Fall May 12, 2017

A gap to close. A literature review of waste management, health, and wellbeing in rural and remote

Kurt W Seemann, *Swinburne University of Technology - Australia*
Sarah McLean, *Swinburne University of Technology - Australia*
Paul Fiocco, *Swinburne University of Technology - Australia*

A gap to close

A literature review of waste management, health, and wellbeing in rural and remote Aboriginal and Torres Strait Islander communities

Project: WasteAid Review 2017
Partner: WasteAid Ltd
Authors: Seemann, K., McLean, S., & Fiocco, P.
Date: 2017

ISBN: 978-0-6480892-0-9

Terms of Reference and Background

WasteAid and Swinburne University of Technology have partnered to undertake a review of available literature on the matter of "waste" and its relationship with health and wellbeing in rural and remote Aboriginal and Torres Strait Islander Communities. This review was conducted by a cross-discipline research team in public and environmental health, remote community health hardware innovation research, and policy design and development research in the Centre for Design Innovation. The review represents a national and international look at key ideas and articles relevant to the topic of waste management and the health and wellbeing of Remote Indigenous Australian communities. The review complements the work by Anne Prince, 'The Rubbish Report' (Prince, 2011) that investigated the specific circumstances of waste management in the Anangu Pitjantjatjara Yankunytjatjara Lands of Central Australia, and the early benchmark work of Kurt Seemann and Bruce Walker, "Remote Controlled Waste" on the specific issues affecting Waste and 'Rubbish" in the Western Desert Pintupi Lands of Central Australia (K. Seemann & B. Walker, 1991).

The Terms of Reference for this literature review are provided below. The project aimed to form where possible, integrated insights published in the literature about the following:

- An appropriate definition from the literature to date (end 2016), for rural and remote Indigenous Australian localities/communities, and useful categories of waste management systems and their degree of efficacy
- Reported primary and secondary main health and wellbeing impacts from inorganic and organic waste in Indigenous Australian Localities, and where informative, in the boarder general Australian literature, where service and technology systems used have failed, do not exist, or have struggled to be maintained
- Reported key causal relationships driving health and wellbeing impact between poor organic and inorganic waste systems in Australia, and in Indigenous Australian Localities specifically
- Regional climatic seasonality impact on health from ineffective waste management systems

As a review of literature, this report does not include recommendations. However, we assert that there is *a significant gap to be closed* on this topic, especially in quantitative causal information in different locations, for different types of health impact found to be a direct relationship to existing poor or non-existing waste-management services. The potential for further research targeting incidents of causal relationships between waste and health in communities would significantly inform policy and fit-for-purpose place-based responses. The dearth of research to guide viable, maintainable, and effective outer-rural, remote, and very remote community waste management service innovations represents a research gap deserving dedicated attention.

Citation: Seemann, K. McLean, S. and Fiocco, P. (2017) *A gap to close: A literature review of waste management, health, and wellbeing in rural and remote Aboriginal and Torres Strait Islander communities.* Swinburne University of Technology, and Waste Aid Australia Ltd. Melbourne.

Acknowledgement: Ms Sutter and A/Prof. Barron: Readers, CDI, Swinburne University of Technology

Table of Contents

1. Executive Summary

A gap to close captures the main ideas evident in the literature on the relationship between health, waste management, and Aboriginal and Torres Strait Islanders living in rural and remote Australia (hereafter Indigenous Australians). The report represents the most comprehensive account on the theme to date. Modest information on the relationship between waste- and health in remote communities was captured in the recent "Closing the Gap" Report (Commonwealth of Australia, 2017). Our report offers a complementary account of waste and the gap of knowledge we have identified for guiding future policy and improvement to the quality of life in communities as it relates to place-based solutions, and policy development, for improving health and wellbeing.

Since European colonisation, the growth and development of sedentary human settlements across coastal, rural, and outback Australia has introduced extensive lifestyle and place-based challenges for Indigenous Australians. One of these challenges has been the concentrated accumulation of waste (in particular, domestic solid/physical waste that normally finds its way to landfill) and its impact on health, habitat, and wellbeing. While most Indigenous Australians now live in urban and inner/outer rural regions, about 98% of discrete Indigenous Australian communities, representing about 15,000 houses, and about 90,000 people, are located in outer regional, remote and very remote Australia (Australian Bureau of Statistics, 2003). Typically, these communities are small in size, sparsely dispersed, away from major markets and central service economies, often in extreme climate locations, and have relatively low local cash flow to socially, economically, and technologically sustain "conventional" waste management technologies designed for and used in urban waste collection, processing or environmental-health public services. Indigenous Australian families living in urban areas normally have access to reliable and weekly council waste collection and processing services, in addition to waste separation, annual or biannual, hard-waste collection, and two to three bin waste re-processing services.

However, those living in outer rural and particularly remote Indigenous managed community service locations experience considerably different waste impact challenges in both relative and absolute terms. Our summative analysis of the literature suggests that most remote communities continue to struggle to reliably collect, and sustain, domestic waste management systems designed to operate in urban street kerb conditions, with very different economic, service, and climatic seasonal factors.

We found that while the literature suggests an understanding of the broad causal relationship between personal health and substantial degrees of accumulated waste – such as human contact with toxic and harmful materials, trauma due to sharp objects, vector based diseases, parasites, and with harmful bacteria that can harbour and establish themselves in ideal micro-climate conditions in waste – the literature has a noticeably 'gap' in any serious studies that map the type and extent of failed waste management services and the causal health impact in rural and remote Indigenous Australia of such failure. This is a research gap we recommend deserves closing in the literature to inform policy design for managing the public and environmental health of remote and very remote Indigenous Australian communities. This is a major area for further definitive research if public health policy and the development of locally, place-based sustainable waste management services and technologies are to be assure for such households.

Waste is acknowledged to be a complex phenomenon in rural and remote Indigenous Australian communities. It has several categorical manifestations of its form, each potentially responding differently to local and regional conditions in how waste affects the environmental health and wellbeing of communities. This relationship between context and waste categories offers a basis for recommending place-based strategic public health priorities across Australia's diverse range of remote and rural communities. This targeted review of the literature offers categories of waste systems and services that WasteAid and similarly interested organisations may use to prioritise for developing locally and regionally sustainable waste management and innovation outcomes.

1.1. Problem statement

Remote Indigenous communities experience poor health compared to non-Indigenous Australians. Remote Indigenous communities also experience greater deprivation across the social determinants of health compared to non-Indigenous Australians. Many essential services that are taken for granted in non-Indigenous communities are either absent or inadequate in remote Indigenous communities. Poor solid waste management may be one factor that contributes to this health gap. Reasons for this inequity are myriad and cannot be cogently reviewed in the literature without reference to the related challenging policy, or interpretation of policy landscape.

1.2. Health status of Indigenous Australians

Indigenous Australians have significantly poorer health outcomes and a lower life expectancy compared with non-Indigenous Australians. It is estimated that Indigenous Australians suffer an almost two-and-a-half times greater burden of disease than non-Indigenous Australians (Australian Institute of Health and Welfare, AIHW 2016). Chronic diseases, including cardiovascular disease (CVD), and mental and substance abuse disorders contribute significantly to the burden of disease experienced by Indigenous people (AIHW 2016). In addition, the incidence and severity of infectious diseases is much higher in the Indigenous population than in the non-Indigenous population (Gracey & King, 2009). Hospitalisation rates for Indigenous Australians are also significantly higher than for non-Indigenous Australians, despite a greater proportion of Indigenous people living in remote areas which has been shown to disproportionately impact on access to health care services (Australian Institute of Health and Welfare, 2014a; Woods, Usher, Edwards, Jersmann, & Maguire, 2015).

The reasons for these disparities are complex, and include a range of interrelated historical, social and environmental factors. While it is acknowledged that these factors impact on health concurrently and cumulatively (Gee, Dudgeon, Schultz, Hart, & Kelly, 2014), this review will focus on the environmental determinants of Indigenous health, with an emphasis on the impact of solid waste on Indigenous health and wellbeing in remote communities.

1.3. Environmental determinants of Indigenous health in remote communities

A number of environmental factors may have a significant impact on health in remote Indigenous communities. Ware (2013) highlights that while a causal relationship has not been established between the living environment and health there is extensive evidence consistently linking the two. Holman and Joyce (2014b) estimate that poor environmental health in regional W.A. is responsible for approximately 20% of premature mortality amongst the Indigenous population.

This may be related to:

- Environmental factors unique to remote communities, including exposure to geogenic dust, biomass smoke and heavy-metal contaminated water (Clifford, Pearson, Franklin, Walker, & Zosky, 2015)
- Geographic isolation and inadequate transport and communications infrastructure (Bailie et al., 2002), and
- Living conditions within communities, particularly housing and related infrastructure such as power, water and waste management, household overcrowding, personal and community hygiene and poor dog control (Bailie & Runcie, 2002; Gracey & King, 2009; Gracey, Williams, & Houston, 1997; Torzillo et al., 2008)

The impact of poor housing on Indigenous health in remote communities has received a great deal of attention in the academic literature (Bailie & Runcie, 2002; Bailie, Stevens, McDonald, Brewster, & Guthridge, 2010; McDonald, Bailie, Grace, & Brewster, 2010; Torzillo et al., 2008) and in Government policy (Ware, 2013). The importance of a safe water supply, and sewerage and liquid waste removal is also acknowledged in the effort to maintain hygiene and prevent gastrointestinal disease (Bailie et al., 2002; Gracey & King, 2009; Gracey et al., 1997). While solid waste disposal is often mentioned in the same breath as water, sewerage and liquid waste disposal; its impact on health in remote Indigenous communities is not well understood and it is often considered a visual or aesthetic problem rather than a public health problem (Carson & Bailie, 2004). The causal link between solid waste and human health is also lacking in the non-Indigenous specific literature (Giusti, 2009). Despite this conclusion, waste collection is included in the Atlas of Health Related Infrastructure in Discrete Indigenous Communities (Bailie et al., 2002) and Wayte, Bailie, Gray, and Henderson (2007) emphasise the apparent lack of research and intervention in this area when compared with liquid waste.

1.4. How does solid waste contribute to poor health?

Potential health issues are associated with every step of the handling, treatment and disposal of waste (Giusti, 2009). Health impacts may occur following exposure to environmental hazards found in wastes. Waste is a complex mixture of different substances - only some of which are intrinsically hazardous to health (Rushton, 2003). Figure 1 and 4, adapted from Lisa Saffron, Lorenzo Giusti, and Derek Pheby (2003) illustrates the process by which adverse health outcomes may occur following exposure to hazards in solid waste. The likelihood of hazards associated with household level disposal and landfills are deemed to be considerably greater in rural and remote Indigenous Australian communities than the broader population.

1.5. The Gap to close

We assert that there is *a significant gap to be closed* on this topic, especially in quantitative causal information in different locations, for different types of health impact found to be a direct relationship to existing poor or non-existing waste-management services. The potential for further research targeting incidents of causal relationships between waste and health in communities would significantly inform policy and fit-for-purpose place-based responses. The dearth of research to guide viable, maintainable, and effective outer-rural, remote, and very remote community waste management service innovations represents a research gap deserving dedicated attention.

A keystone strategy that could address the future gap in knowledge identified in this report and that would inform policy, would be to classify waste management in remote and regional areas as essential services alongside power and water.

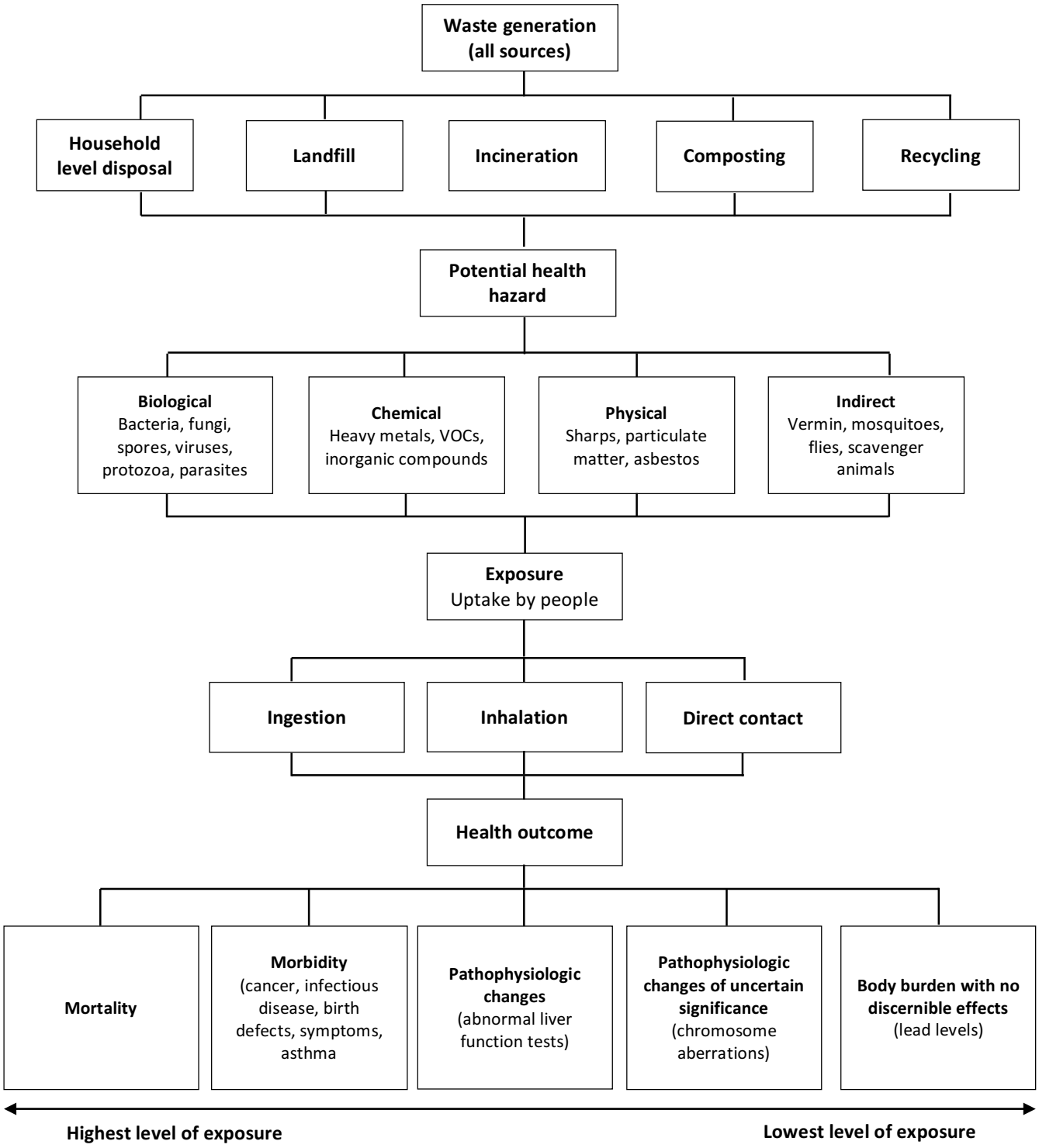

Figure 1 *Adverse health outcomes may occur following exposure to hazards in solid waste (Fig 1 is repeated as Figure 4 in main body of report with additional information)*

2. Defining Remote Indigenous Communities

What may appear to be a straightforward question, “How many communities are health affected by poor waste management services?” presents nominal classification challenges. The reviewed literature defines the term ‘Indigenous community’ as a geographical location based on the Australian Indigenous Geography Classification (AIGC) boundaries. The AIGC comprises three levels of geographic units in a single hierarchy: Indigenous Region (IREG), Indigenous Area (IARE) and Indigenous Location (ILOC).

ILOCs constitute the smallest geographical unit, representing statistical boundary locations that approximate small Indigenous communities with a minimum population of 90 Indigenous usual residents. For the 2011 Census, there were 1,116 ILOCs across the whole of Australia (see Figure 2.1 below).

