Health New Zealand
Te Whatu Ora

Sewage Spills to Land
Protocol for Clean-up and Management

Purpose and scope

These Guidelines provide information for public health officers on the clean-up and management of sewage spills to land at non-workplace environments.

Spills of sewage sludges or liquefaction silts contaminated with sewage are excluded as pathogens can be concentrated in sediments. Seek specific advice for these types of events.

Background

Overflows and spills from sewerage systems to land are unauthorised discharges under the Resource Management Act 1991 and can expose people to untreated sewage. These discharges can create a nuisance under the Health Act 1956 and/or not comply with the Building Regulations, 1992.

Untreated sewage can contain a range of pathogens including bacteria (e.g. *Salmonella* spp., *Campylobacter* spp., *Staphylococcus aureus*), viruses (e.g. rotavirus, norovirus, adenovirus, hepatitis A virus), and protozoa (*Cryptosporidium* spp., *Giardia* spp.) and helminthic parasites. Potential health effects associated with exposure to untreated sewage include skin, gastrointestinal and respiratory infections. The amount and types of human pathogens in sewage at any given time depends on the health status of the population (WHO, 2006). A range of factors such as moisture, sunlight, temperature and soil properties will affect the survival of microorganisms on the ground (WHO 2006, Santamaría and Toranzos 2003). High moisture, lack of sunlight, soil properties (e.g. low pH, presence of organic matter), and some soil types (e.g. clay) assist pathogen survival.

Communication

If the local office of the National Public Health Service (NPHS) is the first point of contact, then district and regional authorities should also be informed of any sewage spill and subsequent remediation.

Transfer routes

When sewage spills or overflows the potential exposure routes to be considered include:

- Ingesting soil in residential settings with some home grown produce – amounts ingested are about 50 mg/day for children and 75 mg/day for adults (MfE 2011)
- Hand-mouth contact with contaminated ground, objects or surfaces (e.g. playground surfaces, balls). Children <2 years-12 years have been observed to have hand and object contact with mouth 14 times an hour (AuYeung et al. 2005;

Beamer et al. 2012). The frequency decreases with age.

- Direct contact with contaminated ground while playing contact sport like rugby. Estimated amounts ingested are 25 mg/day for a child up to 14 years and 75 mg/day for an adult (MfE 2011).
- Walking over the contaminated ground and transferring contaminated material inside on shoes/feet.
- Pets coming into contact with contaminated material and tracking contaminants inside and/or people touching pets.
- Dust and aerosols from the contaminated ground e.g. watering or mowing lawns and/or digging.
- Consumption of vegetables grown in contaminated soil, or fruit or vegetables dropped onto contaminated ground.

Children are at higher risk as they engage in behaviours which are more likely to bring them into contact with contaminants – e.g. hand to mouth, object to mouth, walking outside in bare feet, playing and consuming more food per body weight.

Remedial options

General Notes

- Mitigation measures depend on the size and the location of the spill (see Table 1).
- Clean surfaces as much as possible by scrubbing with water and detergent, before disinfection with diluted bleach (1:10 dilution of bleach), as residual organic matter will reduce the effectiveness of the disinfectant.
- The time period for excluding access to the affected area depends on the season as micro- organisms will survive longer in soil in cooler temperatures.

Precautions - Personal Safety

- Anyone cleaning the affected area or handling contaminated equipment or material must wear appropriate protective clothing such as waterproof gloves, masks, overalls (preferably waterproof), and gumboots. These must be disinfected after each use with diluted bleach (1:10 dilution), washed separately or thrown away.
- No eating, drinking, smoking or vaping within the affected area before decontamination.
- Wash with soap and dry hands thoroughly after handling any contaminated materials and before eating.
- Cover wounds or grazes to protect from contact with sewage or contaminated soil.
- Bleach is a hazardous chemical, so handle it with care.
- Do not mix cleaning chemicals and bleach as hazardous products may form.

Precautions - Environmental

- Runoff (sewage, rinse water, or bleach) must not contaminate waterways. Contact the Regional Council if the spill occurs close to a waterway.
- Control runoff when using bleach as it will damage grass.

