HOUSEHOLD

WATER SUPPLIES

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The selection, operation and maintenance of individual household water supplies

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Contents

1 INTRODUCTION

This booklet gives information about the supply of safe drinking water to households that are not connected to town water supplies. It includes information on water sources, storage and treatment. For greater detail, see *Guidelines for Drinking-water Quality Management for New Zealand*, published in 2013 by the Ministry of Health. (Go to http://www.moh.govt.nz/water and click Publications.)

The Health (Drinking Water) Amendment Act 2007 applies to all public water supplies serving more than 25 people, plus small, neighbourhood, rural agricultural and tankered water supplies. It does not apply to households that supply their own water (self suppliers).

Self-suppliers are covered by the Building Act 2004, which requires any building intended for use as a dwellinghouse to have an adequate and convenient supply of water that is potable.

Potable water is drinking water that does not contain any determinand that exceeds the maximum acceptable values (MAVs) specified in the *Drinking-water Standards for New Zealand* (DWSNZ). Wholesome water is water that satisfies the aesthetic guideline values (GVs) in the DWSNZ.

2 HOUSEHOLD REQUIREMENTS

The main requirements for household water and the number of litres people use on average each day are shown in Table 1. As you can see, only a small part of the total supply needs to be biologically and chemically safe.

Table 1: Household Requirements

HOUSEHOLD USE	MAIN REQUIREMENTS	LITRES / PERSON / DAY
Drinking	Biologically and chemically safe	2
Cooking and food preparation	Biologically and chemically safe	3
Bathing/showering/cleaning	Biologically safe	100
Toilet flushing	Not discoloured or stain causing	80
Clothes washing	Not discoloured or stain causing	65
General use	No special requirements	50
	Total	**300**

As well as using water for domestic purposes, some households may need water for gardening and stock watering. Typical volumes and quality requirements are shown in Table 2.

Table 2: Other Uses

OTHER USES	MAIN REQUIREMENTS	VOLUME / DAY
Garden watering	Boron[1] and salinity not excessive	5 litres / m^2
Stock watering	Not biologically contaminated by other stock	Up to 50 litres / stock unit

1 Only a few plants in New Zealand are sensitive to boron, usually when grown in glasshouses.

These figures can be used to calculate total daily usage. For example, the total daily requirements for an isolated farmhouse with five people, 100 square metres of garden and troughs for eight head of dry stock (40 stock units) would be:

5 people @ 300 litres each	=	1500 litres
100 m² @ 5 litres per m²	=	500 litres
40 stock units @ 50 litres per unit	=	2000 litres
Total required		4000 litres per day

Typical household water use is shown in the following pie chart. The largest component, about half, is used in the bathroom area. Both the toilet and the shower each use 25 percent of the household's water use. The laundry and garden use another 20 percent each while the kitchen uses 10 percent. Garden use tends to be seasonal.

Typical Household Water Use

3 CONTAMINATED WATER

Drinking water can be affected by contaminants, which will make it undesirable or even dangerous to use. You can find contaminants, their sources, and the problems they may cause listed in Table 3.

Table 3: Contaminants, Their Sources and Problems

DETERMINAND	SOURCE	PROBLEMS
Arsenic	Geothermal areas, mining areas	Health problems
Bacteria	Septic tanks, bird and animal faeces, back flushing from incorrectly connected waste systems, sewage discharges	Diarrhoea Gastroenteritis Other waterborne diseases
Boron	Geothermal areas	Health problems
Carbon dioxide	Atmosphere, decaying vegetation	Corrosion
Chemicals	Naturally occurring, industrial waste; backflow (suck-back) from incorrectly connected dosing equipment, cattle feeding systems, garden hoses dangling in container etc.	Health problems depending on the nature of chemical contaminants
Colour	Decaying vegetation and leaf litter	Appearance
Copper	Dissolved from pipes or fittings by aggressive water	Staining, taste, health problems
Cyanobacteria (blue-green algae)	Streams, rivers and lakes	Cyanotoxins cause health problems
Faecal material	Backflow from incorrectly connected waste disposal equipment, animal washdowns, etc.	Diarrhoea Gastrointestinal infections
Hardness	Dissolved rocks, especially limestone	High soap demand, scale formation in kettles and hot water cylinders
Iron	Dissolved from soil/rocks, especially in bore water	Taste, staining, clogging of pipes and valves
Lead	Roofing and plumbing materials	Health problems
Manganese	Dissolved from soil/rocks, especially in bore water	Health problems, taste, staining
Nitrate and nitrite	Fertilisers, clover, septic tank soakage, animal urine	Can cause health problems for bottle-fed babies
Pesticides	Agricultural and home use	Health problems
pH	Atmosphere, decaying vegetation or dissolved rocks	Corrosion if too low Scale forming if too high
Protozoan cysts, e.g., *Giardia, Cryptosporidium*	Septic tanks, bird and animal faeces on roofs and in streams, sewage discharges	Diarrhoea Protozoan infection
Taste and odour	Algae, some chemicals	Unpleasant to drink. Can be toxic
Turbidity	Dirt	Appearance (usually biologically contaminated as well)
Viruses	Sewage, bird and animal faeces	Gastroenteritis and other waterborne diseases

4 WATER SOURCES

Your water source needs to provide the following:

- enough quantity to meet requirements (normally 300 litres per person per day)
- good quality water or water that can be treated to a good quality standard.

Table 4 shows various water sources and compares their quality.

Table 4: Source Water Quality

RAW WATER SOURCE	BIOLOGICAL QUALITY	CHEMICAL QUALITY	AESTHETIC QUALITY
Mains supply*	Usually good	Usually good	Usually good
Roof water	Usually poor	Usually good	Corrosive
Shallow bore, spring or shingle aquifer	Often poor	Can be high in nitrate, iron, carbon dioxide, manganese	Variable – can be turbid and discoloured, corrosive
Deep bore	Usually good	May be high in iron, carbon dioxide, manganese and ammonium	Hard, possibly corrosive
River	Usually poor	Variable	Can be turbid and discoloured
Stream	Variable	Usually good	Can be turbid and discoloured
Lake or reservoir	Variable	Usually good	Usually good

* For details of your supply consult the Ministry of Health *Register of Community Drinking-water Supplies* in your local library or www.health.govt.nz/publication/register-community-drinking-water-supplies-new-zealand-2011-edition, or go to http://www.drinkingwater.esr.cri.nz and click Water Supplies.

NOTE: if the biological quality of source water is described as “variable”, then at times it will probably be poor. If it is known when this is happening, the intake can be shut off, otherwise the water will need to be treated permanently as a “usually poor” or “often poor” source.