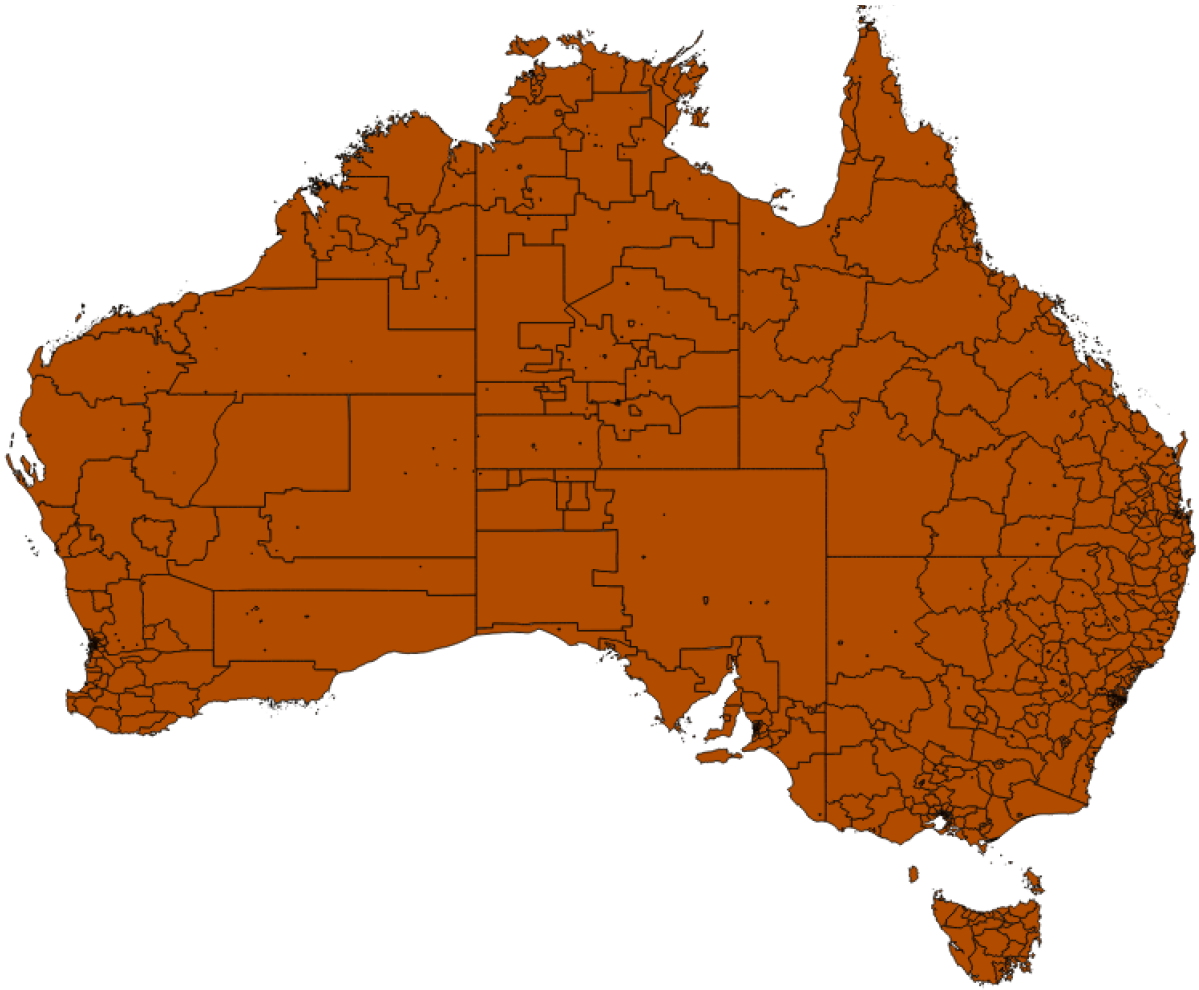

Figure 2.1. *Digital Boundaries for ILOCs (ABS, 2011)*

IAREs are medium sized geographical units consisting of one or more ILOCs and generally have a minimum of 250 Indigenous usual residents (ABS, 2016, p. 1). The 2011 Census identified 429 IAREs across the whole of Australia (see Figure 2.2 below).

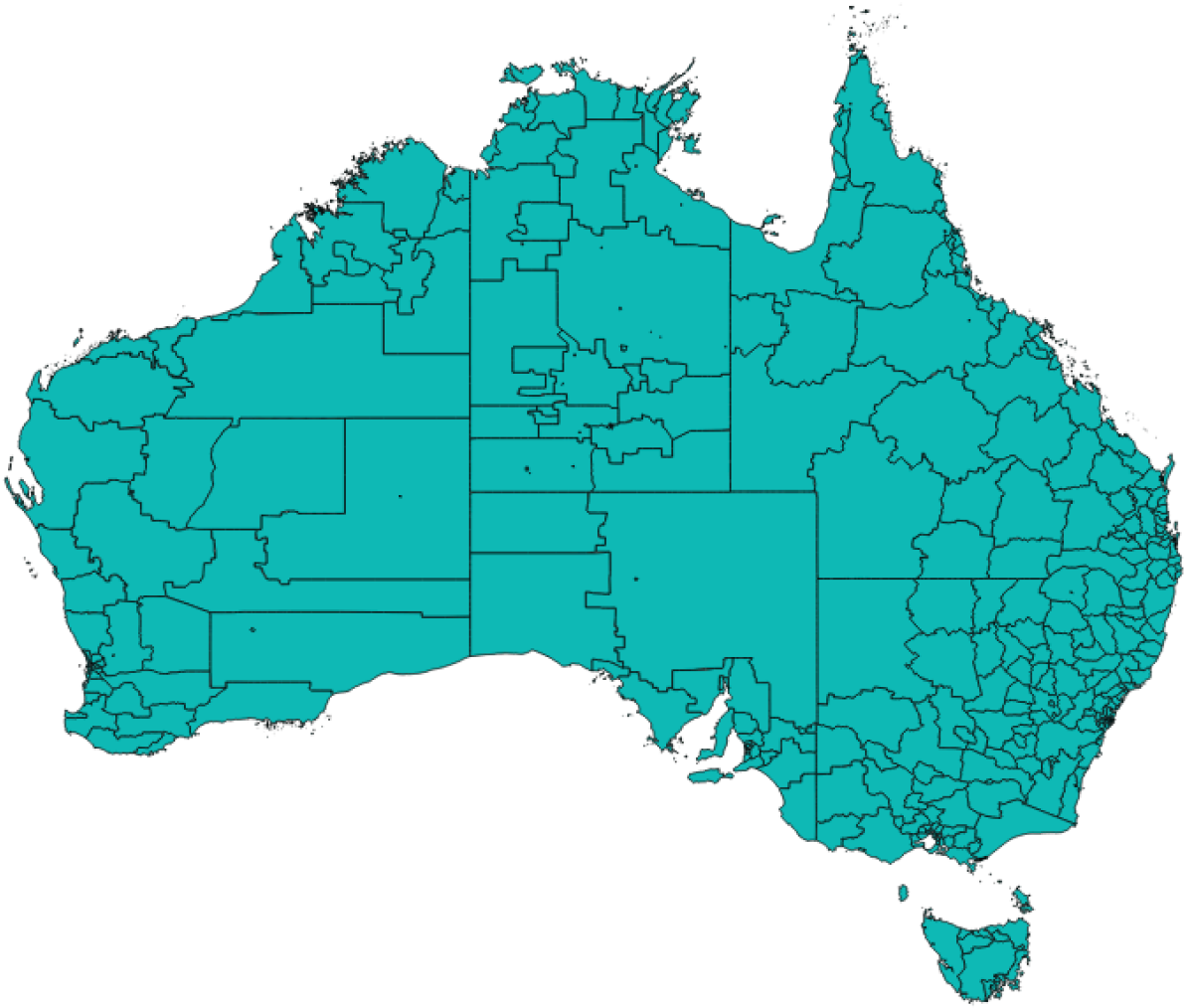

Figure 2.2. *Digital Boundaries for IAREs (ABS, 2011)*

IREGs constitute the largest geographical unit and are made up of one or more IAREs. The 2011 Census identified 57 IREGs across the whole of Australia (see Figure 2.3 and 2.4 below).

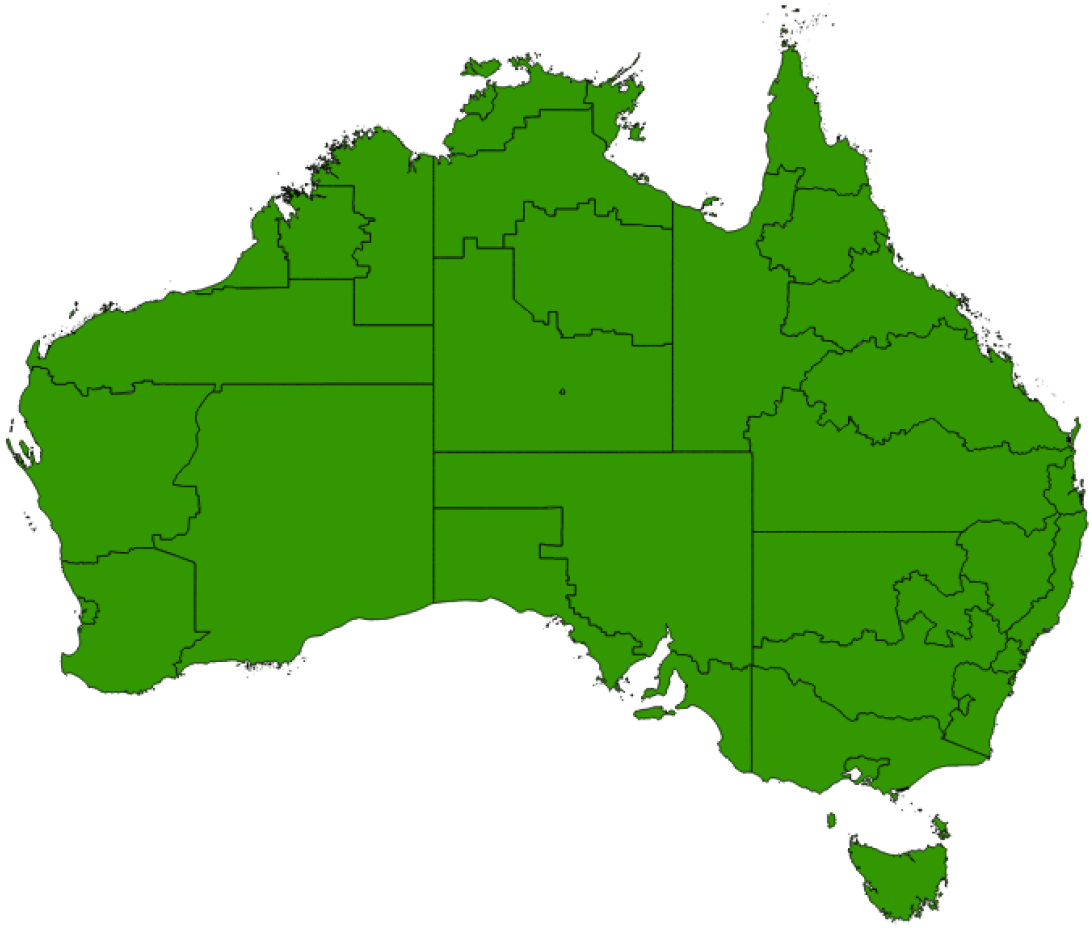

Figure 2.3. *Digital Boundaries for IREGs (ABS, 2011)*

Indigenous Regions (depicted in Figure 2.4 below) are the highest level of the AIGC and are based on the earlier Aboriginal and Torres Strait Islander Commission (ATSIC) Regions. Each IREG is divided into a number of IAREs, which each have a minimum population of approximately 300 Indigenous Australian persons (ABS, 4705.0, 2007). In turn, each IARE is divided into a number of ILOCs, which each have at least 50 Indigenous Australian inhabitants. Table 1 is a summary of Indigenous geographic units as at July 2011.

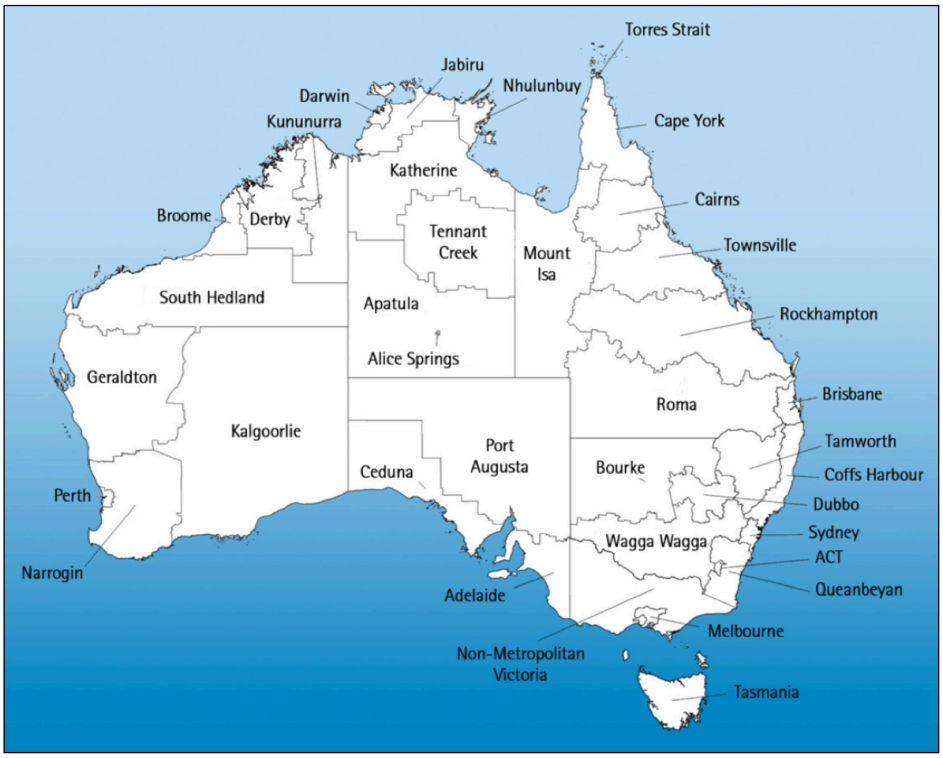

Figure 2.4 *Indigenous Region (IREG) structure, 2006 (Biddle, 2009, p. 12)*

Spatial Unit	Name	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.
IREG	Indigenous Region	9	4	10	5	10	3	9	3	53
IARE	Indigenous Area	109	41	87	34	71	13	64	5	424
ILOC	Indigenous Location	293	91	191	89	215	36	187	8	1110

Table 1 Summary of Indigenous units at July 2011 (excludes Other Territories)

Just under half a million (455,000) Aboriginal and Torres Strait Islander people were counted in the 2006 Census. The majority lived in Major Cities (31%). The remaining Aboriginal and Torres Strait Islander populations were evenly distributed across Inner Regional (22%), Outer Regional (23%) and Remote/Very Remote Australia (24%). Eighty-one per cent of the Indigenous population counted in the Northern Territory (NT) lived in Remote/Very Remote areas. Likewise, in WA, 41% of the Indigenous population lived in Remote/Very Remote areas (Australian Bureau of Statistics (ABS), 2016).

While ILOCs statistically approximate density locations of Indigenous Australians, these do not refer to places commonly perceived as communities where waste services are to be managed. Indigenous communities with housing or infrastructure that is “either owned or managed on a community basis” are referred to as discrete Indigenous communities (Australian Institute of Health and Welfare [AIHW], 2014). It is important to note that every discrete Indigenous community (see Figure 2.5 below) ‘has traits and characteristics which are unique and attributable to the local setting’ (Zubrick et al., 2005, p. 43).

