Design wastewater volumes for on-site wastewater service

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1 Introduction

This Fact Sheet has been prepared to address the question of what is an appropriate wastewater volume for the **design** of an on-site wastewater service.

Wastewater volume for domestic on-site wastewater system is usually expressed as L/day

2 Design wastewater volume (DWV)

2.1 Defining DWV

Design wastewater volume (DWV), is different from **average wastewater volume** (over, say, a 1 year period). Normally the DWV will be of higher magnitude. The DWV is chosen to ensure that the system for managing the wastewater for a specific site is going to perform well, for the period of its design life (or consent duration), and to the required/specified performance standards. These standards may be specified by, for example, the conditions of the resource consent, regional or district rules or approved standards (e.g. AS/NZS 1547:2000). The DWV is usually a conservative value.

Appropriate value of the DWV is dependent on:

- The level of conservatism desired in the design of the component;
- The actual component (and its resilience) that is being designed e.g. treatment unit or land application component. The DWV for each component of the same system does not necessarily have to be the same as their resilience (to variable daily volume) may be different; although it is common that they are the same.

Wastewater volumes from a family dwelling can vary and are dependent on:

- Number of people occupying the house;
- Types of wastewater producing technologies used in the house such as the type of washing machine, shower heads, toilet cisterns;
- Habits and behaviour of the occupants – for example duration of showering;
- Reliability and availability of the water supply to the house. Some houses may be on roof water or restricted water supply and under these circumstances occupants develop habits of efficient and low water use, resulting, therefore, in lower wastewater production.

There are two common approaches to choosing a **design wastewater volume (DWV).**

- Apply a **peaking factor** (PF) to the average volume.
- Use a design volume based on standards such as AS/NZS 1547:2000 and TP58 3rd Edition.

2.2 Determining DWV using the Peaking Factor.

It is standard and common practice to apply a peaking factor (PF) to the average daily wastewater volume to determine the DWV such that:

DWV = PF x Average wastewater volume (L/p.day)x Average number of occupants

For example, if the average wastewater volume is 180 L/person.day and the average number of occupants is 2.7 people/house then;

DWV = PF x 486 L/day

Crites et al (1998) recommend a peaking factors of between 2 to 5 with a typical PF of 2.5 (Table 4.20, p 205).

In the above example, for a PF of 2.5, **DWV becomes 1215 L/day.**

2.3 AS/NZS 1547:2000 recommendations

Section 2.4.2.1 (p24) recommends 200L/person.day for all waste units and notes that this ….*is conservative to ensure that the unit has capacity to cope with peak discharge rates or for temporary or unusual overloads.*

Note that AS/NZS 1547 offers no recommendation on the occupancy per bedroom.

If an average occupancy of 2.7 people/house (NZ Statistics for Canterbury Region) then:

DWV becomes 2.7x 200 = 540L/day.

Section 4.3.4.2 states that *wastewater-treatment units in general shall be of sufficient volume to cope with the flow range generated from a population equivalent of up to 10 persons and a maximum flow rate of up to 14000L/week*

On this basis **DWV becomes 10 x 200 = 2000L/day.**

Note: Section 4.3.4.2 of the Code refers to the **treatment unit**. The code makes no flow volume recommendation for the **land application system**.

Table 4.2D AS/NZS 1547 recommends typical wastewater flow allowances in L/person.day. and notes that these are *minimum flow rates unless actual flows from past experience can be demonstrated.* The household daily flows given are as in the following table.

Household source conditions	Typical wastewater flow allowance in L/person.day	
	On-site roof water tank supply	Reticulated community or a bore-water supply
Standard fixtures (including automatic washing machines)	140	180
Standard water reduction faculties	115	145
Full water reduction faculties	80	110
Extra wastewater producing features	170	220
Blackwater only	50	60
Grey water only	90	120

2.4 TP58 3rd Edition recommendations

TP58 (3rd Edition) offers recommendations in terms of wastewater volume per person and occupancy in relation to the number of bedrooms.

TP58 recommends that:

- *design flows should be based on the maximum possible number of persons occupying the premises*

and

- *per capita wastewater flow allowance according to the nature of that occupancy*

(p 49)

They recommend the following occupancy levels:

Number of bedrooms	Occupancy
1	2
2	4
3	5
4	6
5	8
6	9
Minimum occupancy 4	

TP58 recommends a range of daily per capita wastewater flows depending on:

- Type of water supply (roof water to reticulated community supply);
- Types of household fixtures.