Table 1 – Actions for sewage spills for different land uses

Land use	Remedial action

Residential backyard, including vegetable gardens	• Restrict access to essential people only, exclude children and pets.
	• Remove gross solids and dilute as much as possible.
	• If the spill is large, use a waste contractor to remove as much liquid and solids as possible.
	• Play areas:
	  ○ Remove all moveable equipment in the affected area (e.g. outdoor furniture, play equipment) to a restricted area until it has been scrubbed with water and detergent, disinfected with diluted bleach (1:10), and thoroughly dried (at least 24 hours).
	  ○ Sand and bark from children's play areas should be removed and disposed of in accordance with the district and regional rules. Pathogens in sand can be transferred to hands (Whitman et al. 2009) and have been associated with a *Salmonellosis* outbreak (Staff *et al*. 2012).
	• Vegetable garden and fruit: The potential for contamination is variable and depends on the type of vegetable, how it grows, and how it is prepared for eating (WHO 2006). For example, peeling fruit or vegetables gives a two log reduction in exposure to pathogens on the outside of produce (NRMMC, EPHC, and AHMC 2006), but pathogens may be internalised during the growth of vegetables so a cautious approach is needed (Ge *et al.* 2012). Pathogens may survive in soils for many months (WHO 2006).
	  ○ Dispose of all produce and dropped fruit in the affected area.
	  ○ Replace soil if possible[1], change use (lawn, ornamental garden, but follow Personal Safety requirements above when working with the soil), cover with more soil and compact (e.g. raised garden) or refrain from growing vegetables for the next for 60 days (USFDA 2011).
	• Restrict access
	  ○ Until the area has dried out AND
	  ▪ Withholding Period Scenario 1 – exclude access for seven days where there may be direct or indirect contact (e.g. playing with a ball) and advise residents to wash and dry hands for next seven days after direct or indirect contact.
	  ▪ Withholding Period Scenario 2 – exclude access for 38 hours if mean daily temperatures are above 17°C[2].

[1] Addition of lime is not recommended by CDC, as it is hazardous to achieve pH 12 (based on treating sewage sludge, not soil) and potentially causes other health and environmental problems (CDC 2011).

[2] Mean monthly air temperatures of 17-20°C in major New Zealand cities (NIWA):

- December - March: Auckland, Tauranga, Whangarei, extending to April around Kaitaia
- January - March: Hamilton, Wanganui Gisborne and Napier
- January - February: Rotorua, Taupo, Masterton, New Plymouth, Palmerston North, Blenheim, Nelson
- February - Wellington.

Land use	Remedial action

School playing field / Playground	• Erect signage and barriers to exclude people and pets
	• Use a specialist waste contractor to remove gross solids and as much liquid as possible and dilute spill if possible.
	• Play areas
	  ○ Remove all moveable equipment in the affected area (e.g. outdoor furniture, play equipment) to a restricted area until it has been scrubbed with water and detergent, disinfected with diluted bleach (1:10 dilution) and thoroughly dried (at least 24 hours).
	  ○ Sand and bark from children's play areas should be removed and disposed of in accordance with the district and regional rules Pathogens in sand can be transferred to hands (Whitman et al. 2009) and has been associated with a *Salmonellosis* outbreak (Staff *et al*. 2012).
	• Restrict access
	  ○ Until the area has dried out AND
	  ▪ Withholding Period Scenario 1) - exclude access for seven days and erect signage advising people to wash and dry hands for next seven days after direct or indirect contact with ground
	  ▪ Withholding Period Scenario 2) - exclude access for 38 hours if mean daily temperatures are above 17°C

Sportsground / Golf course	• Erect signage and barriers to exclude people and pets
	• Use a specialist waste contractor to remove gross solids and as much liquid as possible and dilute spill if possible.
	• Restrict access
	  ○ Until the area has dried out AND
	  ▪ Withholding Period Scenario 1) - exclude access for seven days and erect signage advising people to wash and dry hands for next seven days after direct or indirect contact with ground
	  ▪ Withholding Period Scenario 2) - exclude access for 38 hours if mean temperatures are above 17°C
	  ▪ Withholding Period Scenario 3) - exclude access for 14 days in areas where there may be direct contact (e.g. contact sports such as rugby), AND ground conditions are wet and muddy, so unintentional ingestion is possible[3].

Parkland	• Erect signage and barriers to exclude people and pets • Use a specialist waste contractor to remove gross solids and as much liquid as possible and dilute spill if possible. • Restrict access until the area has dried out.

[3] In wet conditions, pathogens may be ingested through direct contact with puddles, mud or objects in contact with the ground e.g. balls.

Appendix A: Estimation of withholding period after raw sewage spill using log reductions

After a spill is cleaned up, there will still be a period when the ground will potentially have higher than normal concentrations of pathogens. Exposure to pathogens needs to be minimised, as transfer of pathogens from the ground to mouths may occur through contact (e.g. via hands or objects such as balls) or ingestion in wet weather for contact sports like rugby.