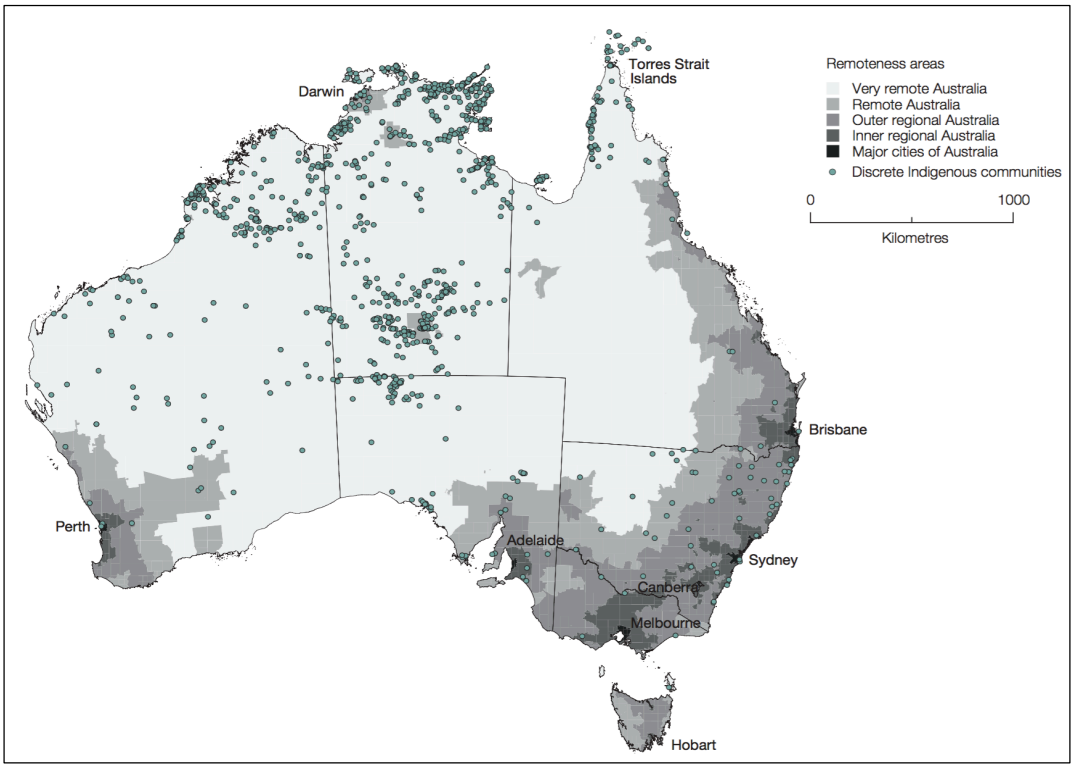

Figure 1.5. Discrete Indigenous communities and remoteness areas

2.1. Climate change, waste, and health in remote Indigenous Australian communities

Affecting the capacity for rural and remote communities to sustain their waste collection service, is their geographic location relative to their nearest service centre and economic hub, and relative to their local climate, and so potential local impact of climate change. Figure 2.6 highlights the vast distances most remote communities rely upon for service support and maintenance of waste collection vehicles, equipment, bin replacement, governance, training, and expertise (National Aboriginal Community Controlled Health Organisation [NACCHO], 2016).

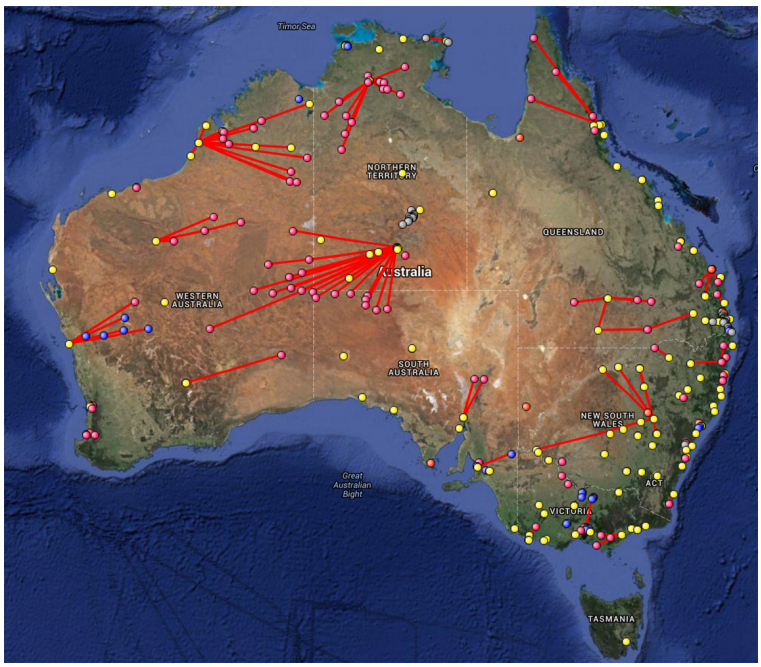

Figure 2.6 Links between Service Delivery Locations and their Coordinating Centres (NACCHO, 2016)

For many, these place-based factors affect the viability of using waste collection systems designed for urban usually sealed road, multi-bin, street kerb systems, where local councils are supported by the income from a denser population of households to maintain services, and to assure frequent weekly waste collection cycles. Remote place-based factors can present delays in cycles of services and in return to service when major equipment requires routine or unplanned

repairs. One consequence of such delays is the increased opportunity for the breeding of insect vectors of disease where accumulating rubbish provides an extended means for vectors to exploit ideal micro-habitats (Aboriginal and Torres Strait Islander Commission (ATSIC), 2002, p. 33).

While the literature is still immature in how models of climate change are impacting, and could impact, on the health and wellbeing of remote communities due to the accumulation of rubbish, articles are beginning to ask this question. An increase in the number of days of extreme heat in remote Indigenous communities due to climate change "may affect disease vectors, [and the] reproduction and survival of infectious pathogens" (Green, 2008, p. 7). Further, and known to relate to climate change, Green (2008, p.7) notes that extreme rainfall events and flooding may cause infrastructure damage, including filling waste trenches with water leading to greater opportunity for more vectors of diseases to grow and spread. Supporting this concern, from comparable circumstances in Ghana, Boadi and Kuitunen (2005, p. 35) highlight the potential for surface-water contamination increases in the rainy season because of flooding in low-lying areas in the proximity of open dumps, noting how "Open spaces and empty yards in which refuse accumulates serve as breeding grounds for rats, flies, and other vectors of disease pathogens." These examples from the literature suggest the possibility that there is a causal link between climate, environmental health concerns related to waste, and community location. At the same time there remains a gap in the literature that identifies estimates of clinically reported health impact rates in remote Indigenous Australian communities. This quantitative information is largely missing in the literature and would provide scope and scale data: information essential for guiding waste management place-based policy direction.

Remote communities typically endure extreme ranges of weather conditions, from desert heat and very cold desert nights, to tropical humidity in the northern remote regions of Australia: Figure 2.5 shows where the vast number of discrete Indigenous Australian communities are located. The social consequence of locally unsustainable, unviable, or unmaintainable waste collection services was identified in the ATSIC 2002 report, which found that "In the hot climate of much of Australia the collection of rubbish only once a week may be inadequate to discourage the breeding of insect vectors of disease" (ATSIC, 2002, p. 33). Green (2008, p.7) identified that, "Indirect impacts of temperature change can also have significant impacts on health. The incidence of communicable diseases such as bacterial diarrhea, which are more common in hot dry conditions, may increase, unless additional preventative actions are taken…. [and that] The combined impact of precipitation and temperature changes on a range of infectious disease transmission rates is complex because those rates tend to be very locally specific, depending on a combination of several physical factors and the presence of the necessary 'vector' host (for example: fleas, mosquitoes, birds or mammals)."

A 2008 study by the Centre for Appropriate Technology (CAT) (2008) found that waste management approaches needed to differ according to local and regional climatic conditions, particularly in the design of landfills where rainfall is a consideration. Where waste services failed, or were not in operation, inadequate access to disposal facilities often resulted in indiscriminate disposal in open spaces (Boadi & Kuitunen, 2005, p. 35).

3. Health status of Indigenous Australians

Indigenous Australians have significantly poorer health outcomes and a lower life expectancy compared with non-Indigenous Australians. It is estimated that Indigenous Australians suffer an almost two-and-a-half times greater burden of disease than non-Indigenous Australians (Australian Institute of Health and Welfare, 2016). Chronic diseases, including cardiovascular disease (CVD), poor mental health, and substance abuse disorders and injuries, contribute significantly to the burden of disease experienced by Indigenous people (Australian Institute of Health and Welfare, 2016). In addition, the incidence and severity of infectious diseases is much higher in the Indigenous population than in the non-Indigenous population (Gracey & King, 2009). Despite a greater proportion of Indigenous people living in remote areas, which has been shown to disproportionately impact upon access to health care services, hospitalisation rates for Indigenous Australians are also significantly higher than for non-Indigenous Australians (Australian Institute of Health and Welfare, 2014a; Woods et al., 2015). The reasons for these disparities are complex, and include a range of interrelated historical, social and environmental factors, outlined in Figure 3.

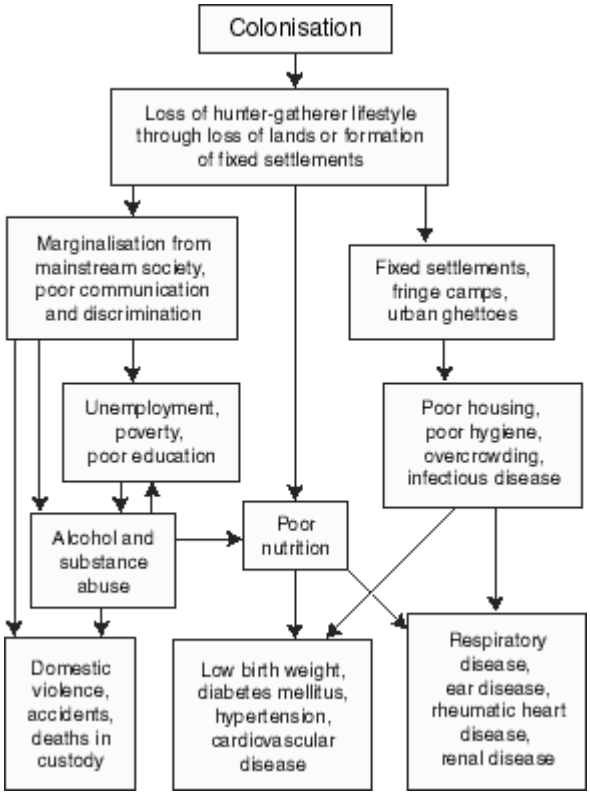

***Figure 2**. Historical impacts of colonisation upon Indigenous health (Mathews, 1998)*

While it is acknowledged that the factors identified in figure 2 have an impact on health concurrently and cumulatively (Gee et al., 2014); this review will focus on the environmental determinants of Indigenous health, with an emphasis on the impact of solid waste on Indigenous health and wellbeing in remote communities.

4. Environmental determinants of Indigenous health in remote communities

There are a number of environmental factors in remote Indigenous communities that may have a significant impact on health. Ware (2013) highlights that there is extensive evidence in the

non-Indigenous and Indigenous-specific literature linking the living environment and health. Holman and Joyce (2014a) estimate that poor environmental health in regional W.A. is responsible for approximately 20% of premature mortality amongst the Indigenous population in this region.

This may be related to:

- Environmental factors unique to many remote communities, including exposure to geogenic dust, biomass smoke and heavy-metal contaminated water (Clifford et al., 2015);
- Geographic isolation and inadequate transport and communications infrastructure (Bailie et al., 2002); and
- Living conditions within communities, particularly housing and related infrastructure such as power, water and waste management, household overcrowding, personal and community hygiene and poor dog control (Bailie & Runcie, 2002; Gracey & King, 2009; Gracey et al., 1997; Torzillo et al., 2008).

4.1. Housing, health infrastructure and overcrowding in remote Indigenous communities

The impact of poor housing on Indigenous health in remote communities has received a great deal of attention in the academic literature (Bailie & Runcie, 2002; Bailie et al., 2010; McDonald et al., 2010; Torzillo et al., 2008) and in Government policy (Ware, 2013). Housing is at the intersection of many environmental health issues affecting remote Indigenous communities and overcrowding is a significant issue, which increases with remoteness. Australian Institute of Health and Welfare data indicate that in 2011, approximately 12% of indigenous households in non-remote areas were overcrowded compared with 20% of households in remote areas and 39% of houses in very remote areas (Australian Institute of Health and Welfare, 2014b). Overcrowding puts stress on housing infrastructure, which can exacerbate communicable disease transmission, as well as affect mental health and wellbeing (Steering Committee for the Review of Government Service Provision, 2014).

In addition to housing, the importance of a safe water supply, sewerage and liquid waste removal, and access to electricity in maintaining personal and community hygiene is also acknowledged in the literature (Bailie et al., 2002; Gracey & King, 2009; Gracey et al., 1997). Many remote Indigenous communities do not have reliable access to electricity, which impacts on residents' ability to store food safely and increases the risk of infectious disease. Furthermore, many communities are reliant on bores to supply potable water tanks, septic tanks and sewage lagoons for effluent treatment and disposal (Environmental Health Needs Coordinating Committee, 2010). These systems can contribute to outbreaks of gastrointestinal disease if not properly maintained.

While solid waste disposal is often mentioned in the same sentence as sewerage and liquid waste disposal, its impact on health in remote Indigenous communities has not been determined and it is often considered a visual or aesthetic problem rather than a public health problem (Carson & Bailie, 2004). Despite this conclusion, rubbish collection is included in the Atlas of Health Related Infrastructure in Discrete Indigenous Communities (Bailie et al., 2002) and Wayte et al. (2007) emphasise the apparent lack of research and intervention in this area compared to liquid waste.

5. Solid waste and ill health

A number of comprehensive reviews have concluded that to date, there is no direct, causal link between solid waste and poor health (Giusti, 2009; Ncube & Ncube, 2016; Porta, Milani, Lazzarino, Perucci, & Forastiere, 2009; Rushton, 2003; Saffron, Giusti, & Pheby, 2003). There are a number of difficulties associated with measuring health impacts related to solid waste including the complex composition of wastes, interactions between hazards during waste management and latency between exposure to waste and onset of symptoms of some diseases. Furthermore, epidemiological studies of the impact of solid waste on health typically rely on indirect exposure data, including emissions data or household proximity to waste management facilities, and are unable to make accurate exposure assessments which are required to determine causation (Rushton, 2003; Saffron et al., 2003).

Despite the difficulties in demonstrating a causal link between solid waste and health, a range of *potential* health issues associated with the handling, treatment and disposal of waste have been identified (Giusti, 2009). Figure 4, adapted from Saffron et al. (2003), illustrates the process by which adverse health outcomes may occur following exposure to hazards in solid waste. The elements of Figure 4 will be discussed in the subsequent sections.

Waste is a complex mixture of different substances, including many that are innocuous and a small proportion, which are hazardous to health (Rushton, 2003). One goal of waste management is to minimise human exposure to these hazards in order to reduce the potential risk of illness and injury. People may be exposed to hazards via various routes. These include:

- Inhalation – e.g. of particulate matter such as dust, ash or bio aerosols emitted from landfill, compost or incineration facilities.
- Ingestion – via water supplies contaminated with landfill leachate, via food that is farmed in areas where contaminated water is used for irrigation; or via cross contamination in the home environment where rubbish is not adequately disposed
- Direct contact – this may include contact with the skin or mucosal membranes or physical or chemical burns.
- Vectors – pathogenic microorganisms may be transmitted to humans via vectors that are attracted to solid waste.