5 WATER QUALITY TESTING

If you need to have a water source checked for its suitability as a household supply, contact a specialist water testing laboratory. See Laboratories Analytical and Testing Laboratories in the yellow pages, or contact your local public health service, or go to http://www.ianz.govt.nz/ and select Find accredited organisations. Alternatively go to http://www.drinkingwater.esr.cri.nz/

Choose a laboratory experienced in analysing water in your area and ask for an estimate of the work to be done. A laboratory representative will give you instructions on where to go and on how to take water samples. The laboratory will also provide you with containers for the samples.

Testing will reveal the quality of water and the treatment needed to make it safe. You can also contact laboratories for advice on water analysis and interpretation.

Table 5 lists some determinands, the problems they cause and the typical levels at which they cause concern.

Table 5: Contaminants: Levels of Concern

DETERMINAND	PROBLEM	LEVEL OF CONCERN
Arsenic	Health problems	0.01 mg/L
Bacteria	Waterborne disease	Any faecal coliforms / *E. coli*
Boron	Possible health problems	2.5 mg/L (WHO 2011)
Carbon dioxide	Corrosive	20 mg/L
Colour	Appearance	10 Hazen units
Copper	Possible health problems, taste and staining at lower levels	2.0 mg/L (1 mg/L aesthetic)
Cyanobacteria	Cyanotoxins cause health problems	Very low
Hardness (total)	Scale, excessive soap use	200 mg/L as $CaCO_3$
Iron	Staining, taste, pipe clogging	0.2 mg/L
Lead	Poisonous to humans, especially infants, young children and unborn children	0.01 mg/L
Manganese	Possible health problems, staining, taste	0.4 mg/L (0.04 mg/L aesthetic)
Nitrate and nitrite	Bottle fed infants can have breathing problems	Nitrate: 11 mg/L as N Nitrite: 0.06 mg/L as N
Pesticides	Possible health problems	As low as possible
pH	Corrosion of plumbing materials possibly causing copper or lead to dissolve, OR: scale formation on hot water cylinders and heating elements causing reduced efficiency and early failure	Below 6.5 Above 8.5
Protozoan cysts, e.g., *Giardia, Cryptosporidium*	Waterborne disease	Any cysts or oocysts
Taste and odour (many causes)	Taste and odour	Objectionable
Turbidity	Appearance; reducing effectiveness of any disinfection	5 NTU aesthetic 1 NTU disinfection
Viruses	Waterborne disease	Any virus from faecal sources

6 TREATMENT METHODS

If you cannot get a good quality supply reticulated to your house, you will probably have to treat the water yourself.

Table 6 lists common determinands and treatments that can remove or reduce them.

Table 6: Treatments Methods

DETERMINAND	TREATMENT
Bacteria	Ultraviolet disinfection (only effective in low turbidity waters); chlorine; reverse osmosis; boiling
Carbon dioxide	Aeration; pass through dolomite granules (e.g., akdolit)
Colour	Activated carbon; reverse osmosis
Copper	Make water less corrosive; use plastic pipes; treat as for carbon dioxide; other methods can remove if these are not effective
Cyanotoxins	Activated carbon, or temporarily seek alternative source (see notes)
Hardness	Ion exchange or water softener
Iron	Aerate and filter; chlorinate and filter; ion exchange (if iron dissolved)
Lead	Make water less corrosive; avoid fittings/paint with lead; treat as for carbon dioxide; other methods can remove if this is not possible
Manganese	Ion exchange; chlorinate and filter; potassium permanganate and filter
Nitrate and nitrite	Ion exchange; supply alternative water for infants
Pesticides	Activated carbon; reverse osmosis
pH	If too low, treat as for carbon dioxide If too high, treat as for hardness
Protozoan cysts	Reverse osmosis; boil; cartridge filter; ultraviolet disinfection
Taste and odour (many causes)	Activated carbon; boil; reverse osmosis
Turbidity	Cartridge filter; reverse osmosis; ultrafiltration
Viruses	Chlorine; reverse osmosis; boil; ultraviolet; ultrafiltration

Note that:

- treatment processes that are expensive have not been suggested in Table 6, e.g., ozone
- alum coagulation requires a fairly high level of operator skill and monitoring, so has not been suggested
- ion exchange has been included but can be expensive; water softening is less expensive
- boiling the water used for drinking is probably not cost-effective
- it is probably cheaper to find an alternative source for waters containing arsenic, or, with a lesser concern, boron
- pesticides are likely to be found in water for brief periods only, e.g., spray drift or spills
- roof water should not be used for drinking if the roof is near a highway or a factory that discharges pollutants into the air
- for information about cyanotoxins, see *Guidelines for Drinking-water Quality Management for New Zealand or the New Zealand Guidelines for Managing Cyanobacteria in Recreational Waters.* (see www.mfe.govt.nz/publications/water/guidelines-for-cyanobacteria)

7 POINT-OF-USE DEVICES

A point-of-use device is like a mini-treatment plant. It can be used to treat all household water, or you can put it on the end of a tap for treating drinking water only.

Most people already have one cheap, effective point-of-use device in their kitchen – the electric kettle. If you boil your drinking water for one minute, all biological and most gaseous contaminants will be removed or destroyed. Electric jugs with automatic cut-off are fine especially if the water is left to cool for some minutes before use. Do not hold down the cut-off switch to keep the jug boiling.

Regularly check and maintain your point-of-use devices. See Section 9 (page 17) for maintenance requirements of these devices. You will find that point-of-use devices vary in quality. Some devices may also require pumping to get a sufficient flow.

Before buying a point-of-use device, ensure that you get a written statement that states clearly what the device **will** achieve and what it **will not** achieve in the way of water purification. The device should provide some way of indicating when it will no longer function effectively. Check that the device has been tested to AS/NZS 4348: *Water supply – Domestic Type Water Treatment Appliances – Performance Requirements* and complies with AS/NZS 3497: *Drinking Water Treatment Units - Plumbing Requirements*.

