Government of South Australia
Office of Green Industries SA
An initiative of Zero Waste SA

DISASTER RESILIENT AUSTRALIA

Disaster Waste Management Scoping Study

Final Report

September 2015

rawtec

RWA resources and waste advisory group

Resilient ORGANISATIONS

MIKE HAYWOOD sustainable resource solutions › making the in-between green

Photograph on front cover: Clean-up following 2010/11 Queensland Floods. Source: (The Conversation, 2011)

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This document was prepared for the Office of Green Industries SA by Rawtec in collaboration with Resources and Waste Advisory Group, Resilient Organisations and Mike Haywood Sustainable Resources Solutions.

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Resources and Waste Advisory Group (RWA)	RWA is a UK consulting business specialising in a range of disciplines across waste and resource management.
Resilient Organisations (ResOrgs)	ResOrgs is a public-good research programme based in New Zealand that researches what makes organisations resilient to crises.
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Document status

Version	Date	Prepared by	Peer review by	Approved by
Final report	17/09/2015	Kat Heinrich, Mark Rawson, Michael Cowing & Mike Haywood	Charlotte Brown	Mark Rawson

Executive Summary

The management of debris following a disaster can have real and lasting impacts on affected communities and the environment. Disaster waste management can:

- Greatly impact the speed and cost of recovery
- Provide local employment following the disaster
- Deliver recycled products to rebuild infrastructure in affected communities, and
- Have long lasting impacts on human health and environmental outcomes from the disaster

Experience from around the globe demonstrates that developing a disaster waste management plan can greatly improve outcomes by building capacity within individuals and organisations to undertake waste management activities. Without contingency planning, volumes of disaster debris have the potential to overwhelm a city's waste and recycling infrastructure, impede disaster response and recovery activities, and contribute to poor outcomes for human health and the environment.

This study, commissioned by the Office of Green Industries SA, reviewed the current status of disaster waste management in South Australia. It was found there is no set framework for managing disaster waste in SA. Rather, disaster waste management has been carried out effectively through the joint efforts of several organisations and individuals, and with waste quantities largely managed and disposed/recycled using local government resources.

SA's responses and systems haven't yet been tested to handle millions of tonnes of debris from a single disaster event, such as the volume produced by the 2011 Christchurch Earthquake in New Zealand. Should SA face a major disaster event, it is expected that greater challenges would arise requiring more centralised management and additional resources beyond local government capacities.

This study:

- Provided a review of current disaster waste collection and management practices in SA
- Developed waste profiles for flood, severe storm, earthquake and bushfire, including identification of waste nature, streams and potential issues/challenges
- Estimated potential debris types and volumes that may be generated in SA for select disaster scenarios
- Identified potential skills, administration and equipment needed for disaster waste management, and explored the opportunity for developing pre-approved panels of suppliers
- Identified considerations for the establishment of temporary debris storage sites
- Identified disposal/recycling facilities in SA that could potentially manage disaster waste, including their locations, waste streams accepted and capacities
- Reviewed the regulatory framework for disaster waste management, and identified potential ambiguities and/or inadequacies in policies and regulations.

Disaster debris volume estimates for select scenarios in SA are provided in Figure E.1, including for:

- Earthquakes – 10,000 Average Recurrence Interval (ARI)1 and 1,000 ARI earthquake in Metropolitan Adelaide
- Bushfire – 300 ARI bushfire in Adelaide Mount Lofty Ranges
- Flood – 100 ARI flooding of the Brownhill Keswick Creek
- Severe storms – 1,000 ARI and 70 ARI severe storm in Metropolitan Adelaide

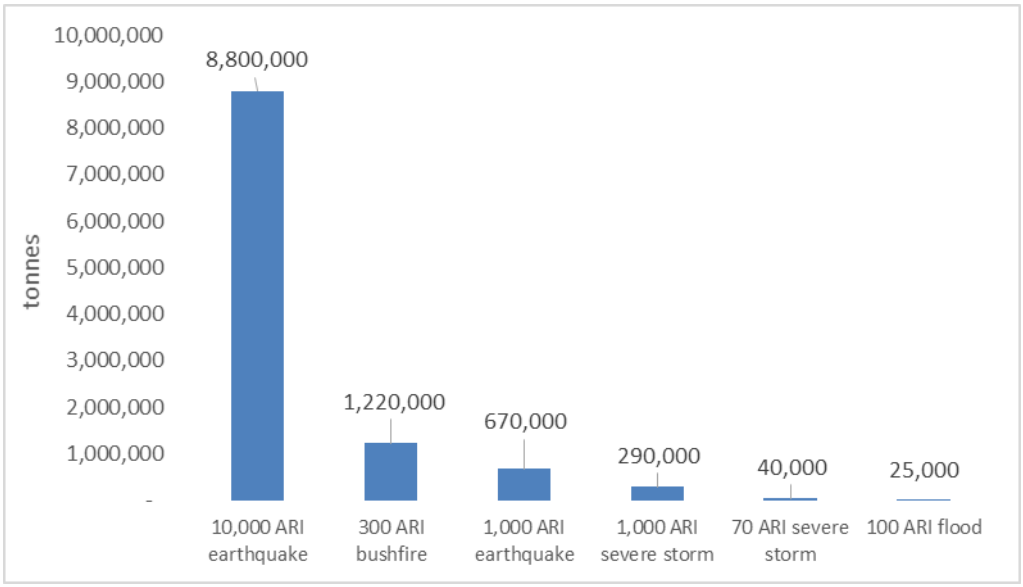


Figure E.1: *Disaster debris volumes for select disaster scenarios in SA*

It was estimated that a 10,000 ARI earthquake would generate 8.8 million tonnes of debris in SA, which is equivalent to about twice the volume of waste that is generated by the state every year (Zero Waste SA, 2014). These 'order of magnitude' estimates, along with classification of disaster waste volumes and associated potential management issues/challenges (Chapter 2), may be used to develop strategies and guidelines for disaster waste removal and management, and identify appropriate facilities for their disposal/recycling.

