank.

The minimum water level is usually 100 mm above the water supply outlet. Mains water supply is opened, for trickle feed, and shut by a float-activated valve with its float at the minimum water level.

When a mains augmented minimum water level is provided, the design quality volume should be provided above this level.

11.6.6 Water supply outlet

The water supply outlet should be placed 150 mm to 200 mm above the tank base. The dead storage below the water supply outlet would accumulate any debris that settles within the tank. This dead storage should be cleaned out at regular time intervals.

Note that when mains augmented minimum water level is not provided, the design quality volume should be provided above the water supply outlet level.

11.6.7 As-built plans

There is no requirement for submission of an As-Built plan upon construction completion.

11.7 Operation and maintenance

Proper operation and regular maintenance of the rainwater tank system is necessary to achieve the design objectives.

Regular maintenance includes:

- inspection of the tank (at least annually), clean-out of dead storage and repairs as necessary
- inspection of the orifice outlet and pipework (no greater than annually) and repairs as necessary.
- inspection of the overflow pipework (at least annually) and repairs as necessary.
- where applicable, inspection for erosion damage of areas receiving flow from the orifice and overflow and repairs as necessary (after unusually severe storms)
- water supply pumps and associated electrical work maintenance as per manufacturer's requirements
- inspection of the backflow preventer by a certified inspector and repairs as necessary every 5 years
- maintenance and replacement of the filters as per instruction manual
- inspection of first flush device at least annually and repairs as necessary, along with cleaning of screens in gutters and downspouts

11.8 Design examples

Example 1

A proposed housing project would involve the development of a 600 m^2 greenfield site to have a roof area of 150 m^2 and a paved area of 65 m^2. In order to minimise the effects of the project on the stream system, the TA requires:

- 55% roof runoff capture, (TA has a downstream pond which can treat 60% of the roof area runoff)
- developed 2 year peak flow not to exceed the pre-developed 2 year peak flow;

Calculate the long-term and temporary storages required and orifice size. Select the tank and find the orifice position.

(1) Runoff capture would require non-potable water use from rainwater tank.
Estimate the daily demand rate = 325 L/d (for an average household, Table 11-4, toilet laundry and gardening)

(2) From Table 11-2, long-term storage = 3000 L (for 150 m^2 roof, 325 L/d water use, and 55% runoff capture
From Table 11-5, percentage water supplied = 70%. Therefore mains augmentation would be necessary.

(3) From Figure 11-5 Chart 1, temporary storage = 4000 L (for 150 m^2 roof, 65 m^2 paved area)
From Figure 11-5 Chart 3, orifice size = 15 mm diameter.

(4) Position of water supply outlet:
Tank height (say) = 2000 mm; tank diameter 2200 mm (refer manufacturer's data)
Select: water supply outlet height from base = 200 mm (refer water supply outlet section)
Select: minimum water level with mains augmentation = 300 mm from base (refer Minimum Water Level Section and Figure 11-4)
Calculate: storage below minimum water level = 9000 L (volume for size tank) / 2000 mm x 300

mm = 1350 L
Check: storage available above minimum level = 9000 L - 1350 L = 7650 L. This is satisfactory because it is greater than the required 7000 L (i.e. 3000 + 4000)

(5) Position of orifice (refer Figure 11-8):
Calculate: height of long-term storage = 2000 mm / 9000 L x 3000 L = 667 mm
Add: height of minimum storage = 667 mm + 300 mm = 967 mm
Drill the orifice between 965 mm and 985 mm

Example 2

A proposed housing project would involve the development of a 600 m^2 greenfield site to have a roof area of 200 m^2 and a paved area of 100 m^2. The TA requires that the developed 10 year peak flow should not exceed the pre-developed 10 year peak flow in order to minimise the effects of the project on the reticulated system. Calculate the temporary storage required and orifice size.