Table 7: Point-of-use Devices

DETERMINAND	**POINT-OF-USE DEVICE TYPE AND EFFICIENCY**										
	Activated Carbon (1)	**Boiling (4)**	**Candle (2)**	**Filtration (plain) (2)**	**Ion Exchange (6)**	**Reverse Osmosis (7)**	**Ultra Filtration (7)**	**Ultra Violet (8)**	**Calcium Filtration (9)**	**Chlorine Dosage**	**Magnetic treatment**
Arsenic	P	N	N-G	N-G	N-G	Ex	N-G	N	P-G	N	N
Bacteria	N(1)	Ex(4)	G	P	P-M	Ex	Ex	Ex(8)	P	Ex	N
Boron	N	N	N	N	Ex	N	N	N	N	N	N
Carbon dioxide	P	G	N	N	P	P	N	N	G	N	N
Colour	M	N	N	N	P	G	P-M	N	N	N-P	N
Hardness	P	M(5)	N	N	G(6)	M	P-M	N	N	N	P
Iron, soluble	P	N	N	N	G(6)	G	M	N	M	N-G(11)	P
Manganese, soluble	P	N	N	N	G(6)	G	M	N	M	N-G(11)	P
Nitrate, nitrite	P	N	N	N	G(6)	G	P	N	N	N	N
Protozoa	G(2)	Ex(4)	Ex	G(2)	N	Ex	Ex	P(8)	P(10)	N-G(12)	N
Taste and odour	G(3)	M	N	N	P	M	P	N	P	N-M	N
Turbidity	M	N	P	P	G	Ex	Ex	N	P	N	N
Viruses	M	Ex(4)	P	P	M	Ex	Ex	Ex(8)	P	Ex	N

Terms used in table:

Ex excellent removal, where equipment is in good condition

G good removal to an acceptable level

M moderate removal, constituent may still give a problem

P poor performance, most of constituent levels unaffected

N no removal at all

Explanation of numbers:

1 Activated carbon filters should not be exposed directly to water containing biological contaminants; carbon granules can act as a growth medium for bacteria.

2 Either plain or activated carbon cartridge type filters can remove protozoan cysts, as long as the nominal particle retention size of the filter is 1 micron or less; however, see note 1.

3 Activated carbon will eventually become full of contaminants and must be replaced to prevent contaminants returning to the water.

4 Boil water to a rolling boil for at least one minute.

5 Boiling hard water removes some of the hardness, but a scale will form on the jug element making the element less efficient and shortening its life.

6 Ion exchangers can remove a range of chemical contaminants if the appropriate resins are chosen. General purpose resins are often not suitable. Water softeners tend to just reduce the calcium content.

7 While some treatment methods work well for some contaminants, they can be upset by the presence of others. For example, ion exchange, reverse osmosis and ultrafiltration are capable of removing a range of contaminants. When fouled with excess turbidity and bacterial growths, their performance falls off dramatically and they can break down.

8 Ultraviolet disinfection is upset by anything that shields biological contaminants from ultraviolet light. This includes dissolved organic matter, which absorbs UV light, iron and manganese, lime scale, colour and turbidity. Keep these constituents low or remove them before using the UV device. The lamp must be kept clean.

9 This treatment uses the form of calcium in calcium carbonate, marble or dolomite.

10 This treatment is of variable effectiveness, depending on the exact details of the filter.

11 Chlorine can oxidise soluble iron and manganese, which may then be removed by filtration.

12 A high dose/long retention time can inactivate *Giardia*; however, *Cryptosporidium* is unaffected.

Additional comments:

- It is important to adhere rigidly to the manufacturer's operating and maintenance instructions. Operating filtration or adsorption equipment at high flow rates or switching suddenly from off to on can dislodge material that has previously been removed from the water.
- Some people have found that magnetic treatment can modify the nature of sludges, from scale-forming to flocculent particles.
- Cyanobacteria can produce cyanotoxins and these can have serious health effects. Activated carbon and reverse osmosis are able to remove cyanotoxins from water, but it would be preferable to avoid abstracting water during cyanobacterial blooms.
- Pesticides in shallow bore water can be removed by activated carbon. If using roof water, isolate the storage tank while pesticides are being sprayed and do not reconnect until after rain.

8 SYSTEM DESIGN

This section explains how you can design your own water treatment and storage system.

It includes information on intakes, pumping arrangements and connections, pipework and connections, storage tanks, point-of-use devices and use of dual sources.

Intakes

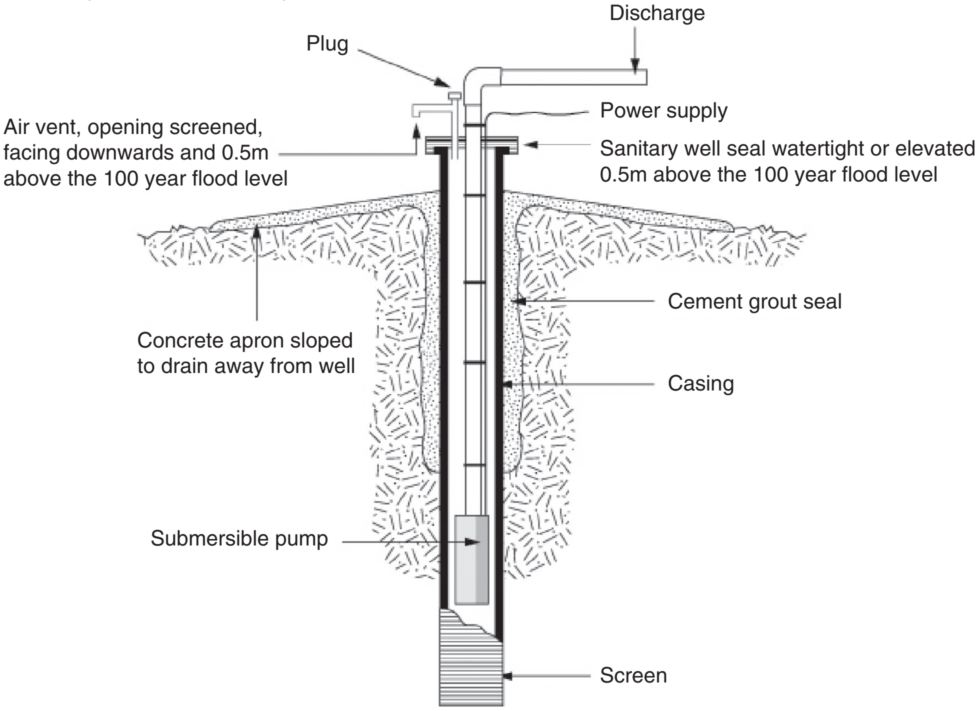
The intake is an important part of your system. Usually, providing a good intake is only a little more expensive than a poor one, yet a good intake will fix many of the problems caused by turbidity and other contaminants.