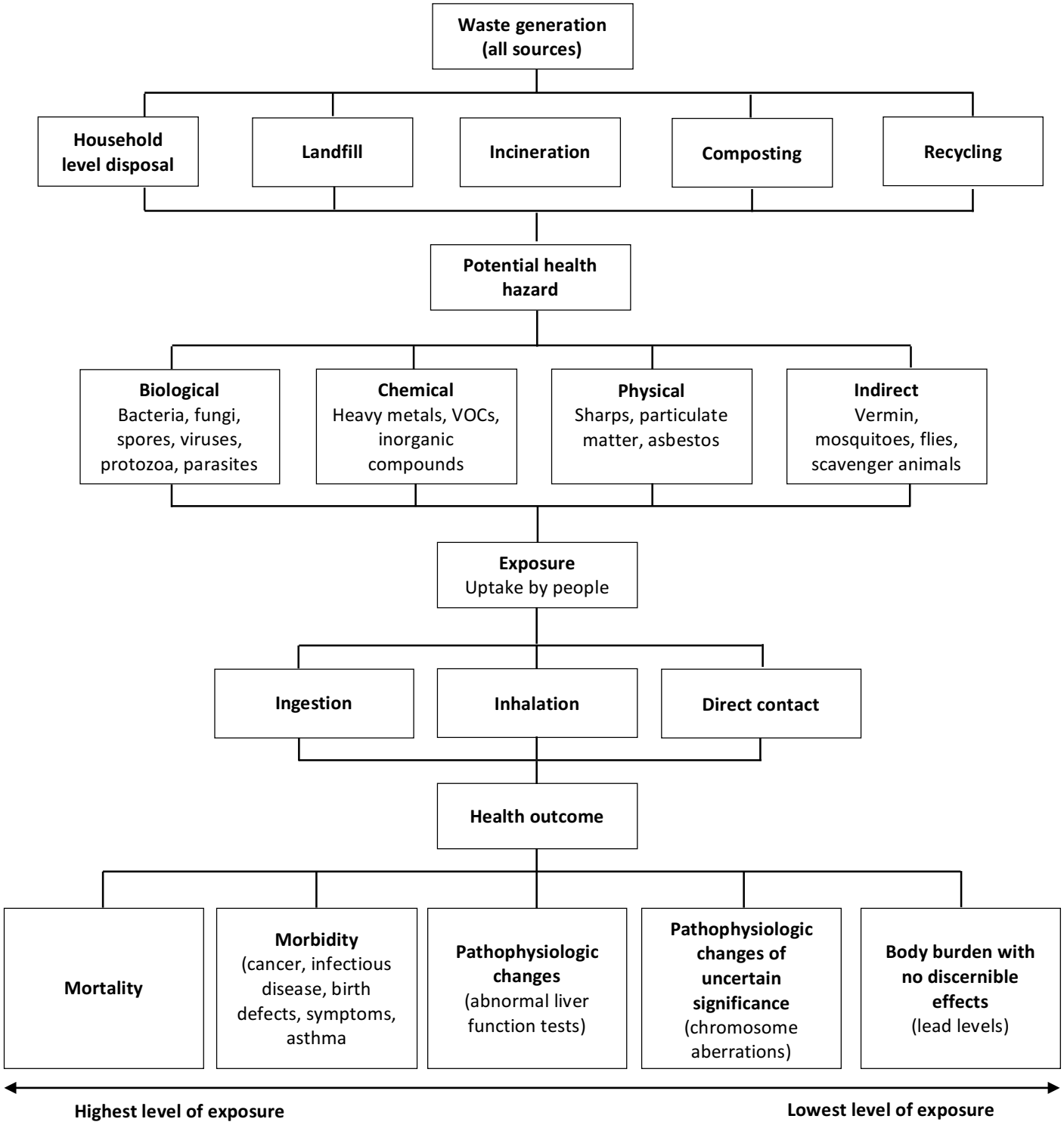

Figure 3. *Pathways for health outcomes caused by exposure to hazards in waste (Adapted from Saffron et al 2003)*

5.1. Hazards and potential health issues associated with solid waste

There are a number of *hazards* associated with solid waste and solid waste management practices outlined in Figure 4. It is *exposure* to these hazards, which may result in negative health outcomes. These hazards can be divided into biological, chemical, physical, and indirect hazards, which are described below along with their associated health issues. It is important to note that not all exposure to hazards will result in illness. The disease causation pathways outlined in Figure 4 are influenced by a range of factors, including waste composition and volume, level and duration of exposure, environmental conditions (i.e. temperature, wind and rainfall) and genetic and biological characteristics of the exposed person (i.e. age and underlying medical conditions).

5.1.1. Biological hazards and associated health issues

Solid wastes may provide a nutrient rich environment suitable for the growth of a range of microorganisms, some of which may be human pathogens. The microorganisms found in waste are dependent on the waste type and nutrients present, as well as environmental conditions such as temperature and water availability. Pathogenic microorganisms associated with waste include those that proliferate in food waste, faecal matter and clinical wastes. These pathogens may be transmitted via the faecal-oral route, inhalation or through direct contact with the skin or mucous membranes. Pathogenic microorganisms may also be found in bioaerosols emitted from composting facilities which may cause illness if inhaled (Giusti, 2009). Examples of pathogens associated with solid waste are outlined in Table 2.

Table 2. *Microorganisms associated with solid waste*

Hazard	Example	Source
Bacteria and their spores	*E. coli*, *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., Clostridium spp.	Disposable nappies, food waste, pet faeces, clinical waste
Fungi and their spores	*Aspergillus* spp.	Food waste, compost
Viruses	Noroviruses, rotaviruses, Hepatitis A Hepatitis B, HIV	Food waste, disposable nappies, clinical waste
Protozoa	*Cryptosporidium* spp., *Giardia* spp.	Disposable nappies, pet faeces
Parasites	*Sarcoptes scabiei, Strongyloides stercoralis, Toxocara canis,*	Infested linen, disposable nappies, pet faeces

The microorganisms outlined in Table 2 can cause a range of communicable diseases, including gastroenteritis, respiratory illnesses and skin infestations. Gastroenteritis is the broad term used to describe infection of the digestive system and is typically transmitted via the faecal-oral route. While gastroenteritis is often self-limiting, it can be severe and even fatal in some cases, particularly in the young, elderly and immunocompromised. Gastroenteritis is associated with poor hygiene and is highly communicable in situations of overcrowding, which is common in remote Indigenous communities. Indigenous populations also experience high rates of parasitic infection when compared with the non-Indigenous population. A study by Reynoldson et al. (1997) found that concurrent infection with more than one intestinal pathogen is likely to be common in remote Indigenous communities due to the asymptomatic nature of many infections. Furthermore, Sankoh, Yan, and Tran (2013) highlighted an increased incidence of gastroenteritis in populations residing in close proximity to a dumpsite in Sierra Leone, possibly as a result of ground water pollution.

In addition to gastroenteritis, infectious respiratory illnesses can be caused by inhalation of dust containing bacteria, fungi or their toxins which may be emitted from waste management facilities. In particular, compost workers have been shown to be at greater risk of developing respiratory illnesses than the general public (Giusti, 2009) and respiratory infections are also six times as high in areas where household waste is dumped or burned in the yard as in areas where waste is collected regularly (Wilson et al., 2013). Respiratory infections are a significant cause of morbidity in remote Indigenous populations, and control measures including improving housing, waste disposal and water and power supply (Australian Indigenous HealthInfoNet, 2005).

5.1.2. Chemical hazards and associated health issues

Many solid waste materials from the municipal and industrial waste streams contain a variety of chemicals, which are inherently hazardous. In addition, chemical hazards may be produced or released during waste management processes such as landfilling and incineration (Giusti, 2009). Exposure to chemical hazards may occur via inhalation of volatile organic compounds released during incineration, by ingestion of leachate contaminated groundwater or surface

water, or by direct contact with hazardous waste items such as solvents. An overview of chemical hazards associated with solid waste is presented in Table 3.

Table 3. *Chemical hazards associated with solid waste*

Hazard	Example	Source
Heavy metals	Lead, arsenic, chromium	Paints, solvents, batteries, e-waste, landfill leachate
Gases	Ammonia, sulphur dioxide, nitric oxide	Landfill, incineration
Volatile organic compounds	benzene, toluene, dichloromethane, tetrachloroethylene	Landfill, incineration
Other chemical compounds	Polyaromatic hydrocarbons, dioxin, furans	Incineration

Many remote indigenous communities rely on bore water for their potable water supply (Environmental Health Needs Coordinating Committee, 2010). Groundwater pumped by bores may become contaminated with leachate if landfills are unlined and located in close proximity to water supplies. Run-off from landfill following heavy rain may also contribute to contamination of surface water supplies.

In addition to the risks associated with landfill leachate, several studies have suggested an association between proximity of residence to landfill or incinerator facilities and increased risk of congenital anomalies, such as low birth weight (Berry & Bove, 1997; Sankoh et al., 2013), and cancers including non-Hodgkin's lymphoma (Viel et al., 2008). However, the strength of this evidence has been contested given the number of confounding factors and lack of accurate exposure data (Rushton, 2003; Saffron et al., 2003). While studies have shown adverse health effects following exposure to a range of individual hazardous chemicals, often found in solid wastes; these effects are usually observed in animal model studies involving large doses or following occupational exposure to higher concentrations than would be expected to occur in the environment (Rushton, 2003).

5.1.3. Physical hazards and associated health issues

Physical hazards in solid waste include sharp objects that may cause trauma or particulate matter that may be harmful when inhaled. An overview of physical hazards associated with solid waste are outlined in Table 4 below.

Table 4. *Physical hazards associated with solid waste*

Hazard	Example	Source
Particulate matter	Asbestos Dust, ash	Construction and demolition waste Incineration, landfill, composting
Sharps	Needles	Clinical waste

	Broken bottles, sharp objects	Municipal waste
Flammable / explosive material	Aerosol cans, tyres, methane	Municipal waste, landfill

Most studies investigating the incidence of trauma associated with solid waste are focused on occupational exposures. Solid waste management workers suffer greater rates of injury compared to the general population, with the rate of occupational accidents in waste management workers in the UK approximately four times the national average. These accidents most commonly occur during refuse collection and unloading (Health and Safety Executive, 2004).

In Australia, there is no published information on solid waste related trauma among Indigenous Australians. However, in general, the reported rate of total injuries and accidents is higher among Indigenous people compared to non-Indigenous people across all age groups. Moreover, exposure to hazardous environments and risky home environments are factors that are known to contribute to injury rates among Indigenous Australians (MacRae, Thomson, Potter, & Anomie, 2013). In the context of waste management, the Western Australian Environmental Health Needs Survey 2008 identified that 64% of the Aboriginal communities included in the study had a rubbish tip that was not well fenced (Environmental Health Needs Coordinating Committee, 2010). Bailie et al. (2002) similarly observed that a large number of Indigenous communities in Central, Northern and Western Australia disposed of their rubbish in unfenced community tips. Unfenced tips may be attractive play sites for young children who may be injured when exposed to sharp objects or corrosive materials.

5.1.4. Indirect hazards and associated health issues

5.1.4.1 Pests and disease vectors

Solid waste often provides an environment suitable for harbourage and proliferation of disease vectors such as mosquitoes, flies, vermin and cockroaches (Australian Indigenous HealthInfoNet, 2013). These vectors may be capable of transmitting a range of diseases under suitable environmental conditions.

Currently in Australia, there are several important mosquito species capable of transmitting disease. These include:

- *Culex annulirostris*: a vector for Ross River Virus, which is widely distributed across Australia; and
- *Aedes aegyptii*: currently restricted to Northern Queensland and is a vector for Dengue, Zika virus, and Chikungunya virus (Russell et al., 2009).

Ross River Virus is the most common vector-borne disease in Australia with more than 5000 cases notified annually. The disease is not fatal, but results in debilitating polyarthritis, which can last for weeks or months (Russell, 2002). While not endemic in Australia, there are numerous outbreaks of Dengue Virus in Queensland every year (Russell et al., 2009). To date there has been no local transmission of Zika or Chikungunya virus in Australia. However, the potential exists for these diseases establishing, given projections for increasing geographic distribution of the *Aedes aegyptii* vector and increased international travel to disease endemic regions (Johnson et al., 2008).

Mosquitoes breed in stagnant water and solid waste, and *Aedes aegyptii* typically breeds indoors. Solid waste that is not disposed of properly in the home may collect water and encourage mosquito breeding during warm weather. Furthermore, improperly maintained landfills may also attract mosquito breeding following rainfall. In particular, waste tyres, which are likely to form a significant component of waste generated in remote Indigenous communities due to their limited lifespan and lack of degradability, have been identified as a major site for mosquito breeding (Adebote, Kogi, Oniye, & Akoje, 2011).

Houseflies (*Musca domestica),* and blowflies (*Calliphora* spp.) are capable of transmitting enteric diseases including bacterial and protozoan illnesses. Flies are attracted to and breed in food, food waste, animal dung and other organic wastes produced by humans. Of particular concern in remote Indigenous communities is the role of filth flies (*M. sorbens*) and houseflies in transmitting trachoma: an infectious disease of the eyes caused by the bacterium *Chlamydia trachomatis*. Australia is the only developed country in the world to have endemic trachoma, where it exists only in the Indigenous population. Chronic infection with trachoma can lead to blindness. The current best practice strategy for managing trachoma infection is termed "SAFE", which stands for Screening, Antibiotic treatment, Facial cleanliness and Environmental hygiene (World Health Organization, 2012). In the context of waste management, effective disposal of waste in the home is important in reducing flies that spread the disease (Creative Spirit, 2016).

5.1.4.2. Scavenger animals

In addition to disease vectors, other animals (domestic, feral and native) may be attracted to solid waste when scavenging for food. In the US and Canada, black bears have become accustomed to scavenging for food amongst solid waste in human habituated areas (Spencer, Beausoleil, & Martorello, 2007). In many remote Indigenous communities in Australia, dogs are known to scavenge for food among rubbish dumps and bins (Gracey et al., 1997). Dogs have a very close traditional association with Indigenous people and dog numbers are often much higher in remote Indigenous communities than in non-Indigenous communities. Dog health in remote Indigenous communities is often poor. This increases the chance they may carry parasitic diseases, including hookworm and roundworm, and bacterial diseases, such as Campylobacteriosis, all which may be transmitted to humans (Gaskin, Bentham, Cromar, & Fallowfield, 2007; Meloni, Thompson, Hopkins, Reynoldson, & Gracey, 1993). Historically, scabies was thought to be transmissible between humans and infested dogs. However, recent studies have shown a high degree of genetic variation between strains that infect dogs and strains that infect humans, suggesting that zoonotic transmission between dogs and humans is unlikely (Holt, McCarthy, & Carapetis, 2010). Dogs may also attract other disease vectors such as flies if their excrement is not disposed properly.

6. Impact of solid waste on Indigenous wellbeing

6.1. Indigenous definitions of health

The literature on health impacts associated with solid waste is focused on a Western biomedical interpretation of health, which is concerned with isolating the specific causes of physiological illness (Ganesharajah, 2009). This interpretation of health is much narrower than the Indigenous interpretation of health, which encompasses the physical, social, emotional and cultural wellbeing of the individual and the community as a whole (National Aboriginal Health Strategy Working Party, 1989). In Indigenous conceptions of health, country is considered to be intrinsically linked to wellbeing and studies have illustrated the connection between Indigenous people's self-perceptions of health and the health of their country (Ganesharajah, 2009). For example, Willis, Pearce, and Jenkin (2004) found that Indigenous people from the Murray River region directly attributed aspects of their own ill health to the poor state of the River, which had been impacted by excessive development, irrigation and overfishing. The majority of perceptions of waste in remote Indigenous communities outlined above are from a non-Indigenous perspective. Wayte et al. (2007) highlighted that a growing priority for research is enhancing our understanding of Indigenous peoples' perceptions and behaviour in relation to the physical environment; but, to date, there has been limited research into Indigenous perceptions of solid waste and pollution.