(1) From Figure 11-5 Chart 2
Read the required temporary storage from the graph for 150 m^2 = 4.0 m^3
Read the required temporary storage from the graph for 250 m^2 = 5.1 m^3
Interpolate to find the required temporary storage for 200 m^2

= 4.0 + (5.1-4.0)/(250-150) x (200-150) = 4 + (1.1/100) x 50 = 4.55 m^3

(2) From Figure 11-5 Chart 4:
Read the orifice size from the graph for 150 m^2 = 25 mm
Read the orifice size from the graph for 250 m^2 = 33 mm
Interpolate to find the orifice size for 200 m^2

= 25 + (33-25)/(250-150) x (200-150) = 25 + 8/100 x 50 = 29 mm

Example 3

A proposed housing project would involve the development of a 600 m^2 greenfield site to have a roof area of 250 m^2 and a paved area of 150 m^2. The TA requires that the developed 2 year peak flow should not exceed the pre-developed 2 year peak flow in order to minimise the effects of the project on the stream system. Assess whether this condition can be met by providing roof rainwater tank temporary storage, and explore other possible options.

(1) From Figure 11-5 Chart 1:
Read the required temporary storage from the graph for 250 m^2 roof
Paved area 150 m^2 is out of the range of this graph
Therefore, it is not possible to meet the TA or ARC requirement by providing roof rainwater tank only. (120 m^2 paved area has been set as a standard maximum. Specific design, on a case by case basis, is required for paved areas greater than 120 m^2)

(2) Consider other options
(2.1) Reduce the paved area
Try a paved area of 100 m^2
It is within the Chart 1 graph for 250 m^2 roof
Required attenuation volume = 8500 L
(2.2) Keep 150 m^2 paved area. Provide a rain garden in addition to roof tank.
Select temporary storage = 6 m^3 (by trial and improvement) from Chart 1 and read the corresponding paved area = 100 m^2
Calculate excess paved area = 150 - 100 = 50 m^2
Design the rain garden to mitigate runoff from 50 m^2 (refer to Chapter 7)

Example 4

A proposed housing project would involve the redevelopment of a 600 m^2 site to have a roof area of 350 m^2 and a paved area of 70 m^2. Prior to the redevelopment the site has a 150 m^2 roof and a 30 m^2. paved area. The TA requires that the developed 10 year peak flow should not exceed the current 10 year peak flow in order to minimise the effects of the project on the reticulated system. Calculate the temporary storage required and orifice size.

(1) Calculate the additional roof area and paved area
(a) Additional roof area = 600 - 350 = 250 m^2
(b) Additional paved area = 70 - 30 = 40 m^2
Note: If (b) is negative, then the effective additional roof area would be equal to the actual additional roof area less the difference in paved areas, and the effective additional paved area would be taken as zero

(2) Based on the effective additional areas, calculate the temporary storage and orifice size:
From Figure 11-5 Chart 2, temporary storage = 4000 L (for 250 m^2 roof, 40 m^2 paved area)
From Figure 11-5 Chart 4, orifice size = 37 mm diameter

11.9 Bibliography

Auckland Regional Council, Technical Publication 108, Guidelines for Stormwater Runoff Modelling in the Auckland Region, April 1999

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Coombes, P. and Kuczera, G. Rainwater tank design for water supply and stormwater management, Stormwater Industry Association 2001 Regional Conference, Port Stephens, NSW, April 2001

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Tremain, G. Design Guidelines for Sizing Urban Rainwater Tanks for Stormwater Mitigation, prepared for North Shore City Council, August 2001

URS New Zealand Ltd, Countryside and Foothills Stormwater Management Code of Practice, February 2001

Design Calculation Report Form

(To be produced by the Developer for the approval of City/District/Regional Council)

Date: ______________________

Project: ____

Location: ____

Owner: ____

Developer: ____

Designer: ____

1. Development Type (tick appropriate box):	
Greenfield to Developed	
Lower intensity to higher intensity development	

2. Land Use	Type	Current Area (m^2)	Developed Area (m^2)

3. LNO Design Requirement (tick appropriate box):

Hydraulic neutrality (tick appropriate box) Note that LNO may require greenfield flows, depending on the existing system capacity, even if the site is currently developed	Greenfield – 1 in 2year	
	Greenfield – 1 in 10year	
	Current land use – 1 in 2year	
	Current land use – 1 in 10year	