The main types of facilities likely to handle disaster waste volumes in SA include:

- Landfills
- Landfills that are specially licenced to receive asbestos
- Construction and demolition recyclers
- Waste-to-energy facilities
- Organics processing facilities
- Metals recyclers

There are 30 major waste or recycling facilities in SA across these categories. A number of factors should be considered when selecting a recycling or disposal option for disaster waste, including: the

[1] The long-term average number of years between the occurrences of a disaster event of a given scale/magnitude.

nature of the waste stream, laws and regulations, local waste industry capabilities, waste facility locations and costs.

A review of experience from interstate and overseas has found that a range of social and economic factors should also be considered when selecting a disposal/recycling option for disaster debris, including: impact of debris management on the speed of recovery, employment and outcomes for health, safety and the environment. It was found that these decisions sometimes involve trade-offs. For example, the decision to recycle waste may lead to improved environmental and employment outcomes, but at the cost of a longer recovery period. Decision makers need to weigh-up the relative advantages and disadvantages of available options for the disposal/recycling of disaster waste, taking into account these considerations.

A high-level review of SA's regulatory framework found that existing regulations and policies can help facilitate improved outcomes for disaster waste management (e.g. through penalising unwanted behaviours such as illegal dumping). Potential challenges under the current regulatory framework were also identified (such as increased cost of debris management due to resource recovery requirements, and slowing down recovery due to approval processes for licensing). The EPA Act has provisions for emergency situations where circumstances of urgency exist and there is a need to protect life, the environment or property. It also allows the transport of waste where there is no fee or reward which can assist with a rapid clean-up of sites. This requires support through advice and guidance to ensure that the waste is transported appropriately and ends up in the destination able to receive and dispose of that waste

A planning methodology was developed for this study, which provides a framework to guide the development of a Disaster Waste Management Plan for each Emergency Management Zone in SA. This methodology provides guidance on the development of content, and materials to help practitioners in commencing the development process.

A number of recommendations are provided for further stages of contingency planning for disaster waste management in SA. These include:

- Integrate responsibilities for disaster waste management into SA's emergency management arrangements via development of a Disaster Waste Management Support Plan under the State Emergency Plan. Consideration should then be given to whether a further stage of Zone-level planning is required or of benefit.
- Identify funding and payment mechanisms for disaster waste management
- Assign roles and responsibilities for strategic management of disaster waste management activities
- Develop State guidelines for debris collection and management
- Establish and maintain panels of pre-approved suppliers, including provision of training
- Further develop SA debris metrics and calculator tool
- Develop register of tools and resources that may be used for disaster waste management.

Contents

Acronyms

ABC	Australian Broadcasting Corporation
ARI	Average Recurrence Interval
BHKC	Brownhill Keswick Creek Catchment
BOM	Bureau of Meteorology
CCA	Copper Chrome Arsenate
CFS	South Australian Country Fire Service
DEWNR	Department of Environment, Water and Natural Resources, Government of South Australia
DPTI	Department of Planning, Transport and Infrastructure, Government of South Australia
DWM	Disaster Waste Management
EMA	Emergency Management Australia
EPA	Environment Protection Authority
EPO	Environment Protection Order
ICA	Insurance Council of Australia
MFS	Metropolitan Fire Service
NDRRA	Natural Disaster Relief and Recovery Arrangements
NEXIS	National Exposure Information System
SAFECOM	South Australian Fire and Emergency Services Commission
SAPN	SA Power Networks
SAPOL	South Australia Police
SEMC	State Emergency Management Committee
SEMP	State Emergency Management Plan
SES	State Emergency Service
VBRRA	Victorian Bushfire Reconstruction and Recovery Authority
WMMA	Waste Management Association of Australia
W2R EPP	Environment Protection Policy (Waste to Resources) 2010

1. Background

Natural disasters such as floods, fires, earthquakes and severe storms can generate millions of tonnes of debris.

Clean-up and management of this waste is an important component of disaster response and recovery activities. In the initial disaster response phase, debris needs to be cleared from roads and other areas to make way for search-and-rescue efforts, and to remove potential hazards (such as fallen trees on power lines). Collections of putrescible and medical waste need to be established across relief centers, and where possible resumed across occupied homes and hospitals to prevent potential health hazards. Throughout the recovery stages, waste from damaged/demolished buildings and damaged infrastructure needs to be cleared so that rebuilding can commence.