6.2. "Rubbish"

Waste is a common feature in many remote Indigenous communities and has been highlighted as an issue of concern in these communities (Carson and Bailie, 2004; Department of Environment and Climate Change NSW, 2008). The Environmental Health Needs Survey used waste levels as one indicator of solid waste management adequacy. Waste is a consequence of inadequate waste management infrastructure as well as other environmental, cultural and behavioural factors. Seemann and Walker (1991) estimated the amount of solid waste accumulated in Kintore, NT during the period 1989/1990 and found that most waste was inert, composed of such items as aluminium cans, plastic bottles and bags, flour drums, tyres, leaf rakes and "rubbish cars". It was determined that inappropriate waste management infrastructure, such as heavy bins, inappropriately designed trailers and flimsy plastic garden rakes, created a disincentive for community residents to adequately dispose of solid waste (Seemann and Walker, 1991). The issue of waste in remote Indigenous communities is further compounded by environmental factors including; wind, which blows waste from its source throughout the community (Seemann and Walker, 1991) and scavenger animals, which often tip bins over and scatter waste in search of food (Gracey et al., 1997). These factors make ownership of and responsibility for waste unclear. A lack of perceived responsibility for dealing with waste was also identified as a contributing factor to environmental contamination in the living environment by McDonald et al. (2009). The authors argued that while improving health infrastructure in the home is necessary to improve health outcomes in remote Indigenous communities; significant gains will not be made without also addressing the lack of understanding of hygiene and behavioural practices that contribute to disease among Indigenous people.

Although there is limited epidemiological evidence linking poor health and solid waste outcomes, the mismanagement of waste may indirectly contribute to poor health if waste deters health workers or tradespeople from working in a community due to poor impressions of tidiness or safety (Australian Indigenous HealthInfoNet, 2013). The accumulation of waste can also

indirectly contribute to environmental health problems when it blocks drains and septic tanks or encourages breeding of disease vectors. However, Seemann and Walker (1991) also identified a potential positive outcome of waste accumulation when windblown waste helps to trap soil against fence lines resulting in the formation of dunes which may act as windbreaks. This may be one novel technique for managing lightweight solid waste.

6.3. Illegal dumping

Illegal dumping of waste was identified by the Department of Environment and Climate Change NSW (2008) to be an issue for remote Indigenous communities in New South Wales, with the potential to cause environmental damage through degradation of bushland and pollution of water supplies, as well as the potential to harm culturally significant or sacred sites. It was suggested that illegal dumping presented biomedical health risks to the community, from the risk of trauma through contact with dangerous objects or via disease vectors attracted to the waste, as well as harm to country by disturbing the community's connection with it and its ability to provide fresh drinking water and bush tucker. Illegal dumping occurs when existing waste management systems are inadequate or when people wish to avoid costs associated with legal disposal of waste and Aboriginal land is often targeted for illegal dumping of wastes due to its remoteness (Department of Environment and Climate Change NSW, 2008).

7. Solid waste management in remote Indigenous communities

Notwithstanding the lack of causal evidence regarding the health impacts of waste; solid waste management is considered an essential service in non-Indigenous Australian communities, particularly in metropolitan and regional areas (Wayte et al., 2007). In 2003, the Department of Environment and Climate Change NSW (DECC) liaised with 55 NSW Aboriginal communities about environmental issues affecting Aboriginal people and waste was identified as the most common issue affecting communities (Department of Environment and Climate Change NSW, 2008). However, many remote Indigenous communities do not have access to a reliable waste management service. While solid waste management policy and practice in mainstream Australia is becoming more sophisticated and complex in an effort to improve sustainability and reduce the impact of waste on the environment and on health (Environment Protection and Heritage Council, 2009); the limited discussion surrounding solid waste management in remote Indigenous communities is typically concerned with identifying the frequency of rubbish collection services and waste levels.

7.1. Challenges relating to solid waste management in remote communities

Overwhelmingly, the literature surrounding environmental health risks related to solid waste management is focused on urban areas. Rural and remote communities in developing and developed countries also experience issues related to the management of waste. However, the unique conditions of these communities, including low population densities, geographic isolation and often challenging climate, mean that these communities may experience different issues related to solid waste management, compared with urban populations (Bernardes & Günther, 2014; Eisted & Christensen, 2011).

A study of waste management practices in rural Brazilian Amazonian communities found that while the amount of waste generated in these communities was much lower than in urban areas, the lack of waste management infrastructure meant that even small quantities of inorganic wastes could potentially pose environmental and health impacts. Furthermore, as rural

populations become increasingly dependent on industrialised products, the amount of potentially hazardous inorganic waste generated in these communities is likely to increase (Bernardes & Günther, 2014). Similarly, waste management infrastructure in remote Greenlandic communities is limited due to conditions related to geographic isolation, scarce population and extreme weather. The majority of mixed waste is landfilled or incinerated and opportunities for recycling are limited due to the small amounts of waste generated and the long distances to recycling facilities. The development of residential areas in close proximity to landfills and a lack of environmental monitoring may also contribute to health effects in the population (Eisted & Christensen, 2011).

Solid waste management in rural and remote First Nations communities in Canada is also challenging. These communities also experience added complexities related to the ongoing effects of colonisation on health and wellbeing (Gracey & King, 2009); and the negative effect of land degradation due to waste mismanagement on individual, cultural and community health. In many rural and remote First Nations communities, individual households do not have access to rubbish collection and dispose of waste in open dumps or via burial. Open dumps pose health and safety risks to the local community due to the potential contamination of drinking water supplies by runoff or seepage, the proliferation of disease vectors, and scavenging animals including stray dogs, wolves and bears (Bharadwaj, Nilson, Judd-Henrey, & Ouellette, 2006). As with many Indigenous populations in countries around the world, including Australia, First Nations people in Canada experience poor solid waste management in the context of widespread socioeconomic disadvantage.

7.2. Defining and classifying solid waste

One of the difficulties in determining the health impacts associated with waste is that the definition of waste has changed significantly over the past 50 years. Historically, waste was defined as any material or substance that has no further use and has been discarded, typically in landfill. However, the definition of waste is becoming more complex due to: the changing nature of waste composition, increasing waste generation, strengthening of regulation and oversight, and improved knowledge and understanding of the social, environmental and economic risks associated with different types of waste and waste management practices (Hyder Consulting, 2011).

Knowledge of the sources and types of solid waste is useful for determining the best means of disposal and minimising the associated risks. Table 5, adapted from the EPA NSW (2016), provides an overview of the different types of waste.

Table 5. *Classification of waste by composition*

Type of waste	Example
Organic (putrescible) solid waste	Food waste, disposable nappies, animal waste, manure
Inert (inorganic) solid waste	Bricks, tiles, ceramics, concrete, steel, inert soil
Liquid waste	Sewage, greywater, cooking oil, petrol, motor oil
Electronic waste (e-waste)	Televisions, computers, lighting, mobile phones, white goods

Clinical waste	Used sharps, soiled dressings, blood samples, pharmaceuticals
Asbestos	Friable and non-friable asbestos
Hazardous	Paints, solvents, batteries, biohazardous waste, household chemicals

Source: EPA, NSW

In addition to composition, waste may also be categorised according to its source or stream. The following categories of waste streams are widely adopted throughout Australia:

- **Municipal solid waste (MSW)**: primarily household waste collected through kerbside waste and recycling services. It includes biodegradable material, recyclable materials such as bottles, paper, cardboard and aluminum cans, and a wide range of non‐degradable material including paint, appliances, old furniture and household lighting.
- **Commercial and industrial waste**: waste generated by businesses (i.e. offices, restaurants, schools, etc.) and industry (i.e. manufacturing).
- **Construction and demolition waste:** waste produced by demolition and building activities, including road and rail construction and maintenance and excavation of land associated with construction activities (Department of the Environment and Energy, 2013).

7.3. Types of waste generated in remote Indigenous communities

Data on the types and volumes of solid waste generated in remote Australian Indigenous communities is lacking. As described previously, remote Indigenous communities vary in terms of size, geography, population demographics and distance to urban centres. These variables likely contribute to different patterns of consumption and subsequent waste generation and available disposal options. In order to develop a fit for purpose waste management system for these communities, more information on waste composition and volume is required.

7.3.1. Waste management practices in remote Australian Indigenous communities

Waste management practices can be categorised into household/domestic and community level practices. Household waste management practices include disposal of domestically generated waste into rubbish bins, sorting/separation of waste prior to collection for final disposal, or household level composting, reuse, burial or incineration. The major methods of community level waste management are landfill, composting, incineration, sewage treatment and recycling (Rushton, 2003). The following sections will describe these waste management practices in the context of remote Indigenous communities.

7.3.2. Household level waste management

At the household level, domestic waste may be disposed in bins prior to collection or final disposal. In urban and regional areas with kerbside waste collection services, waste may be sorted and separated at the household prior to collection. However, there is a lack of data regarding domestic waste sorting practices or domestic waste management infrastructure in remote Indigenous communities. Domestic waste management in remote indigenous communities is exacerbated by overcrowding. As at 2012, approximately 49,714 Indigenous Australians living in very remote Australia resided in overcrowded households (Overcoming

Indigenous Disadvantage [OID], 2014, p. 53). In remote Australia, approximately 16,080 Indigenous Australians lived in overcrowded households (OID, 2014, p. 53).

The OID working group - which is made up of representatives of the Australian Government, all State and Territory governments, the Australian Bureau of Statistics and the Australian Institute of Health and Welfare - included safe removal of waste in the household as a necessary factor in providing safe and healthy living conditions in Indigenous communities, conditions that promote environmental and public health (OID, 2014, p. 54).

Also included is food safety and disease control within the household (OID, 2014, p. 54). Adequate household solid waste disposal is necessary to prevent the spread of infectious diseases and to encourage 'healthy living practices' (OID, 2014, p. 10.4). An 'adequate' waste disposal system refers to a safe, functional, reliable, and effective housing amenity.

There are no detailed reports in the national literature on the adverse health outcomes in relation to food, disease and poor household solid waste management in remote Indigenous communities. However, international data clearly shows that inadequate waste disposal in the home is associated with the presence of houseflies in the kitchen and the toilet, which significantly increases the chance of spreading infectious diseases, particularly in children (Boadi & Kuitunen, 2005, p. 32).

As Boadi and Kuitunen (2005) conclude, "houseflies are vectors for various infectious diseases and transmit diseases through food contamination either by direct contact with food or through their droppings." Adequate solid waste practices in the household are therefore necessary to bring about better environmental health conditions in remote Indigenous communities and support healthy living practices (OID, 2014, p. 10.4).

The OID report identified the need for improved housing amenity in remote Indigenous communities to promote health and wellbeing, particularly in children, and a safe waste disposal system is a key part of this (OID, 2014, p. 10.3).

7.3.3. Landfill

Landfill involves depositing waste into predetermined and prepared sites and is the most common method of waste disposal in Australia, including in remote Indigenous communities (Australian Bureau of Statistics, 2013; Bailie & Runcie, 2002; Productivity Commission, 2006). Modern sanitary landfills are lined with an impermeable layer to prevent contamination of soil or groundwater (Rushton, 2003). Landfills in Australia are also subject to design, construction and operational controls (Environment Protection and Heritage Council, 2009). However, compliance with these regulations is often low, particularly for landfills in rural areas (Productivity Commission, 2006).

In remote areas, landfills are less likely to be effectively monitored or maintained. Gracey et al. (1997) found that a high proportion of rubbish tips in remote Indigenous communities in Western Australia were unsatisfactorily located (i.e. built on poor soil or upwind of the community), poorly contained and unfenced. This has also been identified by others (Bailie et al., 2002; Environmental Health Needs Coordinating Committee, 2010). The composition of landfill waste is also changing in Australia, with a greater proportion of non-degradable and hazardous goods being landfilled. This may contribute to increased risks to the environment and health that may

be relevant to remote Indigenous communities in the future (Environment Protection and Heritage Council, 2009).

7.3.4. Incineration

Incineration involves the combustion of solid waste and is used when other means of waste disposal are not practicable. Incineration reduces waste volume by up to 90% and produces heat, gas and ash in the process (Rand, Haukohl, & Marxen, 2000). In Japan, incineration is the most common means of waste disposal (Giusti, 2009). While older incineration plants were implicated in emitting high levels of dioxins and other pollutants, modern facilities control air pollutants much more effectively (Giusti, 2009). As a result, operational costs for modern incinerator facilities are high and the technology is limited to use in developed countries (Rand et al., 2000). In remote areas and areas where waste collection services are inadequate, open burning of solid waste may be used as a means to reduce waste volumes (Australian Indigenous HealthInfoNet, 2013; Wilson et al., 2013). Seemann and Walker (1991) reported in their case study of waste management practices in Kintore, Northern Territory, that 200 litre drums were sometimes used as incinerators. This type of small-scale incineration is usually inefficient and results in incomplete combustion of waste and large amounts of fly ash and emissions of toxic and carcinogenic pollutants (K. Seemann & B. Walker, 1991; Wilson et al., 2013). The 1999 Community Housing and Infrastructure Needs Survey (CHINS) identified that 117 Indigenous communities (9.8%) included in the study burnt their rubbish as a primary means of disposal (Bailie et al., 2002).

7.3.5. Composting

Composting is increasingly being used to divert large volumes of organic waste, such as food and garden waste, from landfill in regional and metropolitan areas. Composting involves the decomposition of organic waste through the actions of microorganisms, earthworms and other insects. The resultant compost has beneficial uses as organic fertiliser or soil conditioner. While composting is often carried out at the household level, an increasing number of Australian municipal councils are adding organics waste to their kerbside rubbish collection services (Bathurst Regional Council, 2016; City of Greater Bendigo, 2016; Orange City Council, 2016). Currently, the majority of organic waste is composted in open-air windrow systems, which may facilitate the dispersal of bioaerosols. However, in-vessel plants are likely to become more widely used which may reduce this risk (Giusti, 2009). There is currently a lack of data regarding composting practices in remote Indigenous communities.

8. Education as a component of waste management

Evidence from the national and international literature pointed out that appropriate environmental education for local community members is important for a waste management system to operate in a sustainable and successful manner (Hungerford & Volk, 1990). Education included conducting public awareness campaigns and working with local schools and stores. Education has shown to increase public participation in waste management practices, including recycling (Valdivia, 2010). As Bharadwaj et al (2006) conclude, “the existence of ineffective solid waste management in [remote Aboriginal] communities were somewhat attributed to the inadequacy in awareness programs.” A participant in a study on solid waste management practices in First Nations communities in Canada, claimed that:

> Our communities need education and awareness on waste especially the hazardous materials. We need someone to go to the schools, health authorities, and the local TV and radio stations. We need a worker and someone who has knowledge about wastes management issues to teach us how to do some things appropriately (Oyegunle, 2016, p. 114).

Related to education, is the importance of conducting waste-monitoring programs so as to assess the performance of public participation in waste management practices (The National Environment Protection Council (National Environment Protection Council (NEPC), 2010, p. 35). Studies found that there was a need to translate community education posters in remote Indigenous communities to local language as part of a waste management awareness program (NEPC, 2010, 31); establish a stand-alone education facility and resource centre (NEPC, 2010, 42); involve children and young adults as active participants in the education and general promotion of the waste management project (NEPC, 2010, 73); and design and distribute education materials, such as brochures, to local residents (NEPC, 2010, 78).

Many remote communities lack an understanding of various health risks posed by untreated waste. In addition, communities have difficulty obtaining adequate support or assistance to deal with common hazardous materials. Risk management through education, correct handling of hazardous materials and good facilities design will ensure a safe living and working community environment (CAT, 2008, p. 179). CAT concluded that,

> "For health and safety reasons, many jurisdictions are moving to ban the still-common practice of burning waste in drums or receptacles. Education is needed, but waste collection arrangements also needed to be sufficiently frequent and reliable to make household burning unnecessary". (CAT, 2008, p. 184)

9. Waste Management Policy and Service Implementation in Indigenous Communities

The national policy and regulatory framework for waste management practices in Australia is outlined in the National Waste Policy (NWP): Less Waste, More Resources (Department of the Environment and Energy – Commonwealth of Australia, 2011). It has four general aims: 1) avoid the generation of waste, reduce the amount of waste (including hazardous waste) for disposal; 2) manage waste as a resource; 3) ensure that waste treatment, disposal, recovery and re-use is undertaken in a safe, scientific and environmentally sound manner, and 4) contribute to the reduction in greenhouse gas emissions, energy conservation and production, water efficiency and the productivity of the land (see 2009-2016 reports: (Commonwealth of Australia, 2009-2016).