Locate your stream or lake intake upstream of any waste discharges, drawing sufficiently below drought level to prevent sucking air into the system. Intakes normally incorporate a screen to remove larger items such as leaves, sand or stones and aquatic animals. If the source water becomes dirty after rain, consider introducing a system that shuts off the intake until the water is clear.

Bore heads should be sealed at the surface to prevent surface water and contaminants entering. The bore should be cased so that shallow groundwater doesn't mix with the deeper water. Ensure that your bore is well away from any septic tank soakage areas, offal or rubbish dumps, and animals are excluded from within 5 metres of the bore head.

Springs should have a bund around the abstraction area to prevent surface run-off mixing with the spring water, and the area should be fenced to keep stock out.

Sanitary protection of a typical bore:



Pumps

Pumps are used to bring water up to points higher than the point it is being taken from, or to boost pressure so water can flow over flat gradients.

The most common type of pump used for small water systems is the centrifugal pump.

A pump supplier can advise you on the type and size of pump required. Make sure you give the supplier all the information needed to make the calculations. This includes:

- height difference between the pump and the water surface from where the water is taken
- height difference between the pump and where the water is to go, or the highest point along the way
- for online pumps: the maximum flow rate required through all possible outlets and the minimum pressure required at the outlet points
- for storage tank pumps: the daily flow out of the tank; refer to Section 2
- internal diameter and type of pipes intended for use
- total length of pipes for both the suction and discharge sides of the pump.

It may be necessary for you to pump to another tank that will gravity feed through the system. Alternatively, you could operate a pressurised line with a pressure switch to control the pump.

When water is taken out of the ground, the maximum lift that you can achieve on the suction side of a pump is approximately 8 metres. If your water level is below this, the pump must go down the well. Deep bores may require multi-stage pumps.

You need to check how corrosive your bore waters are as this will affect the materials that the pump needs to be made from.

Pipework and Connections

Water that is not supplied from a full-scale municipal treatment plant is often corrosive.

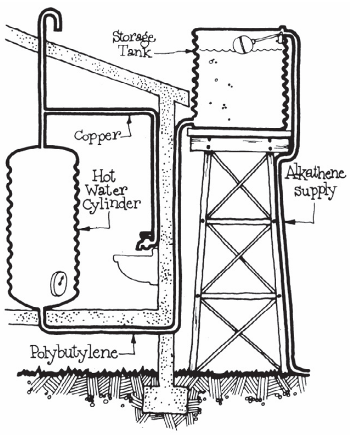
As corrosive water can leach out metals from metallic pipes and fittings, you may need to use plastic pipes and valves for cold water.

The most commonly used plastics are unplasticised polyvinylchloride (UPVC), low density polyethylene (LDPE e.g., alkathene), medium density polyethylene (MDPE), high density polyethylene (HDPE) and polybutylene.

Select your pipe according to cost; availability; resistance to handling, trenching and superimposed loads; flexibility and ease of laying; ease of connection and resistance to frost. Roofing, guttering, downpipes and pipework used in conjunction with drinking water should comply with AS/NZS 4020: *Testing of Products for Use in Contact with Drinking Water*.

While an experienced master plumber or plumbing goods supplier should be able to give you useful advice, a low-cost quality system might consist of low density polyethylene pipe, approximately 20 mm internal diameter for main runs and 15 mm internal diameter for spurs. For long runs or high flow, a 25 mm pipe connecting the source and the house may be desirable.

The pipe should be buried (at least 400 mm) from the source to the storage tank, followed by reticulation, to and throughout the house, of polybutylene for cold water and copper or copper and polybutylene for hot water.



Low-cost system

Storage Tanks

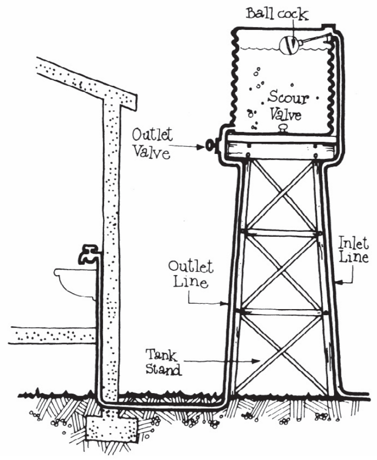
The storage tank, an important part of your system, is usually situated 2 to 4 metres above the level of the highest outlet, either on a tank stand, the house roof or on adjoining level ground. Alternatively, the storage tank may be at or below ground level with a pumped feed to the house.

When selecting and locating a storage tank, you should consider:

- location, elevation and size
- materials used in building the tank – use materials suitable or approved for drinking water
- how to inspect buried tanks for cracks or holes
- safety during earthquakes
- how the tank will be cleaned out
- inaccessibility by vermin, mosquitoes, midges and other insects, etc.
- keeping light out of the tank so algae can't grow.

A large tank will provide plenty of storage should your supply fail for a short period. A long retention time in the tank also allows some water contaminants to settle to the bottom.

As water weighs 1 tonne for every 1000 litres, a large tank, sitting on a roof tank stand or hillock at the back of your house, should be adequately secured to prevent it toppling over during earthquakes or high winds and should be adequately supported at all times.



Typical Tank Set Up

Rainwater Collection

Rainwater may not be suitable for drinking if the property is near a busy highway, near factories discharging contaminants to the air and while pesticides are being sprayed nearby. Avoid collecting water from the section of roof that collects fall-out from a flue from a slow combustion heater or oil burner.

If you live near a volcano, disconnect the inlet after an eruption.

Avoid using lead flashings and lead-headed nails on roofs harvesting rainwater. If the roof does have lead flashings, you may be able to isolate the lead by painting it.

Asphaltic and bitumen-based roofing have been known to impart taste and colour to rainwater. Unpainted treated timber shingles may leach chemicals, e.g., copper, chromium and arsenic.

Guttering should be installed so water does not pond and stagnate; this can allow micro-organisms to grow.

Apart from carrying out maintenance (see Section 9), the quality of the water running off the roof can be improved significantly by:

- adding leaf guards/mesh to the guttering and/or installing a debris diverter
- installing a first-flush diverter – most need manual cleaning so require regular maintanance
- installing the inlet pipe so the water enters the bottom of the tank through a U-bend without disturbing the sediment
- attaching the draw-off pipe to a float so the water is extracted from near the water surface
- installing a vacuum device that uses the overflow to automatically desludge the tank
- operating small tanks run in series rather than installing one large tank; as the water passes to successive tanks, the microbiological quality improves significantly.

Materials Used for Tanks and Fittings

The most commonly used tank materials are:

- plastic, e.g., polyethylene
- fibreglass
- galvanised iron/steel
- concrete
- timber tanks with plastic liners.