As well as protecting public health, the efficiency and effectiveness of these disaster waste management activities impacts the speed and cost of recovery and long-term environment impacts of the disaster. These activities can also provide local employment during the recovery phase, and can deliver recycled masonry products for the construction of new buildings and infrastructure in the affected city.

Planning for disaster waste management can help improve social, economic and environmental outcomes by:

- Developing a strategy to handle the large volumes of waste generated, which have the potential to overwhelm a city's waste management infrastructure
- Setting clear roles and responsibilities for waste management, and identifying potential suppliers and waste management facilities, thereby reducing time taken for resources to be deployed
- Building the capacity of individuals and organisations to undertake disaster waste management activities
- Being aware of potential risks and challenges associated with management of disaster waste, and having strategies prepared to deal with them, thereby removing or minimizing potential harm to human health and the environment
- Putting a legislative and policy framework in place to support good outcomes for waste management, such as deterring illegal dumping of waste and ensuring waste is managed by suitably licensed transporters and facilities
- Improving outcomes throughout the recovery phase through providing local employment, and putting measures in place to provide end recycling markets for recovered debris.

To date, little work has been undertaken on contingency planning for disaster waste management in Australia.

2. This study

This scoping study, commissioned by the Office of Green Industries SA, is the first in a series of projects being undertaken on contingency planning for disaster waste management in South Australia.

It provides a high-level understanding of disaster waste management status and issues in SA, including:

- A review of current disaster waste collection and management practices in SA
- Development of waste profiles for flood, severe storm, earthquake and bushfire, including identification of waste nature, streams and potential issues/challenges
- Estimation of potential debris volumes that may be generated in SA for select disaster scenarios
- Identification of disaster waste management needs and potential suppliers
- Identification of waste collection and management options for disaster waste, taking into account lessons from national and international events
- Maps of accessible waste management facilities in SA, and identification of capacities where available
- Identification of potential temporary waste storage management requirements, including selection criteria and applicable regulations, permits and approvals
- Review of SA's regulatory framework for disaster waste management

A planning methodology was also developed that can be applied to detailed zone-level waste management contingency plans that may be developed in subsequent project stages (Phase 2 – Pilot studies and Phase 3 – statewide roll out of zone contingency plans). See Figure 0.1.

Although the focus of this study was on four natural disaster types (i.e. flood, severe storm, earthquake and bushfire), many of the principles and key learnings can be used to plan for different natural and man-made disaster types (e.g. a terrorist incident).

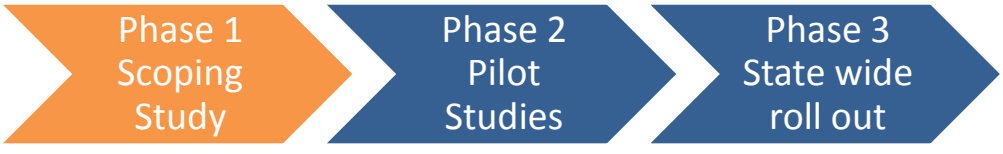


Figure 0.1: *Sequencing of projects for contingency planning for disaster waste management in SA*

3. Consultation and data collection

The project team would like to acknowledge and thank the organisations that provided valuable input into the project. This includes those who participated in the stakeholder roundtable, consultations and data collection.

Stakeholder roundtable

A stakeholder roundtable was held at the outset of this study (held at the Office of Green Industries SA offices in Adelaide, March 2015) to: help set the direction of the project, identify information sources, and understand stakeholder perspectives and considerations for disaster waste management.

Representatives from the following organisations participated in this roundtable:

- Local Government Association of SA
- Office of Green Industries SA
- SA Police
- SA Country Fire Service
- SA Fire and Emergency Service Commission
- SA Environment Protection Authority
- SA Department of Environment, Water and Natural Resources
- SA Department of Planning, Transport and Infrastructure
- SA State Emergency Service
- Engineering Functional Service
- State Recovery Office
- Waste Management Association Australia

Data collection and consultations

Consultation and data collection was undertaken across a 3 month period (March– May 2015) with a range of stakeholders, including:

- A & V Contractors
- Adelaide Hills Council
- Adelaide Resource Recovery
- Bureau of Meteorology
- Cave Civil and Environmental
- City of Burnside
- Clare and Gilbert Valleys Council
- City of Mount Gambier
- City of Whyalla
- District Council of Coober Pedy
- East Waste
- Eyre Waste
- Gambier Earthmovers
- Insurance Council of Australia
- Local Government Association SA
- Northern Adelaide Waste Management Authority
- Office of Green Industries SA
- One Steel Recycling
- Peats Garden and Soil
- ResourceCo
- SA Country Fire Service
- SA Department of Environment, Water and Natural Resources
- SA Department of Planning Transport and Infrastructure
- SA Environment Protection Authority
- SA Metropolitan Fire Service

- SA Power Networks
- SA State Emergency Service
- SA Fire and Emergency Service Commission
- Sims Metal Management
- Sita ResourceCo Alternative Fuels
- Southern Region Waste Resource Authority
- Southern Waste ResourceCo
- State Recovery Office
- Transpacific Industries

Table 0.1 provides a summary of the nature of consultations undertaken for this project and data gathered from these organisations.