The framework has a number of priority areas, one of which is to "increase capacity in regional, remote and Indigenous communities to manage waste and recover and re-use resources" (NWP, 2009). It recommends that waste management solutions be individually tailored to states and territories, for the reason that certain actions have to be identified to "build capacity and ensure an appropriate suite of services is available to regional and remote communities" (NWP, 2009). The policy further recommends that the design and implementation of waste management services in remote Indigenous communities adopt the following principles:

- Holistic approaches, which address market, regulatory and governance failures, duplications and inconsistencies;

- The environmentally sound management of materials, products and services embracing whole-of-life cycle strategies and quality assurance practices;
- Avoidance or minimisation of hazardous and other waste generation, taking account of social, technological and economic factors;
- Evidence-based decisions informed by the waste management hierarchy of actions and the principles of ecologically sustainable development, including the precautionary approach and the principle of intergenerational equity;
- Consideration of overall community benefits taking account of social, environmental and economic outcomes for any measures, whether voluntary or regulatory; and
- Implementation of policy by the appropriate level of government, industry or the community (Department of the Environment and Energy – Commonwealth of Australia, 2011).

This framework does not appear to be in use by local governments providing waste management services in remote Indigenous communities.

A preliminary review of both the national and international literature on waste management identified a variety of impediments to developing effective and sustainable waste management services in remote Aboriginal communities, all of which militated against efforts by governments or service providers to improve service delivery outcomes for Aboriginal peoples. These included:

- High and ongoing transportation costs due to vast distances between communities;
- Hundreds of kilometres of unsealed roads causing high dust levels and high wear and tear on vehicles; frequent maintenance and repair of vehicles becoming too costly;
- Poor economies of scale;
- Limited access to markets due to remoteness (e.g. depressed markets for recyclables); hence a difficulty creating business opportunities around waste management;
- Lack of human capital (e.g. trained workers with specific technical know-how); hence difficulty with recruitment and retention of staff (Chung and Lo, 2008);
- Limited communication options (e.g. internet and fax often down or nonexistent);
- Extremely limited funding to local governments (e.g. “neither sufficient to maintain roads to a satisfactory standard or even improve the condition of existing roads”) (LGAB, 2008, p. 42);
- General community infrastructure and existing plant and equipment in need of repairing or replacing;
- Local residents dependent on outside specialist services to repair machinery (e.g. faulty truck hydraulics); dependency creates long periods of time without adequate services;
- Seasonality (e.g. flooding and washouts making communities inaccessible during the wet season, especially in the tropics; also, cyclone-prone areas result in flying debris from uncovered landfill);

- Inadequate waste management awareness programs for community (Bharadwaj et al., 2006); even if waste management services are implemented local residents are reluctant to change behaviour;
- Pre-existing disadvantage (e.g. poverty, chronic health issues and inadequate housing) militate against sustaining operations on the ground;
- Low motivation among local residents as a result of government neglect, especially regarding inadequate plant and equipment; and
- Lack of communication and/or collaboration between local Indigenous residents, local governments and State and Federal Governments, on both a policy and program or service delivery front.

A review of the literature revealed a clear recommendation to service providers of waste management in Indigenous communities: namely that it is best practice to avoid adopting any standardised or 'one-size-fits-all' approach to service development.

The above constraints illustrate the extraordinarily complex conditions in remote Indigenous communities. As a result, traditional waste management service models that have been used in urban areas, metropolitan regions or even remote non-Indigenous town-based communities "are not necessarily transferable into remote Indigenous communities" (Seemann and Walker, 1991, p. 31). As one study concluded, a centralised door-to-door or kerbside waste collection and disposal system is often found to be inadequate in remote Aboriginal communities (Ampofo, Kumi, & Ampadu, 2015). In the Indigenous affairs policy literature, the basic assumption driving service workers to adopt a standardised approach to service development is the idea that equity of input equals equity of outcome. That is to say, if successful solutions in metropolitan and regional Australia are simply transferred to remote Indigenous communities then positive outcomes will naturally ensue. However, a large amount of evidence in the literature overwhelmingly favoured a 'fit for purpose' approach to service development. A fit for purpose approach implies that solutions are to be tailored to the specific social, economic and cultural conditions of a given community.

A review of thirty-case studies in 2013 regarding the implementation of waste management services in regional and remote Indigenous and non-Indigenous communities in Australia concluded that "each community is unique and there is no single solution to waste management in ... remote Australia. Rather, to improve waste management, successful ... remote communities have tailored solutions to meet their circumstances" (NEPC, 2013, p. 3). Successful waste management practices in Indigenous communities should evidence an equity of impact based on creative and non-standardised forms of input. A review of the literature revealed that is therefore best practice for frontline workers "to trial and test different infrastructure and waste management approaches and to determine the best 'fit for purpose' waste management solutions for the lands" (NEPC, 2013, p. 29; Moran, 2016). The general consensus reached in the literature is that conceiving of solutions to preconceived problems without first fully understanding the uniqueness or particularity of the context in which these problems emerge is a research and design method that almost always results in negative outcomes for Indigenous Australians (see Moran, 2016).

10. Success Factors and opportunities for solid waste management in remote Indigenous communities

The roughly 1,110 Indigenous communities across Australia - ranging from around 20 to 300 people per community and comprising a population of around 47,900 people in remote areas and 79,500 in very remote areas - constitutes a challenging environment in which to implement a successful waste management service model. However, a review of both the national and international literature revealed a number of critical success factors and promising opportunities for implementing a sustainable waste management model in remote Aboriginal communities. These were:

- Promote community ownership of waste management outcomes (NEPC, p. 13);
- "[Local] Indigenous employment is important in developing improved ownership of waste management outcomes. Without local employment in waste management, it would be difficult to see how change could be achieved" (NEPC, p. 27);
- Collaborate between government, communities and service providers to design training programs that allow local residents to gain employment;
- Ecological sustainability ('caring for country') has significant motivational value and should be integrated into waste management practices;
- Opportunities to achieve economies of scale by incorporating collection from larger regional centres are worth exploring further (NEPC, p. 21);
- Expanding the scope of activities of municipal service officers (MSOs) through recycling has the potential to lead to the development of a small recycling enterprise (NEPC, p. 27);
- Establishing a network of Indigenous MSOs in communities;
- Service providers should actively engage women in the design and development of appropriate waste management technologies and strategies in order to gain unique insights and exercise co-creative and respectful approaches (Seemann et al.);
- Waste management should be couched in ecological and environmental terms to facilitate cross-cultural understandings of sustainability and wellbeing of country;
- Employ community members in salaried local government positions;
- Engaging contractors, (e.g. Indigenous Resource Agencies or locally based Indigenous contractors) on an open tender basis to undertake the work on a formal commercial contract basis;
- Investigate viability of waste disposal depot/waste management facility: a waste and resource 'recovery park', including a recycling centre;
- Establishing remote local government workshops/depots in strategic locations from which local government services would be provided to surrounding communities, by local Indigenous peoples;
- Improve communication and engagement between communities and local governments;
- Establish service depots on communities, staffed by community members;

- Develop and implement service agreements between local governments and Indigenous communities;
- Enable local Indigenous residents to voice their concerns and be heard by local government in all decision-making processes;
- Investigate renewable energy production opportunities with waste (i.e. potential waste-to-energy solutions, whereby rubbish is used as a fuel to generate power);
- Implement container deposit schemes;
- Link local employment with environmental policies, such as the carbon tax

It is best practice for researchers and service providers to see waste as a resource that can be turned into an asset (Landry, 2008, p. 40). Creative solutions to waste management should be able to provide local employment, increase health and wellbeing and improve the environment. In other words, waste should aim to promote sustainable livelihoods (National Indigenous Infrastructure Guide, 2010, p. 179).

The Australian sociologist Eva Cox, in a research paper called 'What Works and What Doesn't Work in Indigenous Service Development' (Cox, 2014), identified a number of principles that comprise the mainstream approach adopted by government and non-government agencies in Indigenous affairs, principles classified as 'what doesn't work in Indigenous service development':

- Standardised, 'one size fits all';
- Lack of collaboration;
- External authorities imposing change;
- Interventions without local Indigenous community control and culturally appropriate adaptation;
- Short-term, one-off funding (piecemeal interventions);
- Provision of services in isolation; and
- Failure to develop Indigenous capacity to provide services (2014, pp. 10-11).

In contrast to the above, Cox (2014) reviewed a number of official government evaluations concerning the delivery of Indigenous-specific services and listed a number of factors that significantly increase the probability of bringing about positive and sustainable outcomes in Indigenous service development:

- Community involvement and engagement;
- Adequate resourcing for planned and comprehensive interventions;
- Respect for language and culture;
- Working together through partnerships, networks and shared leadership;
- Development of social capital;
- Recognising underlying social determinants;

- Commitment to doing projects with, not for, Indigenous people;
- Creative collaboration that builds bridges between public agencies and the community and coordination between communities, non-government and government to prevent duplication of effort; and
- Understanding that issues are complex and contextual (2014, pp. 9-10).

Cox's (2014) recommended best practice principles were supported by the national and international literature on Aboriginal development (see (Moran, 2016; Phillips-Brown, Reddel, & Gleeson, 2013; Stewart, Lohoar, & Higgins, 2011)). However, this list is limited and is to be incorporated into an appropriate community development framework that follows a holistic or systems design approach. The systems framework chosen by the researchers for the current report was the 'sustainable livelihoods approach' (SLA).

The SLA framework draws on a number of essential attributes or capital assets that are required for a sustainable livelihood (Davies & Holcombe, 2009; Gasteyer & Araj, 2009) These assets are:

- Human capital: the talents, skills and special knowledge of people;
- Social capital: the complex web of relationships between organisations, communities and interest groups which makes up civil society and more;
- Cultural capital: the sense of belonging to and understanding the unique identity and distinctiveness of the place expressed tangibly and invisibly from heritage and memories;
- Intellectual capital: the ideas and innovative potential of the community;
- Creativity capital: harnessing the capacity to be curious, to imagine, to stand back, to connect the seemingly disconnected, to relax into ambiguity, to be original and inventive;
- Democratic capital: the ability of communities to foster a culture of discussion and choice within a framework of public accountability and transparency;
- Environmental capital: the built and natural landscape and ecological diversity of an area;
- Leadership capital: the motivation, will, energy and capacity to take responsibility and lead;
- Financial capital: how resources are garnered to pay for services and infrastructure.

Livelihood strategies are made available by the quality of these assets, but are also very much either constrained or enabled by larger forces such as policies, local market conditions, government support, etc. The pursuit and possible sustainability of a livelihood strategy therefore depends on addressing both micro- and macro-level factors, namely a community's assets and the institutional processes in which these assets are expressed or exercised. The SLA framework:

> *is not a measure or test of sustainability. Rather, it is a tool or way of thinking designed to assist in identifying changes that can be made to institutions, to people's assets or their strategies in order to promote the resilience of local livelihood systems (Davies et al. 2009, pp. 56-57).*

As a result, development workers in Indigenous affairs must work toward promoting a resilient livelihood for Indigenous Australians, with the notion of "livelihood" not being confined to the level of financial income a person receives, but rather the ability to exercise cultural practices, language, democratic decision-making processes, health and wellbeing, environmental quality and local strengths and capabilities.

Bibliography

Aboriginal and Torres Strait Islander Commission (ATSIC). (2002). *National Housing and Infrastructure Centre* (ATSIC Ed.). Canberra: ATSIC.

Adebote, D., Kogi, E., Oniye, S., & Akoje, E. (2011). Epidemiological significance of the breeding of mosquitoes in discarded automobile tyres in Zaria, Northern Nigeria. *Journal of Communicable Diseases, 43*(3), 183-192.

Ampofo, S., Kumi, E., & Ampadu, B. (2015). Investigating Solid Waste Management in the Bolgatanga Municipality of the Upper East Region, Ghana. *Environment and Pollution, 4*(3).

Australian Bureau of Statistics. (2003). 4102.0 - Australian Social Trends, 2003. Retrieved from http://www.abs.gov.au/AUSSTATS/abs@.nsf/7d12b0f6763c78caca257061001cc588/2e1d3b9176cc05b6ca2570eb00835394!OpenDocument

Australian Bureau of Statistics. (2013). Measures of Australia's progress, 2010, cat. no. 1370.0. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by Subject/1370.0~2010~Chapter~Waste emissions (6.6.6)

Australian Bureau of Statistics (ABS). (2016, 13/Sept/2016). 1270.0.55.002 - Australian Statistical Geography Standard (ASGS): Volume 2 - Indigenous Structure, July 2016. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by Subject/1270.0.55.002~July 2016~Main Features~Summary table~5

Australian Indigenous HealthInfoNet. (2005). Review of respiratory disease among Indigenous peoples. Retrieved from http://www.healthinfonet.ecu.edu.au/chronic-conditions/respiratory/reviews/our-review

Australian Indigenous HealthInfoNet. (2013). Key facts - waste management. Retrieved from http://www.healthinfonet.ecu.edu.au/health-infrastructure/iehp/waste-management/key-facts

Australian Institute of Health and Welfare. (2014a). *Australia's health 2014*. Canberra: Australian Institute of Health and Welfare Retrieved from http://www.aihw.gov.au/publication-detail/?id=60129547205.

Australian Institute of Health and Welfare. (2014b). *Housing circumstances of Indigenous households: tenure and overcrowding. Cat. no. IHW 132*. Retrieved from Canberra:

Australian Institute of Health and Welfare. (2016). *Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011*. Retrieved from Canberra:

Bailie, R., & Runcie, M. (2002). Household infrastructure in Aboriginal communities and the implications for health improvement. *Medical Journal of Australia, 175*(7), 363-366.

Bailie, R., Siciliano, F., Dane, G., Bevan, L., Paradies, Y., & Carson, B. (2002). *Atlas of health-related infrastructure in discrete Indigenous communities*. Melbourne: Aboriginal and Torres Strait Islander Commission.

Bailie, R., Stevens, M., McDonald, E., Brewster, D., & Guthridge, S. (2010). Exploring cross-sectional associations between common childhood illness, housing and social conditions in remote Australian Aboriginal communities. *BMC Public Health, 10*, 147. doi:10.1186/1471-2458-10-147

Bathurst Regional Council. (2016). Food and garden waste. Retrieved from https://www.bathurst.nsw.gov.au/residents/waste/kerbside-food-and-garden-waste-collection.html

Bernardes, C., & Günther, W. (2014). Generation of Domestic Solid Waste in Rural Areas: Case Study of Remote Communities in the Brazilian Amazon. *Human ecology, 42*(4), 617-623. doi:10.1007/s10745-014-9679-z

Berry, M., & Bove, F. (1997). Birth weight reduction associated with residence near a hazardous waste landfill. *Environmental Health Perspectives, 105*(8), 856-861.

Bharadwaj, L., Nilson, S., Judd-Henrey, I., & Ouellette, G. (2006). Waste Disposal in First- Nations Communities: The Issues and Steps Toward the Future. *Journal of Environmental Health, 68*(7), 35-39.

Biddle, N. (2009). *The Geography and Demography of Indigenous migration:Insights for Policy and Planning*. (Working Paper No. 58). Canberra.

Boadi, K. O., & Kuitunen, M. (2005). Environmental and health impacts of household solid waste handling and disposal practices in third world cities: the case of the Accra Metropolitan Area, Ghana. *Journal of environmental health, 68*(4), 32-36.