Some small tanks have been made with stainless steel or tinned copper.

Ensure that the tank is suitable for drinking water – some fibreglass tanks have been known to exert strong tastes and odours. Fibreglass and plastic tanks should be opaque enough to prevent the entry of light. New concrete tanks can leach lime for some months, raising the pH of the water. New galvanised steel tanks can impart a metallic taste to the water, and with some water, the galvanised steel can rust.

You will find that plastic, fibreglass and some of the galvanised iron or steel tanks are relatively light and can be easily transported.

All tanks have a limited life span, especially light-weight galvanised iron or steel tanks.

Tank sizes vary from a pressurised tank of about 100 litres, being refilled automatically from a pump, to a tank of 10 or 20 cubic metres (10,000 to 20,000 litre capacity) for properties relying solely on roof water. Your tank will need to be cleaned out and disinfected regularly (see Section 9, page 17).

Fittings are covered by AS/NZS 2179: *Specifications for Rainwater Goods, Accessories and Fasteners*.

Backflow Prevention Devices

Backflow prevention devices should be installed between the drinking tap and any place where the water supply is connected to equipment containing chemicals, faecal material or other potential contaminants. Commercially purchased WC flushing cisterns have a backflow preventer built in, but any "do-it-yourself" device needs a backflow preventer.

Cattle shed devices used for dosing animal remedies into the animal watering system and hose connections where the hose is used to mix sprays and wash down animal or bird faeces should have preventers fitted.

In many cases, the fitting of such a device to the specifications of AS/NZS 3500.1:2003 *Plumbing and Drainage – Water Services* [2] will meet the requirements of the building code. Water NZ has published a Code of Practice (see Section 10).

2 This Standard sets out the requirements for installing water services from the point of connection to the network utility's water supply or from an alternative drinking water supply to the points of discharge. This Standard applies to new installations and alterations, additions and repairs to existing installations.

Dual Sources

Some New Zealand communities use dual water sources. The two sources are usually rainwater (reasonable quality but not always available) and bore water (poorer quality but usually available).

One storage tank can be used to service both sources, with a ball float dividing the tank in half. Rainwater feeds the top half of the tank and is used until dry spells occur. When this happens and the water level falls, the ball-cock at mid-height in the tank opens as the water is drawn off. This relieves pressure and the bore pump starts up.

Dual Water Supplies

Where rainwater is less abundant or where there is not enough space for multiple storage tanks, untreated stream or lake water can be considered for non-potable purposes such as gardening, car washing, toilet flushing, etc. Ideally the two separate plumbing systems should be readily identified, using different coloured piping and/or labels.

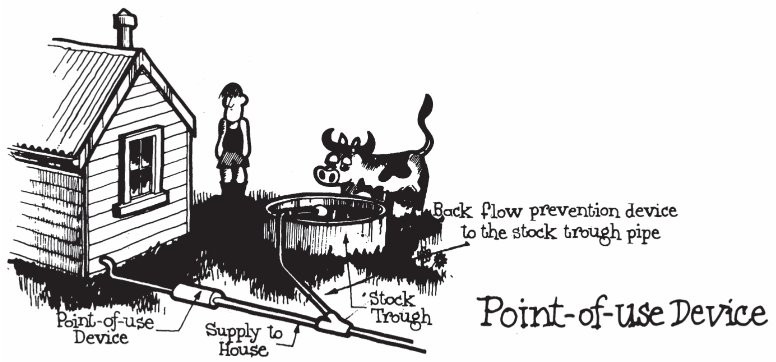
Tankered supplies

Water tanks often need to be topped up by a tanker.

All water carriers who provide drinking water to customers must be registered on the Ministry of Health's *Register of Community Drinking-water Supplies and Suppliers*. Their requirements are covered in Section 11 of the *Drinking-water Standards for New Zealand* (2005, revised 2008) and the *Guidelines for the Safe Carriage and Delivery of Drinking-water* (2008). These publications can be found at http://www.moh.govt.nz/water (Click Publications and go to 2008.)

Point-of-use Devices

You can locate your point-of-use device anywhere in your system. Make sure it is accessible for maintenance. For example, if you have a system that first feeds stock watering troughs and then a household, you may wish to locate your point-of-use device downstream of the tee-off line running into the troughs.



Where the source water is microbiologically suspect, a disinfecting device should treat part of the water.

An alternative is to treat water for drinking and cooking purposes only. For this, a bench-top or under-sink point-of-use device can be used, or water can be boiled. However, it must be made clear that water from the other taps is unsuitable for drinking.

Your hot water cylinder should be set at 60ºC or above to ensure that organisms do not grow in the cylinder. To avoid scalding, you should place a tempering valve on the discharge side of the hot water cylinder. This valve dilutes the 60ºC water with cold water to 55ºC prior to its use at any tap outlet. The New Zealand Building Code requires the tap outlet temperature for child care centres and old people's homes to be no more than 40ºC.

Unfortunately there is a problem with this compromise. The cold water, which may be used for showering, bathing or cleaning and which will temper the hot water, could be biologically impure if it has not been treated.

9 SYSTEM OPERATION AND MAINTENANCE

This section includes maintenance of intakes, maintenance of roofs, cleaning out of storage tanks, disinfection using household bleaches, routine checks and replacement of point-of-use devices.

Intake Maintenance

A correctly designed intake will remove a lot of the large particulate material, but the intake will still need to be cleaned periodically.

You can clean intakes manually by removing and cleaning and/or replacing, cleaning in situ and in some cases back flushing.

Where a bore has a screen, the screen can become fouled with bacterial encrustations. This build-up may not be harmful, but it reduces the size of the screen until water cannot be drawn through it. You can use chlorine down the bore to reduce this problem, but you should seek specialist advice first.

Bores can clog over time, depending on how well the bore was “developed” when it was drilled. If the bore is clogged you will need a specialist well-drilling firm to fix it.

Roof Painting and Maintenance

If you use a roof catchment for your water supplies, there are certain practices to avoid.

For instance, the metals lead, chromium and cadmium are toxic and a roof painted with paint containing these metals should not be used as a source of drinking water. Lead and chromium are more likely to be found in primers and rust control coatings.

While modern roof paints are generally labelled for their suitability for painting a roof for water supply, you should still talk to a technical representative from a paint manufacturer before painting.

A roof used for your water supply requires routine cleaning, with the water flushed to waste.

Water should be set aside for cleaning, and the line feeding the water storage tank should be disconnected.