***Table 0.1**: Summary of project consultations*

Organisation(s)	Nature of consultation	Data gathered
Hazard leaders[2] (DPTI, SES, CFS, MFS and DEWNR)	Mix of face-to-face meetings, phone consults and email	• Information about extent of likely damage for select SA disaster scenarios used to develop waste profiles
Government departments (BOM, DEWNR)	Phone consults and email	• Further data and information used to develop waste profiles
SAFECOM	Face-to-face meeting	• Information about structure of SA's emergency management arrangements
Regulatory authorities (SA EPA)	Face-to-face consultations and phone consults	• Information about SAs regulatory framework and implications for disaster waste management
Waste industry (private and local government waste organisations)	Mix of face-to-face meetings and phone consults	• SA waste and recycling facility locations, throughputs and capacities • Material compositional data on demolished SA building structures used to develop debris metrics
Local government (councils, LGA)	Phone consults	• Management of disaster waste across past SA disaster events
SA Power Networks	Phone consult	• Information about management of disaster waste for electricity network
State Recovery Office	Face-to-face meeting	• Management of disaster waste across past SA disaster events
Insurance Council of Australia (ICA)	Phone consult	• Role of ICA following a disaster
Office of Green Industries SA	Mix of face-to-face meetings and email	• GIS maps of located waste and recycling facilities

[2] The State Emergency Management Committee has identified ten key hazards in South Australia and assigned Hazard Leader agencies to each of these hazards to lead a multi-agency approach to risk mitigation.

4. Report structure

The remainder of this report is set out as follows.

- Chapter 1 – reviews disaster waste management practices in SA, including responsibilities, disposal systems, recycling outcomes, and issues that have arisen, based on case studies of three past local events.
- Chapter 2 – provides disaster waste profiles for floods, severe storms, earthquakes and bushfires, and estimation of potential debris volumes that may be generated in SA for select disaster scenarios. This section also classifies and characterises different disaster waste streams and identifies potential issues that can arise for their management. It provides SA metrics for estimation of disaster waste.
- Chapter 3 – identifies disaster waste management needs and potential suppliers, and explores the opportunity of establishing panels of pre-approved suppliers.
- Chapter 4 – describes different facilities and sites for disaster waste management, including identification of potential existing sites in SA, their capacities and locations (including GIS maps). It also identifies considerations for selection of temporary debris storage sites, and the selection of disposal/recycling option for disaster waste, taking into consideration lessons from disaster waste management across past local, national and international disasters.
- Chapter 5 – provides a high level review of the regulatory framework for disaster waste management in SA. It considers existing legislation, policies and guidelines for management of waste, as well as emergency legislation. It also identifies potential ambiguities and/or inadequacies in policies and regulations, which could potentially have unintended adverse effects for disaster waste management.
- Chapter 6 – provides a structured planning methodology that can be applied to development of a disaster waste management plan for each Emergency Management Zone in SA.
- Chapter 7 – identifies key findings and recommendations from study
- Appendix 1 – SA disaster debris estimation calculator
- Appendix 2 – SA waste/recycling facility database, which includes information about facilities that may potentially be used to manage disaster waste. It includes information about facility locations, waste streams received, throughput, opening hours and capacity.
- Appendix 3 – List of closed landfills in SA, which could potentially be used as temporary storage sites for disaster waste
- Appendix 4 – List of potential suppliers for disaster waste management services and functions.
- Appendix 5 – Disaster debris estimates for scenarios modelled.
- Appendix 6 – List of regulatory contacts for disaster waste management
- Appendix 7 – Table of Contents for a disaster waste management plan

CHAPTER 1

Review of practices in South Australia

1.1 Context

South Australia has experienced a number of severe weather events and fires in recent years that have destroyed properties and generated thousands of tonnes of debris.

A review of waste management practices was undertaken for three recent events, including:

- January 2015 Sampson Flat Bushfire
- February 2014 Burnside Severe Storms
- December 2010 Stockport Floods

The review identifies how waste types and volumes were managed across these events, including responsibilities, disposal systems, recycling outcomes and waste issues that arose. It provides valuable insights into current disaster waste management practices in SA, and identifies potential challenges for management of waste following future disaster events.

It is recognised that the scale of destruction (and hence waste volumes) from these past events is small compared to what SA might experience in a major disaster (such as a 1 in 10,000 year earthquake in Metropolitan Adelaide). Table 1.1 below provides some relativity of waste volumes generated at these 3 events compared to larger, more destructive disasters that have occurred interstate and overseas.

SA's waste management responses and systems haven't yet been tested to handle millions of tonnes of debris from a single disaster event, such as the volume produced by the 2011 Christchurch Earthquake in New Zealand. Lessons from these major interstate and international events are provided throughout relevant sections of this document, to be considered alongside SA experiences, for contingency planning purposes.