Roof runoff percentage capture. State the LNO approved percentage.	%

Design Calculation Report Form

(To be produced by the Developer for the approval of City / District Council)

4. Quality / water use storage calculation

5. Attenuation storage and orifice size calculation

6. Total tank size, and position of water use outlet and orifice

Designer: ______________________ Approver (LNO): __________________

Date: ______________ Date: ______________

Rain tanks
Inspection forms
Construction and operation and maintenance inspection forms

Auckland Regional Council TE RAUHITANGA TAIAO	**STORMWATER COMPLIANCE INSPECTION ADVICE** (Under Section 332 of the Resource Management Act 1991)	Investigating Officer:
		Date:
		Time:
		Weather: Rainfall over previous 2-3 days?
		Person contacted during visit:
		Page 1 of 2

Site Name:		File No:	
Consent Holder:		Consent No:	
Engineer:		Catchment:	

RAIN TANK CONSTRUCTION CHECKLIST	: 9	Needs immediate attention Not Applicable	V	Okay	;	Clarification Required

Rain Tank Construction Components:

Items Inspected	Checked		Satisfactory	Unsatisfactory
1. Inspector should sight Approved Design Calculation Report (tick to confirm)	Y	N		
Observation				
2. Extent of roof catchment conforms to disign	Y	N		
3. Extent of paved (other impervious) area conforms to design	Y	N		
4. Ouality / water use storage	Y	N		
5. First flush device, screens and tank cover	Y	N		
6. Water use outlet position, pump and plumbing	Y	N		

	Checked		Satisfactory	Unsatisfactory
7. Backflow preventer	Y	N		
8. Attenuation storage	Y	N		
9. Orifice position	Y	N		
10. Overflow pipe	Y	N		
11. Maintenance access	Y	N		
12. Erosion protection	Y	N		

OFFICERS REMARKS:

ACTION TO BE TAKEN:

No action necessary. Continue routine inspections? Y / N

Correct noted site deficiencies by ____

1st Notice: ____

2nd Notice: ____

Submit plan modifications as noted in written comments by ______________________________

Notice to Comply issued ____

Final inspection, project completed ____

Officers signature: ______________________________

Consent Holder/Engineer/Agent's signature: ______________________________

Auckland Regional Council TE RAUHITANGA TAIAO	**STORMWATER COMPLIANCE INSPECTION ADVICE** (Under Section 332 of the Resource Management Act 1991)	Investigating Officer: Date: Time: Weather: Rainfall over previous 2-3 days? Person contacted during visit: Page 1 of 2

Site Name:		File No:	
Consent Holder:		Consent No:	
Engineer:		Catchment:	

RAINWATER TANK MAINTENANCE INSPECTION CHECKLIST	: 9	Needs immediate attention Not Applicable	V	Okay	;	Clarification Required

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Rainwater Tank Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
OBSERVATION	Y	N	Y	N		5. Backflow preventer (once in five years)	Y	N	Y	N	
1. Extent of roof catchment conforms to design						6. Orifice	Y	N	Y	N	
2. Extent of paved (other impervious) are conforms to design	Y	N	Y	N		7. Overflow pipe	Y	N	Y	N	
						8. Maintenance access	Y	N	Y	N	
3. First flush device, screens and tank cover	Y	N	Y	N		9. Erosion protection	Y	N	Y	N	
4. Water pump and plumbing	Y	N	Y	N							

Inspection Frequency Key **A = Annual, M = Monthly, 3M = Three monthly, 6M = Six Monthly, 3-6M = Three to Six Monthly**

OFFICERS REMARKS:

OVERALL CONDITION OF FACILITY:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: ____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Officers signature: ________________________________

Consent Holder/Engineer/Agent's signature: ______________________________