You can use a scrubbing brush, broom and clean water to scrub down the roof and clean out and flush through the spouting. This clears the roof of dirt, animal droppings, biological growths, paint breakdown and other potentially harmful rubbish.

Cut back overhanging and nearby vegetation to reduce the load of leaves falling or blowing on to the roof and to restrict access by rats, cats and possums.

It is not uncommon in the summer in rural areas for mass migrations of flying insects to be attracted to the lights of houses, resulting in huge numbers landing on the roof. Many of these animals will have been associated with animal wastes so may be carrying protozoa and helminth eggs. It is advisable to shut the intake and clean the roof and gutters before the next rain event.

Cleaning Storage Tanks

Your tank should be large enough to allow any material to settle out, with a scour valve located at the bottom. If the drinking water is not drawn from a floating intake, ensure that it is drawn from above the sludge layer.

Your tank can be cleaned by removing all the water and then using clean water to sluice it and scrub it out. If the tank has an anti-corrosion coating, clean it carefully. The sediment should be removed, and the tank cleaned, regularly. The frequency will depend on whether leaf guards, first flush diverters and automatic desludgers are installed. Cleaning will certainly be needed if the water becomes coloured or turbid or develops tastes and odours.

WARNING: should you need to enter the tank, ensure the tank has adequate ventilation and there is another person present. If you really have to work inside the tank, first read the Department of Labour's *Safe Working in a Confined Space*, http://www.business.govt.nz/

Refill your tank with disinfected water. This, however, is not always practical for roof supplies.

A long-handled clean broom can be used to push all the sludge on the bottom of your tank out through the scour valve. Alternatively, a device like a swimming pool vacuum cleaner could be used.

Disinfection of Storage Tanks and Reticulation Lines

Tanks and pipework, servicing all biologically impure supplies, should be disinfected regularly to reduce the concentration of biological growth.

You will find that for normal disinfection purposes, a dose of 5 mg/L of chlorine is usually sufficient.

You can use plain household bleach for this job; do not use flavoured, scented or coloured brands. In new containers, the bleach consists mainly of sodium hypochlorite at a concentration of about 3–5 percent active chlorine. As opened or old containers will be significantly weaker than this, they should not be used.

A tank is always disinfected on a water volume basis. The volume may have been provided by the manufacturer or it can be calculated as follows.

Calculating Your Tank Volume:

(a) Square Tank

The water volume in litres is equal to length x width x depth of water x 1000. All measurements of tank dimensions should be made in metres.

- For example, a cubic tank measuring 1 m x 1 m x 1 m would have a volume of 1 x 1 x 1 x 1000 = 1000 litres.

(b) Circular Tank

Measure the diameter and the depth of water. The tank volume in litres is equal to 0.785 x diameter x diameter x depth x 1000.

- For example, a tank 1 m diameter and 1 m deep would have a volume of 0.785 x 1 x 1 x 1 x 1000 = 785 litres.

The Disinfection Tables, Appendix II and Appendix III (pages 24 and 25), can be used to calculate the amount of bleach or pool chlorine.

- For example, a tank with a volume of 1000 litres requiring 5 mg/L for disinfection purposes needs 167 mL of plain household bleach.

Note that some manufacturers now sell household bleach as a 5 percent solution. The volumes in Appendix II are based on a 3 percent solution. If you are confident the solution is fresh, you can multiply the volume stated in Appendix II by 0.6 (i.e., roughly between half and two-thirds). However, household bleach has a fairly poor shelf life so using the volumes in Appendix II would still be effective – the apparent overdose will have no health effects.

An accurate measure, such as a graduated measuring container, should be used to measure the bleach. Most plastic bottles today display their capacity.

After you have dosed your tank and mixed it well, the dosed water should be run through all your household lines so that the newly-disinfected water comes through the taps.

Isolated water supplies also need regular dosing. How often this is done depends on your water source, but it should be done at least once a month. Even though the water looks clear, it may still have high concentrations of bacteria or viruses. If you use chlorine to clear out the tank and the pipework, it can make the water unpalatable, so boil the water before use – this removes most of the chlorine.

Point-of-use Device Checks and Replacement

When you select a point-of-use device, think about how long it will operate before parts need replacing, and how much these parts will cost.

Equipment manufacturers and reputable suppliers should be able to indicate how long the equipment will last with your water supply.

Filter cartridges need to be replaced periodically, including activated carbon types, reverse osmosis and ultrafiltration membranes, ion exchange resins and also the tubes/lamps used in ultraviolet light apparatus.

These items will need regular checking and should be replaced as recommended by the manufacturer.

Where a replacement item is expensive such as a reverse osmosis membrane, water quality tests as shown in Section 5 (page 8), should indicate whether the equipment requires replacement.

10 INFORMATION

Information should be:

- convenient to you
- correct.

Table 8 gives a list of people and places to contact for information.

Table 8: Information Sources

SOURCE	EXPERTISE	HOW TO FIND THEM IN TELEPHONE OR THE WATER NZ DIRECTORY
Environmental health officers	All aspects, including local bylaws and regulations	Your local authority (city or district council)
Health protection officers	All aspects	Your public health service
Water testing laboratories	Water analysis and interpretation	Analytical laboratories
Regional council	Local water sources and likely contaminants, restrictions on use	Your regional council
Water treatment equipment suppliers	Capabilities of their equipment	Water treatment
Specialist environmental consultants	All aspects, especially system design	Environmental consultants
Master plumber	System installation cost	Plumbers
Backflow specialists	Installation, inspection	Backflow listings, or from your local authority
Building Research Assn of NZ (BRANZ)	Building materials, design, installation	Wellington phone book

For further information:
Drinking-water Standards for New Zealand 2005 (revised 2008). Go to www.moh.govt.nz/water and click Publications and select 2008.

Guidelines for Drinking-water Quality Management for New Zealand. Go to www.moh.govt.nz/water and click Publications. The Guidelines were republished in 2013. Small water supplies are discussed in Chapter 19.

New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters – Interim Guidelines. Ministry for the Environment and Ministry of Health. 2009. See http://www.mfe.govt.nz/publications/water/guidelines-for-cyanobacteria/index.html

In 2006, BRANZ published *Rainwater Collection for Domestic Use*, bulletin 478.

NZWWA (2013). *Boundary Backflow Prevention for Drinking Water Supplies*. 41 pp. New Zealand Water and Wastes Association, Wellington. http://www.waternz.org.nz

WHO (2011c). *Guidelines for Drinking-water Quality 2011* (4th Ed.). Geneva: World Health Organisation. Available at: http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/index.html

APPENDIX 1: GLOSSARY

AERATION: usually used with bore waters to drive off carbon dioxide (CO_2) or change (oxidise) dissolved iron into a solid form before filtering it out.