Table 1.1: *Reported or estimated volumes of disaster debris from past Australian and International events*

Location	Disaster event	Reported or estimated volume of waste (tonnes)	Data source
Australia			
SA	2010 Stockport Floods	2,000	Rawtec estimate based on cubic metres provided by Clare and Gilbert Valleys Council
SA	2014 Burnside severe storms	> 3,000	City of Burnside Council
SA	2015 Sampson Flat bushfires	Not estimated	-
Queensland	2010 Queensland floods	>460,000	(WME, 2011)
International			
Italy	L'Aquila earthquake	1,500,000 – 3,000,000	(Di. Coma.C as cited in Brown, 2012)
New Zealand	2011 Christchurch earthquake	8,500,000	(C. Brown &. M., 2012)
China	2008 Sichuan earthquake	20,000,000	(Taylor as cited in Brown, 2012)
Japan	2011 Great East Japan Earthquake	> 22,000,000	(UNEP, 2012)

1.2 January 2015 Sampson Flat Bushfire

Photo: Debris following the 2015 Sampson Flat Bushfire. Source: (The Australian, 2015)

The 2015 Sampson Flat bushfire began on 2 January 2015, and burnt through 12,548 hectares over six days across the Adelaide Hills and outer Adelaide metropolitan area. The fires killed more than 914 stock animals (plus unknown wild animals), damaged 44 homes, destroyed 24 homes, 196 outbuildings and 215 vehicles.

The main waste streams generated by the fires included fallen/burnt trees, and building debris from burnt houses, sheds and other structures. Other waste streams included animal carcasses, farm and household chemicals, asbestos-containing materials, burnt permapine (CCA-treated) posts, and plastic from irrigation and water tanks.

A number of stakeholders were involved in the management of waste including local councils, homeowners, insurers, SA EPA, SES, SA Power Networks, local government, DPTI, the State Recovery Office and others.

The SES assisted with the initial response by clearing trees and vegetative debris that was blocking roads and other infrastructure. SA Power Networks cleared trees on fallen power lines.

Landowners were responsible for disposal of waste on their land. DPTI was responsible for disposal of waste on state land (e.g. fallen trees on state roads), local councils were responsible for disposal of waste on council land (e.g. fallen trees on council roads, parks), and private landowners (homeowners and farms) were responsible for disposal of waste from their properties.

There were instances where the line of responsibility for waste disposal was unclear. For example, where a public tree fell onto private land, and when a private tree fell onto

public land. In these cases, the local council generally took responsibility.

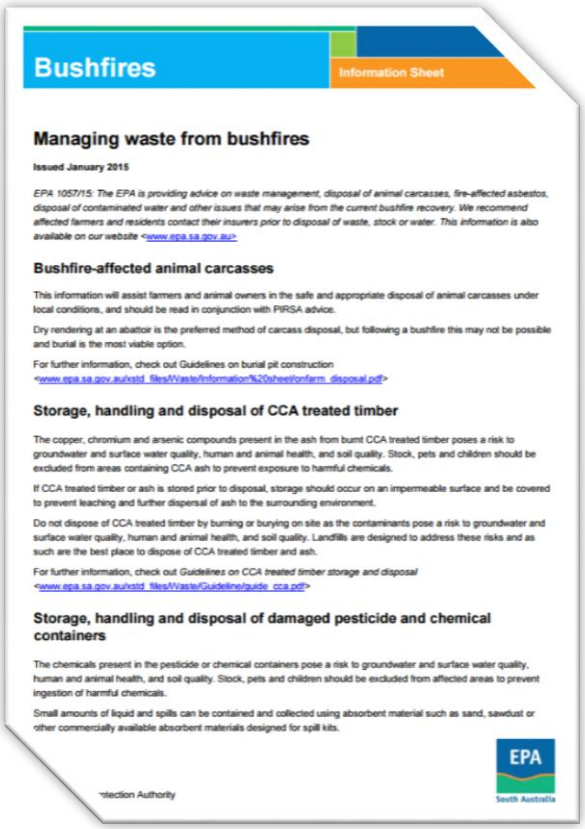
Vegetative debris collected by councils and DPTI was stockpiled on state-owned land. Local councils are currently seeking a cost-effective option for disposal of this waste stream in a manner that creates benefits for the community.

In most instances, vegetative debris on private land was piled up and burnt on-site. Some of the larger properties had to manage up to 6,000-7,000 dead trees.

Local councils increased the operating hours of their public transfer stations to receive waste from local residents and businesses. They also negotiated with the SA EPA on how best to administer the waiver of the waste levy authorised by the Minister for the Environment.

The State Recovery Office coordinated communications about recovery following the fire. This included directing enquires from the public about disposal of waste to the SA EPA website including disposal of animal carcasses, CCA-treated posts, chemicals and asbestos-containing materials. See below information sheet produced by the SA EPA about managing waste from bushfires.

The disposal of CCA-treated posts by private landowners (e.g. farmers and homeowners) was problematic given their chemical treatment and high cost of disposal (up to $220/tonne plus freight). These posts should not be burnt because of the hazardous nature of both the air emissions and the ash. The Barossa council organised to collect CCA-treated posts from homeowners and farms, free of charge, to ensure they were appropriately disposed at a landfill.



Bushfires

Information Sheet

Managing waste from bushfires

Issued January 2015

EPA 1057/15: The EPA is providing advice on waste management, disposal of animal carcasses, fire-affected asbestos, disposal of contaminated water and other issues that may arise from the current bushfire recovery. We recommend affected farmers and residents contact their insurers prior to disposal of waste, stock or water. This information is also available on our website <www.epa.sa.gov.au>

Bushfire-affected animal carcasses

This information will assist farmers and animal owners in the safe and appropriate disposal of animal carcasses under local conditions, and should be read in conjunction with PIRSA advice.

Dry rendering at an abattoir is the preferred method of carcass disposal, but following a bushfire this may not be possible and burial is the most viable option.