The daily per capita wastewater flows vary from 145L to 220 L for permitted activity (Refer Table 6.2, p 52 in TP58 3rd Edit.) .

If water saving facilities are adopted in the dwelling, TP58 suggests that daily per capita wastewater volume may be 115L

Therefore, based on TP58 for a 4 bedroom home:

- with luxury water facilities - DWV = 6x220 = 1320 L.
- with full water saving facilities – DWV = 6 x 115 = 690 L.

If per capita wastewater flows of less than 145 L are specified then TP58 requires that a water meter is fitted to monitor flows.

3 ecoEng Assessment

There are a number of stakeholders who are concerned that the on-site wastewater service performs well. These include:

- The consenting authority who, on behalf of the public, require that the system meets public health and ecosystem performance standards for the duration of the consent; and this duration may be for up to 35 years;
- The property owner who requires a trouble free and cost effective service;
- The system designer and technology suppliers require the system to meet accepted performance standards to ensure the integrity of their profession and industry;

The performance standards are normally determined by experts and in consultation with the consenting agencies and the industry. These standards also will draw on good science, engineering and field experience/data.

It is clear from the information offered in Section 2, that the selection of the DWV is not a simple matter and that there is no clear agreement, among the experts, on the appropriate value or the procedure for determining DWV.

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3.1.1 ecoEng offers the following comments:

AS/NZS recommends that *wastewater-treatment units…. shall be of sufficient volume to cope with the flow range generated from a population equivalent of up to 10 persons.* A number of on-site biological wastewater units are designed to operate at a specific phase of the biological growth curve of the organism (mostly bacteria) performing the biodegradation of the incoming wastewater organics. Such systems use the biological processes of aerobic suspended growth and/or fixed media. If the biological processes fall outside the desired growth curve phase, due to either under-loading or overloading, then the treatment performance will decline. Therefore if such a unit is designed for a volumetric and organic load from 10 people, and there are only 2 people occupying the house then the system will under-perform and the effluent standard will be compromised. If, in such a case, the dispersal system is subsurface drip irrigation, then this could result in blockage of the filter and maybe the dripper lines.

As mentioned earlier, the two key components of most systems are the treatment system and the land application system. It is ecoEng's experience that some treatment systems have a lower resilience (in terms of treatment performance) to variable daily flow volumes than the disposal system has. For example a subsurface irrigation system may have the capacity for several days of higher than normal application volumes (say during holiday season and family gatherings) without unacceptable public health or environmental consequences and provided the treatment unit continues to perform to a high and consistent standard.

3.1.2 ecoEng recommendations

Based on the recommendations offered in Section 3, DWV for a typical household may be anywhere between 540 to 2000L/day. Therefore even by using recommended codes and guidelines there remains some uncertainty as to a suitable value for DWV.

When deciding on an appropriate value for the DWV, ecoEng recommends that the following factors are taken into consideration:

- Number of bedrooms
- Average and peak occupancy
- Average and peak per capita wastewater volume
- Type of water supply and nature of water supply restrictions
- Type of wastewater treatment system and land application system and their respective resilience to variable hydraulic loads.
- Type of water fixtures in the house (e.g. water saving fixtures).
- Detail of the conditions that can be applied by the consenting authority and particularly in relation to the ongoing servicing and monitoring of the system.

When considering the DWV for the land application system, consider the post-treatment effluent quality and its variability – in particular refer to the work of Laak (1986).

In taking these factors into consideration, a risk assessment approach should be adopted to assist with the selected DWV.

ecoEng supports the TP58 recommendation that if per capita wastewater flows of less than 145 L are specified, then it be a requirement that a water meter is fitted to monitor flows.

While consenting authorities are concerned to ensure adequate system performance over the duration of the consent as granted, most consents can specify conditions that require adherence to performance criteria such as; maximum daily volume to be dispersed, required separation distances, no odours, no ponding or runoff…….. Therefore, once granted, it is the responsibility of the consent holder that these conditions are adhered to over the duration of the consent.

References

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