AESTHETIC QUALITY: factors that affect the water's appearance, taste, odour or the economics of its use, but are not directly a health concern.

ALGAE: small plants that can live in natural surface waters. They can cause discoloration, taste and odour problems. The toxins from blue-green algae (cyanobacteria) can be toxic.

ACTIVATED CARBON: a form of charcoal, the black material left behind from partly burnt wood or coal. It is activated by steam treatment at high temperatures, making the material extremely porous and reactive. Granulated activated carbon comes in small lumps or granules. The sizes vary but are usually about 3 to 5 mm in diameter. Powdered activated carbon is a very fine powder that is normally impregnated on to a cartridge.

AKDOLIT: a proprietary material made from dolomite that can be used for filtration or suspended in a tank to reduce corrosivity by taking up the CO_2. The current New Zealand agents are Davey Water Products Ltd, Auckland.

BACTERIA: a type of biological contaminant that in some cases are capable of causing waterborne disease. Bacteria are usually very small, about 1000th of a mm in size, and cannot be seen with the naked eye. They are capable of reproducing at an astonishingly fast rate and are responsible for waterborne diseases such as cholera, typhoid, camplyobacteriosis or gastritis.

BIOLOGICAL CONTAMINANTS: are unwanted living organisms, capable of causing waterborne disease. Biological contaminants can also cause slimes and odours and affect taste. Examples include bacteria, viruses, protozoa and worms.

BORE: a small diameter hole sunk/drilled into the ground tapping into a layer of water and usually, with the aid of an underground pump, pushing the water to the surface. In New Zealand, we do not use wells that are dug holes (usually open to the air) where water is taken by lowering a bucket. Also, see secure bore water.

CALCIUM FILTRATION: see akdolit.

CARTRIDGE FILTER: fine filtering material available in small cartridge form like a tube. This filter can be placed inside a point-of-use device and discarded once the filter is clogged. The filter medium is usually made from polypropylene or similar material. Capable of removing materials down to 1000th of a mm (1 micron), they are a cheap and effective means of removing contaminants like protozoa. Care is needed when assembling them.

CERAMIC CANDLE FILTER: the first clay-based or earthenware models were introduced in the 1820s and are not very common in New Zealand today. Some may incorporate activated carbon to help remove organic substances. They can be cleaned manually.

CHEMICAL DETERMINANDS: are usually dissolved in water and invisible to the naked eye. They may occur naturally, for example, due to the slow leaching of chemicals from soil and rocks. Chemical determinands may cause staining and odour, affect taste and in some cases cause health problems.

CORROSIVE WATER: slowly dissolves metal pipes and fittings, causing taste and staining problems, and even failure of materials. Most natural waters, particularly bore and rain waters, are corrosive to some extent.

CYANOBACTERIA: (previously called blue-green algae) are a major group of aquatic bacteria, often with the ability to carry out photosynthesis. They can form dense populations (blooms) producing cyanotoxins, which can be poisonous.

DIARRHOEA: the excessive evacuation of liquid faeces. It is a symptom of an upset or illness and is usually caused by either irritations or infections by micro-organisms within the intestines. If diarrhoea is caused by microbiological infection then the person or animal will usually produce large quantities of the organism causing the problem.

DISINFECTION: the inactivation of biological contaminants in water that are capable of creating waterborne disease. Chlorine is one of the most commonly used water disinfectants and is readily available in the form of plain household bleach. Small quantities can be used safely to disinfect contaminated tanks and pipes. See Section 9, Appendix II and Appendix III.

DISTILLATION: a process where water is boiled and the steam condensed. Distillation is an effective treatment process removing virtually all contaminants. It requires on-going power usage. A viable option for some people may be to purchase distilled water from a pharmacy. Distilled water is insipid and lacks minerals.

FAECES: the solid waste that comes from the bowels of humans and other animals. If an animal or person is carrying a disease that can be spread by a waterborne route, then their faeces will often contain high concentrations of disease-causing organisms.

FILTRATION: a process where water is passed through a treatment device that screens or removes certain types and sizes of particles. Filters may be coarse and remove large particles, or fine, such as ultrafilters, capable of removing most substances.

GERMS: a general term for organisms that can cause disease.

HARDNESS: almost entirely due to the natural presence of calcium and magnesium. Water hardness does not cause health-related problems, but high hardness can cause excessive use of soaps and the scaling and premature failure of hot water cylinders and heating elements. Calcium can leach from concrete.

HAZEN UNITS: a unit that measures the colour of water.

ION EXCHANGE: ion exchange treatment units can be cationic, anionic, weakly or strongly ionic, or mixed bed, depending on the reason for its use. One of the commonest domestic water supply uses is for water softening.

IRON: a mineral naturally found in water. It may occur in groundwaters and surface waters, or it may come from corrosive action where tanks and pipes are made of iron or steel. Iron can cause brown staining and undesirable tastes and smells and may choke pipes and valves.

MAGNETIC TREATMENT: occurs when water is passed through a magnetic field, usually a permanent magnet, to reduce the formation of hard scale.

MANGANESE: a mineral naturally found in water, often slowly leached out of soil and rocks by the action of carbon dioxide in the groundwater. It may be present in bore water and can cause taste and smell problems and black staining. High levels have health effects.

mg/L: milligrams per litre; a measure of the concentration of a substance in water. Equivalent to parts per million (ppm) or grams per cubic metre (g/m^3).

NTU: Nephelometric Turbidity Unit is the scale of measurement for turbidity.

pH: a measure of the hydrogen ion content of water. Measured on a scale of 0–14, pH 7 being neutral. Low pH waters are acidic and corrosive, high pH waters can be scale forming when heated. Rainwater may have quite a low pH (around 6.0) and may therefore corrode metal pipes and fittings.

POTABLE: safe to drink for a lifetime.

PROTOZOA: are single-celled animals, some of which can cause waterborne disease in humans. Problem-causing protozoa include species of *Entamoeba, Giardia* and *Cryptosporidium.* These are found in the environment in cyst or oocyst form. The smallest is approximately 4 microns (a 250th of a mm) in diameter. Once swallowed, they can hatch into mature protozoa, which are then able to breed and cause internal diseases.

REVERSE OSMOSIS: a process where water is forced by high pressure through a semi-permeable membrane that allows only pure water, some gases and a few trace small elements to pass. A fairly high proportion of the water being processed is discarded.