For further information, check out Guidelines on burial pit construction <www.epa.sa.gov.au/xstd_files/Waste/Information/%20sheet/onfarm_disposal.pdf>

Storage, handling and disposal of CCA treated timber

The copper, chromium and arsenic compounds present in the ash from burnt CCA treated timber poses a risk to groundwater and surface water quality, human and animal health, and soil quality. Stock, pets and children should be excluded from areas containing CCA ash to prevent exposure to harmful chemicals.

If CCA treated timber or ash is stored prior to disposal, storage should occur on an impermeable surface and be covered to prevent leaching and further dispersal of ash to the surrounding environment.

Do not dispose of CCA treated timber by burning or burying on site as the contaminants pose a risk to groundwater and surface water quality, human and animal health, and soil quality. Landfills are designed to address these risks and as such are the best place to dispose of CCA treated timber and ash.

For further information, check out *Guidelines on CCA treated timber storage and disposal* <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guide_cca.pdf>

Storage, handling and disposal of damaged pesticide and chemical containers

The chemicals present in the pesticide or chemical containers pose a risk to groundwater and surface water quality, human and animal health, and soil quality. Stock, pets and children should be excluded from affected areas to prevent ingestion of harmful chemicals.

Small amounts of liquid and spills can be contained and collected using absorbent material such as sand, sawdust or other commercially available absorbent materials designed for spill kits.

...tection Authority

EPA South Australia

***Image 1.1**: Information Sheet from the SA EPA on managing wastes from bushfires (SA EPA, 2015).*

Scrap metal recyclers set-up skips across private and public land for people to recycle metal waste. Building debris was managed by demolition companies which were generally paid for by insurance companies.

Zero Waste SA collected and managed hazardous chemicals through a licensed contractor.

Kerbside waste contractors faced challenges with resuming regular collections of household waste over a two week period. Many areas were not accessible due to road closures.

Kerbside waste collection contractor, East Waste, established procedures for collecting waste from fire affected areas. This included holding daily briefing sessions with staff prior to collections, checking with emergency services for roads closures, making sure it was

safe for staff to undertake collections, monitoring the dangers, managing safe collection in affected areas without obstructing emergency services and daily feedback to council and residents on what is happening with kerbside collections.

Alternative drop off locations for residents to dispose of domestic waste free-of-charge were set up by council (via East Waste). Large skip bins were distributed across parks, ovals and reserves over two weeks.

Power outages led to freezers and refrigerators not running, resulting in excess volumes of spoilt food from households and businesses. East Waste provided additional general waste collections to capture these extra waste volumes over a two week period.

Summary

- Main waste streams included masonry materials and metals (from damaged building structures, fences, sheds) and vegetative waste from fallen/half-burnt trees
- Hazardous waste streams included asbestos, CCA-treated posts and farming/household chemicals
- Extra waste volumes were generated from spoilt food due to power outages
- Waste was managed by landowners, which included a combination of private (e.g. homeowners) and public stakeholders (local and state government)
- Vegetative waste collected by councils is temporarily stored on state-owned land until an arrangement for its beneficial reuse is made.
- Councils provided additional waste services to residents, and negotiated with the EPA on how to best administer the waiver of the waste levy for bushfire waste authorised by the Minister for the Environment.
- The State Recovery Office coordinated communication with the public on waste management. The Office referred the public onto information from the EPA for management of bushfire waste.
- There were challenges involved with resuming domestic waste collections, which were overcome by councils and collection contractors. Waste collections were affected for two weeks.

1.3 February 2014 Severe Storm in Burnside

Photo (left). A fallen gum tree brings down power lines on Greenhill Rd, Toorak Gardens, after high winds hit the city in February. Picture: Roy Van Der Vegt Source: News Limited. Photo (right) huge fallen trees had to be cut up and removed. Source: Spence Denny, ABC

On the 4th February 2014, a severe storm hit Eastern Adelaide bringing winds of more than 100 km/h.

The storm brought down trees, power lines and damaged property. A number of cars, and a school playground were also damaged. Most trees fell on public land rather than onto properties.

The SES assisted with the initial response by clearing trees from roads, and the SA Power Networks cleared trees fallen on power lines.

Burnside council led the subsequent clean-up and collection of trees and debris that was on council land. The required response overwhelmed council resources, and so assistance was sought from other local councils, including staff and equipment from other councils (City of Charles Sturt, Port Adelaide Enfield, Salisbury, Holdfast Bay and West Torrens). A total of 1,750 hours was spent cleaning up the mess (News Limited, 2014), including 350 hours of assistance from these other councils.

Landowners were responsible for managing their own waste. Burnside council assisted homeowners by providing a kerbside collection of vegetative debris. There was some 'opportunistic' disposal of material by residents that was not generated by the storm, but rather had likely been stored for some time. This was managed by council by capping volumes collected at two 6x4 trailers per household.

In total more than 3,000 tonnes of wood waste was collected by the council. Most of the material was sent to Mannum or Alexandrina Councils at no charge and used as a fuel source for paddle steamers. About 900 tonnes of wood waste was mulched and used locally (e.g. on parks and gardens). Unused mulched was sent to a local organics recycler at no charge. The remaining volumes of waste (about 10-15%) was sent to landfill.