A withholding period, where people and pets are excluded from the affected area, allows die-off to occur through environmental factors such as solar radiation, wind, and warm temperatures.

A withholding period can be estimated using information on pathogen die-off rates (log reductions), reductions in concentration along the transfer pathway, and washing and drying hands with soap (Foddai *et al.* 2016; Whitman *et al.* 2009) as shown in Table A, below.

The Australian Guidelines for Water Reuse estimated that viruses were the major contributors to the burden of waterborne gastrointestinal illness and are used in this assessment *(*NRMMC, EPHC, and AHMC 2006). Studies show viral indicators, MS2, FRNA phage and somatic coliphage survive longer in the environment than indicator bacteria, *E. coli* (O'Toole *et al.* 2008, Sidhu *et al*. 2008, Whall and Leonard, 2008) and bacterial pathogens such as *Staphylococcus aureus*, which causes skin infections, and *Salmonella* Typhimurium, (Sidhu *et al.* 2008).

Because these differences in die-off rates mean that indicator bacteria are not representative of the concentrations of pathogens, a log reduction approach has been used for viruses (Table A).

The die- off rates for MS2 from *Sidhu et al.* (2008) at 17-19°C were used to estimate one log reduction of viruses in areas of New Zealand where the mean daily temperature is 17°C or above[4]. For major New Zealand cities these periods are (NIWA):

- December - March: Auckland, Tauranga, Whangarei, extending to April around Kaitaia
- January - March: Hamilton, Wanganui Gisborne and Napier
- January - February: Rotorua, Taupo, Masterton, New Plymouth, Palmerston North, Blenheim, and Nelson
- February - Wellington.

For the remainder of the months and areas, data from Whall and Leonard (2008) were applied.

[4] New Zealand mean monthly air temperatures are not greater than 20°C (NIWA)

Table A shows typical log reductions in virus concentrations (using viral indicators) after a sewage spill:

1. Dilution: The virus concentration in raw sewage is reduced by 1 log (90%) as sewage spills over and into the ground. This is conservative as dilution of the sewage spill with water will further reduce the concentrations of pathogens.

2. Die-off:
   - At 17-19°C a 1 log reduction in the concentration of viruses occurred after 12.5 hours
   - At 2-10°C a 1 log reduction in the concentration of viruses occurred after seven days.

3. Behaviours: Washing hands with soap and water, and thorough drying can reduce virus concentrations by at least 2 log.

Withholding periods are estimated for different types of transfer:

Contact: Object/hand to mouth
- Seven days with signage to wash and dry hands after contacting objects/ground during the second week.
- 38 hours if mean daily temperature is greater than 17°C (12.5 hours if signage for hand washing is in place).

Ingestion[5] Contact sport in muddy conditions with mean temperatures below 17°C[3].
- 14 days assuming ingestion of 75 mg/day(game) during contact sport (MfE, 2011).

Under all conditions the ground must have dried out completely and any solid material removed before access is permitted (NRMMC, EPHC, and AHMC 2006).

[5] An infectious dose (ID) of enterovirus of about 50 is assumed to assess withholding periods as enteroviruses can have more serious consequences than norovirus, which has a very low infectious dose, but is self-limiting.

Table A - Log reductions in pathogens or surrogates with references

Exposure	Reduction	Virus concentration	References
Hazard			
Sewage		10^2 - 10^6 pfu/L	NRMMC, EPHC, and AHMC 2006
Spreading over/into the ground	1 log	10 -10^5 pfu/g	Whall & Leonard, 2008
Barriers			
Withholding period	1 log	1-10 ^{4} pfu/g	Sidhu *et al*. 2008, 12.5 hours based on MS2 phage and grass temperature 17-19°C Whall & Leonard, 2008, 7 days based on somatic phage and soil temperature 2-10°C
Pathway			
Transfer by contact	0.5 log	<1–$10^{3.5}$pfu/g	Bidawid, Malik *et al*. 2004, O'Toole *et al.* 2009
Removing skin of vegetable or fruit	2 log	<1-10^2 pfu/g	Table 3.5 NRMMC, EPHC, and AHMC 2006
Behaviours			
Rinsing/washing hands with soap[6]	2 log	<1–5x10 pfu/g	Whitman *et al.* 2009, Foddai, *et al.* 2016.

[6]These are minimum values as 2-3 log reductions are quite achievable.

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