SCALE: a precipitate that forms on the elements of jugs and hot water cylinders and around the insides of hot water cylinders and pipes. It usually occurs when the water is hard. Scale usually consists of the chemicals calcium carbonate, magnesium oxide and silica. Although harmless to health, it can cause electric heating elements to burn out and hot water cylinders to perform poorly.

SECURE BORE WATER: secure bore water has been demonstrated to be free from surface influences and free from contamination by harmful micro-organisms. It must be abstracted via a bore head demonstrated to provide protection from contamination. Water from springs and unconfined aquifers with bore intakes less than 10 m deep are excluded. See DWSNZ.

SPRING: groundwater that seeps to the surface.

TURBIDITY: is due to suspended material in the water. Much of the suspended material cannot be seen with the naked eye, but as it reflects light, it is seen as cloudiness. Turbid water can prevent disinfection processes from acting effectively.

ULTRAFILTRATION: ultrafiltration can remove particles down to the size of approximately 0.1 micron (1/10,000th of a mm). Some ultrafilters are capable of removing all biological contaminants. They can clog quickly and should only be used with relatively clear water or following upstream filters.

ULTRAVIOLET LIGHT: is used to disinfect water by treating biological contaminants so that they are unable to reproduce, making the organism harmless. A UV point-of-use device must be used with relatively clean water, allowing the light to penetrate with sufficient intensity throughout the reaction chamber. The lamps degrade with time and must be replaced on a six monthly to a yearly basis. UV disinfection devices should have a built-in monitoring system that indicates that the device is operating correctly and warns of lamp deterioration or failure.

UVT: a measure of the amount of UV light that passes through the water to the sensor. Organic matter in water absorbs UV light, thereby reducing the effect of UV disinfection. For the process to be effective, the UVT should exceed 80 percent (measured in a 10 mm cell).

VIRUSES: are extremely small particles (less than 10,000th of a mm) capable of causing waterborne disease. The main source of a virus is human and animal faeces already infected with disease. Disease causing viruses that are capable of being transmitted through water include hepatitis A and norovirus.

APPENDIX II: DISINFECTION USING SODIUM HYPOCHLORITE (PLAIN HOUSEHOLD BLEACH)

Table 9: Disinfecting with Sodium Hypochlorite

TANK VOLUME LITRES	BLEACH (mLs) REQUIRED TO ACHIEVE CHLORINE DOSE OF:			
	1 mg/L	2 mg/L	5 mg/L	10 mg/L
50	2	3	8	12
100	4	7	17	33
150	5	10	25	50
200	7	13	33	67
250	9	17	42	83
300	10	20	50	100
350	12	23	58	117
400	13	27	67	133
450	15	30	75	150
500	17	33	83	167
600	20	40	100	200
700	23	47	117	233
800	27	53	133	267
900	30	60	150	300
1000	33	67	167	333
2000	67	133	333	667
3000	100	200	500	1000
4000	133	267	667	1333
5000	167	333	833	1667
6000	200	400	1000	2000
7000	283	467	1167	2333
8000	267	533	1333	2667
9000	300	600	1500	3000
10000	333	667	1667	3333
20000	667	1333	3333	6667

To use the table:

1. Calculate your tank volume in litres (see Section 9, page 17, and select this on the left-hand column).
2. Select the dose rate required at top of the table:
   - 1 mg/L routine disinfection for clean water
   - 2 mg/L routine disinfection for reasonably clean water
   - 5 mg/L period disinfection for tanks and pipes
   - 10 mg/L superchlorination for biologically contaminated tanks. (Remove contamination. Allow water to sit for 24 hours before drawing. Boil before drinking until the chlorine level is back to normal.)
3. Read the amount of sodium hypochlorite (in millilitres) to be added, where the dose required corresponds to the volume of the tank.
4. Add required millilitres of fresh plain household bleach and mix in thoroughly.
5. If your using imperial measures, 1000 litres equals 220 gallons; 5000 gallons equals 22,730 litres.

APPENDIX III: DISINFECTION USING CALCIUM HYPOCHLORITE (e.g., HTH or SWIMMING POOL CHLORINE)

Table 10: Disinfecting with Calcium Hypochlorite

TANK VOLUME LITRES	HTH (grams) REQUIRED TO ACHIEVE CHLORINE DOSE OF:			
	1 mg/L	2 mg/L	5 mg/L	10 mg/L
50	0.08	0.15	0.4	0.8
100	0.15	0.3	0.8	1.5
150	0.2	0.5	1.2	2.3
200	0.3	0.6	1.5	3.1
250	0.4	0.8	1.9	3.9
300	0.5	0.9	2.3	4.6
350	0.5	1.1	2.7	5.4
400	0.6	1.2	3.1	6.2
450	0.7	1.4	3.5	6.9
500	0.8	1.5	3.9	7.7
600	0.9	1.9	4.6	9.2
700	1.1	2.2	5.4	10.8
800	1.2	2.5	6	12
900	1.4	2.8	7	14
1000	1.5	3	8	15
2000	3	6	15	30
3000	5	9	23	46
4000	6	12	30	60
5000	8	15	40	80
6000	9	20	45	90
7000	10	20	50	110
8000	12	25	60	120
9000	14	30	70	140
10000	15	30	77	155
20000	30	60	154	310

To use the table:

1. Calculate your tank volume in litres (see Section 9, page 17, and select this on the left-hand column).
2. Select the dose rate required at top of the table:
   - 1 mg/L routine disinfection for clean water
   - 2 mg/L routine disinfection for reasonably clean water
   - 5 mg/L period disinfection for tanks and pipes
   - 10 mg/L superchlorination for biologically contaminated tanks. (Remove contamination. Allow water to sit for twenty four hours before drawing. Boil before drinking.)
3. Read the grams of calcium hypochlorite (HTH is a common trade name) to be added where the dose required corresponds to the volume of the tank.
4. Add weighed amount to a bucket of clean water and allow to dissolve for six hours.
5. Pour off the liquid from the top of the bucket.
6. Bury the sludge from the bottom of the bucket.
7. If your using imperial measures, 1000 litres equals 220 gallons; 5000 gallons equals 22,730 litres.

CAUTION:

Calcium hypochlorite is a highly reactive, explosive and poisonous chemical. It should be stored by itself in a secure, dark, dry area and on no account must it be allowed to come into contact with organic liquids such as petrol, diesel, lubricating oils, hydraulic fluids or naked flames. Ensure the chemical you are using is calcium hypochlorite at 65 percent available chlorine, with no other additives.

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