Overall, good outcomes for waste management were achieved. The collaboration between councils and council staff for the clean-up and processing of waste worked well. Arrangements for organics were cost-effective, and resulted in most of the waste being

recovered as a resource rather than being sent to landfill. The cleanup and management of waste, however, was not without its challenges.

Coordination of activities between council and the SES could have been improved. The council and SES both received calls from the public requesting that fallen trees and debris be removed. There wasn't an established system to share information across the two organisations about incoming calls and responses. The Local Government Association of SA and the SA SES have since decided to develop guidelines to assist them to better collaborate when responding to flood or severe weather events.

The cleanup faced additional challenges due to power outages, which meant that council had to rely on its two way radio system to communicate with its staff. The power outages also led to further volumes of waste being generated, including spoilt food across households, local cafés and grocers due to lack of refrigeration. Households and some of the smaller businesses had this waste collected via council kerbside organics collection services. Kerbside collection contractor, East Waste, dedicated another truck to collect all the extra organic waste from the storm. Larger volumes of food waste were managed by businesses through arranging for commercial collections.

Another challenge for waste management was resuming regular kerbside waste and recycling services to households. Waste collections were impacted for two days. Access to households was restricted due to trees blocking roads and street verges, which resulted in delays to regular kerbside collections. East Waste coordinated with council staff to get access to roads, and collect the waste.

Summary

- Key waste stream was fallen trees and other vegetation– estimated at 3,000 tonnes.
- The local council and SES had some challenges with coordinating calls from the public requesting assistance to remove fallen trees from roads and properties.
- The local council worked together with neighbouring councils to collect and recycle/dispose of fallen trees in the public realm. Together council staff spent 1,750 hours on these activities.
- Most vegetative waste collected by council was recycled (as mulch, or as a fuel source for paddle steamers). This provided a cost-effective solution for the waste. Only small quantities were sent to landfill.
- Some properties were damaged. The resulting waste was managed by property owners. The local council provided residents with additional collections for waste generated by the storm.
- Some challenges for waste management included:
    - Power outages that affected communications and led to generation of additional volumes of spoilt food needing to be collected.
    - Road blockages and access issues, which impacted domestic kerbside collections
    - Opportunistic disposal of waste by some residents, who utilised additional council collections for disposal of other waste.

1.4 December 2010 Stockport Floods

Brad Pilgrim with his kids Ryan 10 and Lara 9 at their flooded Stockport home. Source: The Advertiser.

In December 2010 heavy rain caused flooding in many areas in South Australia, with the Mid North hardest hit. Flooding of the Gilbert River caused the river's bank to break, and several residents in the nearby town of Stockport to evacuate their homes (ABC , 2010). The floods also impacted three other towns including Riverton, Tarlee and Rhynie.

Main waste streams generated by the floods included damaged home contents and fallen trees. 40 homes and businesses were affected by the rising waters (ABC news, 2010), and about 5 to 6 houses needed to be demolished (Newscorp, 2010).

The SES and CFS assisted with the response, by clearing trees and vegetative debris that was blocking roads and other infrastructure, such as stormwater drains.

Homeowners were responsible for the cleanup of their properties, and were encouraged to contact their insurance company directly and take photos of any damage before removing and disposing of items, and to consider their safety whilst cleaning up (refer to figure for media release from the SES).

Media Release

State Emergency Service

Government of South Australia

SES RESCUE

Residents should consider safety as clean up begins

Thursday, 09 December 2010, 3.15pm

As flood waters across South Australia begin to subside, the clean up and recovery in some of the areas affected can begin. Government representatives are currently assessing the damage across the state and measures are being taken to assist and consult with the community.

- Residents are reminded to ensure they contact their insurance company directly and to take photos of any damage before removing and disposing of items such as carpets and fittings.
- An emergency recovery centre has been established at the Stockport institute and residents affected by flooding in that area are encouraged to seek assistance if needed.
- An additional transport ferry has been provided for Mannum residents due to road closure.

While the Bureau of Meteorology (BOM) still have a flood warning current for the Gawler River, the risk has significantly reduced the recovery phase, including assessing the full extent of the damage state-wide has now commenced.

The State Emergency Service (SES) reminds those in flood affected areas to remain vigilant and aware of the safety risks that are still present.

Image 1.2: *Media release from the SES reminding residents to consider their safety as they undertake clean up (SA State Emergency Services, 2010).*

In the initial stages of clean-up, there was a significant amount of easily removable materials and items from households, such as furniture, household accessories, clothing, toys, etc. This was later followed by removal of damaged fixings such as floor coverings. In some cases these items were removed relatively quickly out of the residences. In other cases, there was a delay whilst insurance issues were resolved. This disaster waste was placed out on the kerbside for collection by the local council (Clare and Gilbert Valleys Council).

After a period of time there was an amount of 'opportunistic' disposal, with material that had likely been stored for some time by residents being placed out for collection.

The council used trucks to remove debris from the roadside. On occasional instances, council staff also assisted residents with moving waste from households to the roadside. As of the 22nd December (less than 2 weeks after the initial flooding), the council had cleaned over 1,200 cubic metres of rubbish out of the town (ABC, 2010). This increased up to 3000 cubic metres.