Carson, B., & Bailie, R. (2004). Remote Aboriginal and Torres Strait Islander Communities: Issues and Strategies. In N. Cromar, S. Cameron, & H. Fallowfield (Eds.), *Environmental Health in Australia and New Zealand* (pp. 410-435). South Melbourne: Oxford University Press.

Centre for Appropriate Technology. (2008). National Indigenous Infrastructure Guide: Waste. Retrieved from http://static1.squarespace.com/static/5450868fe4b09b217330bb42/t/55879d52e4b04f0a4c0b5a30/1434950994166/08-B4-waste.pdf

City of Greater Bendigo. (2016). Organics. Retrieved from https://www.bendigo.vic.gov.au/Services/Rubbish-Recycling-and-Organics/Organics

Clifford, H., Pearson, G., Franklin, P., Walker, R., & Zosky, G. (2015). Environmental health challenges in remote Aboriginal Australian communities: clean air, clean water and safe housing. *Australian Indigenous HealthBulletin, 15*(2), 1-14.

Commonwealth of Australia. (2009-2016). National Waste Policies. Retrieved from http://www.environment.gov.au/protection/national-waste-policy/publications

Commonwealth of Australia. (2017). *Closing the Gap: Prime Minister's Report 2017*. Retrieved from Canberra: http://closingthegap.pmc.gov.au/sites/default/files/ctg-report-2017.pdf

Cox, E. (2014). What works and what doesn't work in indigenous service development – an annotated compilation of evidence. *The Journal of Indigenous Policy*(16), 1-113.

Davies, J., & Holcombe, S. (2009). Desert knowledge: integrating knowledge and developmentin arid and semi-arid drylands. *GeoJournal, 74*, 363-375.

Department of Environment and Climate Change NSW. (2008). *Illegal dumping prevention and clean up: handbook for Aboriginal communities*. Sydney: Department of Environment and Climate Change NSW, Retrieved from http://www.epa.nsw.gov.au/resources/illegaldumping/080425-aboriginal-communities.pdf.

Department of the Environment and Energy. (2013). *National waste reporting 2013*. Canberra: Department of the Environment and Energy,.

Department of the Environment and Energy – Commonwealth of Australia. (2011). *The National Waste Policy (NWP): Less Waste, More Resources*. Retrieved from Canberra: https://www.environment.gov.au/system/files/pages/94aa70c5-6681-44c6-8d83-77606d1d6afe/files/fs-national-waste-policy.pdf

Eisted, R., & Christensen, T. (2011). Waste management in Greenland: current situation and challenges. *Waste Management & Research, 29*(10), 1064-1070. doi:10.1177/0734242X10395421

Environment Protection and Heritage Council. (2009). *National waste policy : less waste, more resources.* Adelaide, South Asutralia: NEPC Service Corporation,.

Environmental Health Needs Coordinating Committee. (2010). *Environmental health needs of Aboriginal Communities in Western Australia: the 2008 survey and its findings*. Retrieved from Perth:

Ganesharajah, C. (2009). *Indigenous health and wellbeing: the importance of country*. Retrieved from Canberra: http://apo.org.au/resource/indigenous-health-and-wellbeing-importance-country - block-views-citation-popup-block

Gaskin, S., Bentham, R., Cromar, N., & Fallowfield, H. (2007). The Zoonotic Potential of Dogs in Aboriginal Communities in Central Australia. *Environmental Health, 7*(4), 36-45.

Gasteyer, S., & Araj, T. (2009). Empowering Palestinian Community Water Management Capacity: Understanding the Intersection of Community Cultural, Political, Social, and Natural Capitals. *Community Development, 40*(2), 199-219.

Gee, G., Dudgeon, P., Schultz, C., Hart, A., & Kelly, K. (2014). Aboriginal and Torres Strait Islander social and emotional wellbeing. In P. Dudgeon, H. Milroy, & W. R (Eds.), Working Together: Aboriginal

and Torres Strait Islander mental health and wellbeing principles and practice (2nd ed., pp. 55-68). Canberra: Department of The Prime Minister and Cabinet.

Giusti, L. (2009). A review of waste management practices and their impact on human health. *Waste Management, 29*, 2227-2239. doi:10.1016/j.wasman.2009.03.028

Gracey, M., & King, M. (2009). Indigenous health part 1: determinants and disease patterns. *Lancet, 374*, 65-75.

Gracey, M., Williams, P., & Houston, S. (1997). Environmental health conditions in remote and rural Aboriginal communities in Western Australia. *Australian And New Zealand Journal Of Public Health, 21*(5), 511-518.

Green, D. (2008). *Climate impacts on the health of remote northern Australian Indigenous communities*. Retrieved from Sydney: http://www.garnautreview.org.au/CA25734E0016A131/WebObj/03-CIndigenous/$File/03-C Indigenous.pdf

Health and Safety Executive. (2004). *Mapping the health and safety standards in the UK waste industry*. Retrieved from Norwich, UK:

Holman, D., & Joyce, S. (2014a). *A promising future: WA Aboriginal health programs: review of performance with recommendations for consolidation and advance*. Perth: Department of Health,.

Holman, D., & Joyce, S. (2014b). *A promising future: WA Aboriginal health programs: review of performance with recommendations for consolidation and advance* Perth: Department of Health, .

Holt, D., McCarthy, J., & Carapetis, J. (2010). Parasitic diseases of remote Indigenous communities in Australia. *International Journal for Parasitology, 40*(10), 1190-1126.

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *The journal of environmental education, 21*(3), 8-21.

Hyder Consulting. (2011). *Waste and recycling in Australia 2011*. Retrieved from North Sydney: http://www.environment.gov.au/system/files/resources/b4841c02-229b-4ff4-8b3b-ef9dd7601d34/files/waste-recycling2011.pdf

Johnson, D., Druce, J., Chapman, S., Swaminathan, A., Wolf, J., Richards, J., . . . Richards, M. (2008). Chikungunya virus infection in travellers to Australia. *Medical Journal of Australia, 188*(1), 41-43.

MacRae, A., Thomson, N., Potter, C., & Anomie. (2013). Summary of injury among Indigneous people. Retrieved from http://www.healthinfonet.ecu.edu.au/related-issues/injury/reviews/our-summary

Mathews, J. D. (1998). The Menzies School of Health Research offers a new paradigm of cooperative research. *Medical Journal of Australia, 169*(11-12), 625-629.

McDonald, E., Bailie, R., Grace, J., & Brewster, D. (2010). An ecological approach to health promotion in remote Australian Aboriginal communities. *Health Promotion International, 25*(1), 42-53. doi:10.1093/heapro/daq004

Meloni, B., Thompson, R., Hopkins, R., Reynoldson, J., & Gracey, M. (1993). The prevalence of Giardia and other intestinal parasites in children, dogs and cats from Aboriginal communities in the Kimberley. *Medical Journal of Australia, 158*(3), 157-159.

Moran, M. (2016). *Serious Whitefella Stuff: When solutions became the problem in Indigenous affairs*. Carlton: VIC: Melbourne University Press.

National Aboriginal Community Controlled Health Organisation [NACCHO]. (2016). National Distribution of NACCHO Member Services. Retrieved from http://www.naccho.org.au/member-services/www-what-where-when-in-aboriginal-health/

National Aboriginal Health Strategy Working Party. (1989). *National Aboriginal Health Strategy*. Retrieved from Canberra:

National Environment Protection Council (NEPC). (2010). *Solutions for waste management in regional and remote Australia: A compilation of case studies*. Retrieved from http://www.nepc.gov.au/system/files/resources/05068aad-b86a-4b96-96de-513ecfc18165/files/regional-remote-case-studies.pdf

Ncube, F., & Ncube, E. (2016). A systematic critical review of epidemiological studies on public health concerns of municipal solid waste handling. *Perspectives in Public Health, 24*.

Orange City Council. (2016). Food and garden waste FAQs. Retrieved from http://www.orange.nsw.gov.au/site/index.cfm?display=363660

Oyegunle, A. O. (2016). *Solid Waste Management Practices in Two Northern Manitoba First Nations Communities: Community Perspectives on the Issues and Solutions.* The University of Manitoba, Winnipeg, Manitoba, Canada. Retrieved from http://www.umanitoba.ca/institutes/natural_resources/pdf/theses/Oyegunle, Ahmed.MNRM 2016.pdf

Phillips-Brown, P., Reddel, T., & Gleeson, B. (2013). *Learning from experience? Getting governments to listen to what evaluations are telling them.* Paper presented at the Better Indigenous Policies: The Role of Evaluation roundtable proceedings, Melbourne Victoria.

Porta, D., Milani, S., Lazzarino, A. I., Perucci, C. A., & Forastiere, F. (2009). Systematic review of epidemiological studies on health effects associated with management of solid waste. *Environmental Health, 8*(1), 60. doi:10.1186/1476-069x-8-60

Prince, A. (2011). *The Rubbish Report – Waste Management in the Anangu Pitjantjatjara Yankunytjatjara Lands (The APY Lands): Past, Present and Future*. Retrieved from Sydney: http://www.papertracker.com.au/pdfs/rubbish_report.pdf

Productivity Commission. (2006). *Waste management*. Retrieved from Canberra:

Rand, T., Haukohl, J., & Marxen, U. (2000). *Municipal solid waste incineration: a decision maker's guide*. Retrieved from Washington D.C.:

Reynoldson, J., Behnke, J., Pallant, L., Macnish, M., Gilbert, F., Giles, S., . . . Thomson, R. (1997). Failure of pyrantel in treatment of human hookworm infections (Anclyostoma duodenale) in the Kimberley region of north west Australia. *Acta Tropica, 68*, 301-312.

Rushton, L. (2003). Health hazards and waste management. *British Medical Bulletin, 68*(1), 183-197. doi:10.1093/bmb/ldg034

Russell, R. (2002). Ross River virus: ecology and distribution. *Annual Reviews of Entomology, 47*, 1-31.

Russell, R., Currie, B., Lindsay, M., Mackenzie, J., Ritchie, S., & Whelan, P. (2009). Dengue and climate change in Australia: predictions for the future should incorporate knowledge from the past. *Medical Journal of Australia, 190*(5), 265-268.

Saffron, L., Giusti, L., & Pheby, D. (2003). The human health impact of waste management practices: A review of the literature and an evaluation of the evidence. *Management of Environmental Quality, 14*(2/3), 191.

Saffron, L., Giusti, L., & Pheby, D. (2003). The human health impact of waste management practices: A review of the literature and an evaluation of the evidence. *Management of Environmental Quality, 14*(2), 191-213.

Sankoh, F., Yan, X., & Tran, Q. (2013). Environmental and Health Impact of Solid Waste Disposal in Developing Cities: A Case Study of Granville Brook Dumpsite, Freetown, Sierra Leone. *Journal of Environmental Protection, 4*(7), 665-670. doi:10.4236/jep.2013.47076

Seemann, K. W., & Walker, B. W. (1991). *Remote controlled waste: an introduction to waste management and appropriate technology in remote Aboriginal communities. Research study of waste in remote aboriginal communities in Central Australia for the Northern Territory Department of Health and Community Services*. Alice Springs, NT: Centre for Appropriate Technology Inc., Alice Springs College of TAFE.

Spencer, R., Beausoleil, R., & Martorello, D. (2007). How agencies respond to human-black bear conflicts: a survey of wildlife agencies in North America. *Ursus, 18*(2), 217-229.

Steering Committee for the Review of Government Service Provision. (2014). *Overcoming Indigenous Disadvantage: Key Indicators 2014*. Retrieved from Canberra:

Stewart, J., Lohoar, S., & Higgins, D. (2011) Effective Practices for service delivery coordination in Indigenous communities. *Closing the Gap Clearinghouse Resource Sheet 8*. Canberra: Australian Institute of Health and Welfare & Melbourne, Australian Institute of Family Studies.

Torzillo, P. J., Pholeros, P., Rainow, S., Barker, G., Sowerbutts, T., Short, T., & Irvine, A. (2008). The state of health hardware in Aboriginal communities in rural and remote Australia. *Australian and New Zealand Journal of Public Health, 32*(1), 7-11. doi:10.1111/j.1753-6405.2008.00158.x

Valdivia, J. (2010). *Organic Waste Management in Manitoba, Canada: Barriers and opportunities to implement best-practices.* (Masters Thesis), University of Manitoba, Canada.

Viel, J. F., Daniau, C., Goria, S., Fabre, P., de Crouy-Chanel, P., Sauleau, E. A., & Empereur-Bissonnet, P. (2008). Risk for non Hodgkin's lymphoma in the vicinity of French municipal solid waste incinerators. *Environ Health, 7*. doi:10.1186/1476-069x-7-51

Ware, V.-A. (2013). *Improving the accessibility of health services in urban and regional settings for Indigenous people. Resource sheet no. 27*. Canberra: Australian Institute of Health and Welfare,.

Wayte, K., Bailie, R., Gray, N., & Henderson, G. (2007). Framework for Research on Aboriginal Health and the Physical Environment. In I. Anderson, F. Baum, & M. Bentley (Eds.), *Beyond Bandaids: Exploring the Underlying Social Determinants of Aboriginal Health. Papers from the Social Determinants of Aboriginal Health Workshop, Adelaide, July 2004*. Darwin: Cooperative Research Centre for Aboriginal Health.

Willis, E., Pearce, M., & Jenkin, T. (2004). The demise of the Murray River: Insights into lifestyle, health and well-being for rural Aboriginal people in the Riverland. *Health Sociology Review, 13*(2), 187-197.

Wilson, D., Rodic, L., Modak, P., Soos, R., Carpintero Rogero, A., Velis, C., . . . Simonett, O. (2013). *Global Waste Management Outlook* (D. Wilson Ed.): United Nations Environment Programme,.

Woods, C., Usher, K., Edwards, A., Jersmann, H., & Maguire, G. (2015). The tyranny of distance - mapping accessibility to polysomnography services across Australia. *Australian Indigenous HealthBulletin, 15*(3).

World Health Organization. (2012). Global WHO alliance for the elimination of blinding trachoma by 2020. *Weekly epidemiological record, 87*(17), 161-168.

Zubrick, S. R., Silburn, S. R., Lawrence, D. M., Mitrou, F. G., Dalby, R. B., Blair, E. M., . . . Li, J. (2005). *The Western Australian Aboriginal Child Health Survey [WAACHS]: The social and emotional wellbeing of Aboriginal children and young people*. Perth: Curtin University of Technology, Telethon Institute for Child Health Research.

Additional readings informing this review

Altavista, P., S. Belli, F. Bianchi, A. Binazzi, P. Comba, R. Del Giudice, L. Fazzo, A. Felli, M. Mastrantonio, M. Menegozzo, L. Musmeci, R. Pizzuti, A. Savarese, S. Trinca and R. Uccelli (2004). "Cause-specific mortality in an area of Campania with numerous waste disposal sites." *Epidemiologia & Prevenzione* 28(6): 311-321.

Anderson, I., F. Baum and M. Bentley, Eds. (2007). *Beyond Bandaids: Exploring the underlying social determinants of Aboriginal health. Papers from the Social Determinants of Aboriginal Health Workshop, Adelaide, July, 2004*. Darwin, CRC for Aboriginal Health.

Australian Bureau of Statistics. (2007). *Housing and Infrastructure in Aboriginal and Torres Strait Islander Communities*, Australia, 2006, cat. no. 4710.0."

Australian Indigenous HealthInfoNet (2008). *Review of the impact of housing and health-related infrastructure on Indigenous health*. Retrieved: http://www.healthinfonet.ecu.edu.au.

Bailie, R., B. Carson and E. McDonald (2004). "Water supply and sanitation in remote indigenous communities - Priorities for health development." *Australian and New Zealand Journal of Public Health* 28(5): 409-414.

Bailie, R., M. Stevens, E. McDonald, D. Brewster and S. Guthridge (2010). "Exploring cross-sectional associations between common childhood illness, housing and social conditions in remote Australian Aboriginal communities." *BMC public health* 10: 147.

Baker, J. (2010). "Fear of flying." *Rural Society* 20(1): 21-34.

Bathurst Regional Council. (2016). "Food and garden waste." Retrieved 25 November 2016, from https://www.bathurst.nsw.gov.au/residents/waste/kerbside-food-and-garden-waste-collection.html.

Bianchi, F. and F. Minichilli (2006). "Mortality for non-Hodgkin lymphoma in the period 1981-2000 in 25 Italian municipalities with urban solid waste incinerators." *Epidemiol Prev* 30.

Biggeri, A., F. Barbone, C. Lagazio, M. Bovenzi and G. Stanta (1996). "Air pollution and lung cancer in Trieste, Italy: spatial analysis of risk as a function of distance from sources." *Environmental Health Perspectives* 104(7): 750-754.

Biggeri, A. and D. Catelan (2005). "Mortality for non-Hodgkin lymphoma and soft-tissue sarcoma in the surrounding area of an urban waste incinerator. Campi Bisenzio (Tuscany, Italy) 1981-2001." *Epidemiol Prev* 29.

Bresnitz, E. A., J. Roseman, D. Becker and E. Gracely (1992). "Morbidity among municipal waste incinerator workers." *American Journal of Industrial Medicine* 22(3): 363-378.

Briggs, D. J. (2008). "A framework for integrated environmental health impact assessment of systemic risks." *Environmental Health* 7(61).

Bunger, J., M. Antlauf-Lammers, T. G. Schulz, G. A. Westphal, M. M. Muller, P. Ruhnau and E. Hallier (2000). "Health complaints and immunological markers of exposure to bioaerosols among

biowaste collectors and compost workers." *Occupational Environmental Medicine* 57(7): 458-464.

Bünger, J., B. Schappler-Sheele, R. Hilgers and E. Hallier (2007). "A 5-year follow-up study on respiratory disorders and lung function in workers exposed to organic dust from composting plants." *International Archives of Occupational and Environmental Health* 80(4): 306-312.

Cantoni, R. (2016). "The waste crisis in Campania, South Italy: a historical perspective on an epidemiological controversy." *Endeavour* 40(2): 102-113.

Carson, B. and R. Bailie (2004). Remote Aboriginal and Torres Strait Islander Communities: Issues and Strategies. *Environmental Health in Australia and New Zealand*. N. Cromar, S. Cameron and H. Fallowfield. South Melbourne, Oxford University Press: 410-435.

City of Greater Bendigo. (2016). "Organics." Retrieved 25 November 2016, from https://www.bendigo.vic.gov.au/Services/Rubbish-Recycling-and-Organics/Organics.

Clarke, W. (2004). Solid and Hazardous Wastes. *Environmental Health in Australia and New Zealand*. N. Cromar, S. Cameron and H. Fallowfield. South Melbourne, Oxford University Press.

Clifford, H., G. Pearson, P. Franklin, R. Walker and G. Zosky (2015). "Environmental health challenges in remote Aboriginal Australian communities: clean air, clean water and safe housing." *Australian Indigenous HealthBulletin* 15(2): 1-14.

Comba, P., V. Ascoli, S. belli, M. Benedetti, L. Gatti, P. Ricci and A. Tieghi (2003). "Risk of soft tissue sarcomas and residence in the neighborhood of an incinerator of industrial wastes." *Occupational and Environmental Medicine* 60(9): 680-683.

Communicable Diseases Network Australia (2014). Trachoma - national guidelines for public health units. Department of Health. Canberra, Department of Health,.

Cordier, S., C. Chevrier, E. Robert-Gnansia, C. Lorente, P. Brula and M. Hours (2004). "Risk of congenital anomalies in the vicinity of municipal solid waste incinerators." *Occupational and Environmental Medicine* 61(1): 8-15.

Davoli, E., E. Fattore, V. Paiano, A. Colombo, M. Palmiotto, A. N. Rossi, M. Il Grande and R. Fanelli (2010). "Waste management health risk assessment: A case study of a solid waste landfill in South Italy." *Waste management* 30(8-9): 1608-1613.

Department of Environment and Climate Change NSW (2008). *Illegal dumping prevention and clean up: handbook for Aboriginal communities*. Department of Environment and Climate Change NSW. Sydney, Department of Environment and Climate Change NSW,.

Dolk, H. and M. Vrijheid (2003). "The impact of environmental pollution on congenital anomalies." *British Medical Bulletin* 68: 25-45.

Dolk, H., M. Vrijheid, B. Armstrong, L. Abramsky, F. Bianchi, E. Garne, V. Nelen, E. Robert, J. E. Scott, D. Stone and R. Tenconi (1998). "Risk of congenital anomalies near hazardous-waste landfill sites in Europe: the EUROHAZCON study." *Lancet* 352(9126): 423-427.

Dummer, T. J., H. O. Dickinson and L. Parker (2003). "Adverse pregnancy outcomes around incinerators and crematoriums in Cumbria, north west England, 1956-93." *Journal of Epidemiology and Community Health* 57(6): 456-461.

Eisted, R. and T. Christensen (2013). "Environmental assessment of waste management in Greenland: current practice and potential future developments." *Waste Management & Research* 31(5): 502.

Elliot, P., S. Richardson, J. J. Abellan, A. Thomson, C. de Hoog, L. Jaruo and D. J. Briggs (2009). "Geographic density of landfill sites and risk of congenital anomalies in England." *Occupational and Environmental Medicine* 66(2): 81-89.

Elliott, P., D. Briggs, S. Morris, C. de Hoogh, C. Hurt, T. K. Jensen, I. Maitland, S. Richardson, J. Wakefield and L. Jarup (2001). "Risk of adverse birth outcomes in populations living near landfill sites." *British Medical Journal* 323(7322): 363-368.

Elliott, P., N. Eaton, G. Shaddick and R. Carter (2000). "Cancer incidence near municipal solid waste incinerators in Great Britain. Part 2: histopathological and case-note review of primary liver cancer cases." *British Journal of Cancer* 82(5): 1103-1106.

Elliott, P., G. Shaddick, I. Kleinschmidt, D. Jolley, P. Walls, J. Beresford and C. Grundy (1996). "Cancer incidence near municipal solid waste incinerators in Great Britain." *British Journal of Cancer* 73(5): 702-710.

enHealth (2010). *Environmental health practitioner manual: a resource manual for environmental health practitioners working with Aboriginal and Torres Strait Islander communities*. Canberra, Department of Health,.

Executive, H. a. S. (2009). *Update to mapping health and safety standards in the UK waste industry*. Maidenhead.

Feitosa, R. C. and S. Wilkinson (2016). "Modelling green roof stormwater response for different soil depths." *Landscape and Urban Planning* 153: 170-179.

Fielder, H., C. M. Poon-King, Palmer, Sr., N. Moss and G. Coleman (2000). "Assessment of impact on health of residents living near the Nant- y- Gwyddon landfill site: retrospective analysis." *British Medical Journal* 320(7226): 19-22.

Fien, J. and E. Charlesworth (2012). "‘ Why isn’t it solved?’: Factors affecting improvements in housing outcomes in remote Indigenous communities in Australia." *Habitat International* 36(1): 20-25.

Fien, J., E. Charlesworth, G. Lee, D. Baker, T. Grice and D. Morris (2011). "Life on the edge: Housing experiences in three remote Australian indigenous settlements." *Habitat international* 41(1): 343-349.

Fisher, S., R. Elvin, S. McFallan, P. Memmott, T. O'Rourke, S. Peter, R. Porter, O. Stanley, P. Sullivan, D. Tedmanson and M. Young (2011). *Desert services that work: demand-responsive approaches to desert Settlement. Alice Springs*. DKCRC Research Report 70.

Floret, N., F. Mauny, B. Challier, P. Arveux, J. Y. Cahn and J. F. Viel (2003). "Dioxin emissions from a solid waste incinerator and risk of non-Hodgkin lymphoma." *Epidemiology* 14(4): 392-398.

Garvey, D. (2008). *A review of the social and emotional wellbeing of Indigenous Australian peoples - considerations, challenges and opportunities*. Retrieved: https://www.healthinfonet.ecu.edu.au/uploads/docs/sewb-review.pdf

Gaskin, S., R. Bentham, N. Cromar and H. Fallowfield (2007). "The Zoonotic Potential of Dogs in Aboriginal Communities in Central Australia." *Environmental Health* 7(4): 36-45.

Gondim-Porto, C., L. Platero, I. Nadal and F. Navarro-García (2016). "Fate of classical faecal bacterial markers and ampicillin-resistant bacteria in agricultural soils under Mediterranean climate after urban sludge amendment." *The science of the total environment* 565: 200-210.

Green, D. and Minchin, L. (2014). Living on Climate-Changed Country: Indigenous Health, Well-Being and Climate Change in Remote Australian Communities. EcoHealth

Health, D. o. (2016). "Zika Virus." Retrieved 5 December, 2016.

Johnston, L., J. Doyle, B. Morgan, S. Atkinson-Briggs, B. Firebrace, M. Marika, R. Reilly, M. Cargo, T. Riley and K. Rowley (2013). "A Review of Programs That Targeted Environmental Determinants of Aboriginal and Torres Strait Islander Health." *International Journal of Environmental Research and Public Health* 10(8): 3518-3542.

Kingsley, J., M. Townsend, R. Phillips and D. Aldous (2009). ""If the land is healthy ... it makes the people healthy": the relationship between caring for Country and health for the Yorta Yorta Nation, Boonwurrung and Bangerang Tribes." *Health Place* 15(1): 291-299.

Lea, T. and P. Pholeros (2010). "This is not a pipe: the treacheries of Indigenous housing." *Public culture* 22(1): 187-209.

Louis, G. (2004). "A historical context of municipal solid waste management in the United States." *Waste Management & Research* 22(4): 306-322.

Marchettini, N., R. Ridolfi and M. Rustici (2007). "An environmental analysis for comparing waste management options and strategies." *Waste Management* 27(4): 562-571.

Mavropolous, A. (2015). Wasted health: The tragic case of dumpsites. Vienna, International Solid Waste Association.

McDonald, E., R. Bailie, D. Brewster and P. Morris (2008). "Are hygiene and public health interventions likely to improve outcomes for Australian Aboriginal children living in remote communities? A systematic review of the literature." *BMC Public Health* 8: 153-153.

McDonald, E., R. Bailie, J. Grace and D. Brewster (2009). "A case study of physical and social barriers to hygiene and child growth in remote Australian Aboriginal communities." *BMC Public Health* 9(346).

McDonald, E., T. Cunningham and N. Slavin (2015). "Evaluating a handwashing with soap program in Australian remote Aboriginal communities: a pre and post intervention study design." *BMC Public Health* 15(1188).

McMullen, C., A. Eastwood and J. Ward (2016). "Environmental attributable fractions in remote Australia: the potential of a new approach for local public health action." *Australian and New Zealand Journal of Public Health* 40(2): 174-180.

Melody, S. M., E. Bennett, H. D. Clifford, F. H. Johnston, C. C. J. Shepherd, Z. Alach, M. Lester, L. J. Wood, P. Franklin and G. R. Zosky (2016). "A cross-sectional survey of environmental health in remote Aboriginal communities in Western Australia." I*nternational Journal of Environmental Health Research* 26(5-6): 525-535.

Meloni, B., R. Thompson, R. Hopkins, J. Reynoldson and M. Gracey (1993). "The prevalence of Giardia and other intestinal parasites in children, dogs and cats from Aboriginal communities in the Kimberley." *Medical Journal of Australia* 158(3): 157-159.

Montgomery, M. and M. Elimelech (2007). "Water and sanitation in developing countries: Including health in the equation - Millions suffer from preventable illnesses and die every year." *Environmental Science and Technology* 41(1): 17-24.

Moran, M. (1999). *Improved settlement planning and environmental health in remote Aboriginal communities*. Alice Springs, Centre for Appropriate Technology.

Municipal Waste Advisory Council (2010), *Is Waste Management an 'Essential Service'?* Position Paper

Murti, M., Ayre, R., Shapiro, H. and Burger, R. (2011). Public Health Response to Striking Solid Waste Management. *Journal of Environmental Health*, Vol. 74 (3).

National Partnership on Remote Indigenous Housing (NPRIH): *Progress Review* (2008-2013).

The National Environment Protection Council (NEPC) (2010). *Solutions for waste management in regional and remote Australia: A compilation of case studies*. The Regional and Remote Australia Working Group.

Nkwocha, E., R. Egejuru, E. Pat-Mbano and R. Njoku-Tony (2011). "Proximity of municipal waste dumpsites to residential neighbourhoods and rate of hospitalization for malaria." *International Journal of Advanced Biotechnology and Research* 2(1): 159-167.

Overcoming Indigenous Disadvantage (OID): *Key Indicators 2014*, Steering Committee for the Review of Government Service Provision

Oyegunle, A. (2016). *Solid Waste Management Practices in Two Northern Manitoba First Nations Communities: Community Perspectives on the Issues and Solutions*. University of Manitoba, Winnipeg: Manitoba

Poulsen, O., N. Breum, N. Ebbehøj, Å. Hansen, U. Ivens, D. van Lelieveld, P. Malmros, L. Matthiasen, B. Nielsen, E. Nielsen, B. Schibye, T. Skov, E. Stenbaek and C. Wilkins (1995). "Collection of domestic waste. Review of occupational health problems and their possible causes." *The science of the total environment* 170(1-2): 1-19.

Raju, M. V. S. (2012). "Contamination of Ground Water Due To Landfill Leachate." *International Journal of Engineering Research* 1(2): 48-53.

Regional and Remote Australia Working Group (2013). Solutions for waste management in regional and remote Australia: A compilation of case studies. Standing Council on Environment and Water, National Environment Protection Council,.

Report on the Inquiry into Local Government Service Delivery to Indigenous Communities, Local Government Advisory Board (LGAB), (August 2008).

Sahlstrom, L., A. Aspan, E. Bagge, M. Danielsson-Tham and A. Albihn (2004). "Bacterial pathogen incidences in sludge from Swedish sewage treatment plants." *Water Research* 38(8): 1989-1994.

Torzillo, P. J. and P. Pholeros (2002). "Letter to the editor: household infrastructure in Aboriginal communities and the implications for health improvement." *Medical Journal of Australia* 176(10): 502-503.

Vimercati, L., A. Baldassarre, M. Gatti, L. Maria, A. Caputi, A. Dirodi, F. Cuccaro and R. Bellino (2016). "Respiratory Health in Waste Collection and Disposal Workers." *International Journal of Environmental Research and Public Health* 13(7): 1-8.

Walton, S., J. Choy, A. Bonson, A. Valle, J. McBroom, D. Taplin, L. Arlian, J. D. Mathews, B. Currie and D. Kemp (1999). "Genetically distinct dog-derived and human-derived Sarcoptes scabiei in scabies-endemic communities in northern Australia." *American Journal Of Tropical Medicine And Hygiene* 61(4): 542-547.

Wilson, D., L. Rodic, P. Modak, R. Soos, A. Carpintero Rogero, C. Velis, M. Iyer and O. Simonett (2013). *Global Waste Management Outlook*, United Nations Environment Programme,.

Worthington, A. (2000). "Can Australian local government play a meaningful role in the development of social capital in disadvantaged rural communities." *The Australian journal of social issues* 35(4): 349.

Zagozewski, R., I. Judd-Henrey, S. Nilson and L. Bharadwaj (2011). "Perspectives on Past and Present Waste Disposal Practices: A Community-Based Participatory Research Project in Three Saskatchewan First Nations Communities." *Environmental Health Insights* 5: 9-20.

Zeng, C., D. Niu and Y. Zhao (2015). "A comprehensive overview of rural solid waste management in China." *Frontiers of environmental science & engineering* 9(6): 949-961.