At the time, the council still had access to two landfill sites that it operated and the majority of the material was disposed of there. The decision to dispose of waste to landfill was driven by the urgency to remove material from publicly accessible pathways.

The collaboration between various official organisations including council, and the local community worked effectively. Access to a convenient landfill site following an emergency situation was crucial to the management of waste.

Summary

- Main waste streams included damaged home contents (hard waste) and fallen trees, which together made up estimated at 3000 cubic metres.
- This waste was collected by councils which funded and delivered a kerbside pick-up to residents.
- Waste collected by the council was disposed to a local landfill – a decision driven by the urgency to remove waste in a timely manner.
- Some additional volumes of waste were generated from the demolition of buildings (less than 10) that were structurally damaged by the storm.
- Challenges for waste management included:
    - Funding disaster response (including the clean-up)
    - Opportunistic disposal by some residents, who utilised the council collections for disposal of other waste

1.5 Key findings

There is no set framework for managing disaster waste in SA. Several government and non-government organisations have provided disaster waste services and assistance to affected communities. However, generally, the responsibility for managing waste volumes remains that of the landowner. For example, debris on public land is managed by local council or the state government, and debris generated on private land is managed by the landowner.

Local councils in SA have played a key role in managing waste following severe weather events and fires. These councils have collected and disposed/recycled large quantities of waste generated on public land (e.g. fallen trees). They have also provided support to their residents including information on waste disposal options, and undertaking additional waste and recycling collection services. In the case of the 2010 Stockport Floods (where 40 homes and businesses were damaged) the local council funded, collected and disposed of damaged household items, such as furniture, carpet and other personal property.

A large number of other organisations and individuals have been involved in the clean-up and management of disaster waste in SA, including:

- SES – which have cleared fallen trees from roads, and issued notices to the public reminding them to consider their safety when cleaning up waste
- SA Power Networks – which have cleared fallen trees from power lines, and also removed waste from their damaged infrastructure
- DPTI – which have cleared and disposed of debris from state owned roads and infrastructure
- Homeowners – which have managed waste on their properties including fallen trees, damaged fencing and other structures, and organised for demolition and disposal of damaged buildings and their contents
- Insurance companies – which on behalf of homeowners have arranged for demolition of affected buildings, and disposal of resulting waste
- Commercial waste collection contractors (such as scrap metal recyclers, construction and demolition waste recyclers) – which have been engaged by homeowners, insurers, and councils to remove waste
- Kerbside waste collection contractors – which have worked together with councils and state emergency services to resume kerbside collections to residents
- Neighbouring councils – which (in the case of the Burnside severe storms) have provided support and resources to the affected local council
- EPA – which has sought a waiver of the Waste Levy for disposal of bushfire affected waste from the Minister of the Environment and provided advice and information to residents and other stakeholders on the disposal of waste streams, including advice on hazardous waste streams
- State Recovery Office – which has coordinated communications for recovery efforts, including providing information to affected communities on waste management

- Local Government Association SA – which has helped councils to access funding for disaster relief, and are developing guidelines for coordinating between councils and state emergency services for future extreme weather events
- Volunteers, community groups and private organisations – which have assisted with clean-up efforts

The destination of waste has differed across events. In the case of the 2014 Burnside Severe Storms, the main waste volumes were vegetative (fallen trees). Most of this material was mulched by council or sent to a community organisation for use as fuel (for paddle steamers). These arrangements resulted in good resource recovery outcomes and were cost effective. In the case of the December 2010 Stockport floods, all waste collected by the council was sent to a local landfill. This decision was driven by the urgency to remove material to allow public access.

A number of challenges have arisen for management of waste (see Table 1.2 below).

Overall, waste management has been carried out effectively through the joint efforts of several organisations and individuals, and with waste quantities largely managed and disposed/recycled using local government resources.

As noted in the introduction to this section, the extent of damage from these 3 events (and waste volumes generated) has been relatively small compared to some disasters experienced elsewhere, and the waste volumes produced were within the capacities of the existing waste management system. Should SA face a major disaster event, it is expected that greater challenges would arise, requiring more centralised management and additional resources beyond local government capacities. These larger challenges and resourcing needs are considered in the remaining sections of the document.

Table 1.2: *Challenges for disaster waste and management strategies across past SA events*

Challenge	Management strategy
Road blockages and hazards affecting domestic waste collections	This has been overcome at past events through coordination between kerbside contractors, council and SES, to resume collections where possible and also set up temporary skip bins at parks and reserves for residents to dispose of household waste.
Extra volumes of spoilt food waste needing to be collected due to power outages.	This has been managed through additional kerbside collections of waste to residents. For larger waste volumes (e.g. food from restaurants), private waste collections were used.
Power outages resulted in disruptions to communications.	Council works staff have managed through using battery-operated devices, e.g. two way radios.
Opportunistic disposal of material by some residents using council services that were	Councils have placed limits on the volume of material that they would collect from households through their additional services.

intended for only disaster waste volumes (rather than waste that had been stored for some time).	
Risks associated with management of hazardous wastes (such as CCA-treated posts, asbestos and farming chemicals).	Burning of CCA-treated posts can lead to environmental damage. The EPA has provided information about the safe disposal of these posts, asbestos and other hazardous materials. One council also set-up collections for free disposal of CCA-treated posts.

CHAPTER 2

Waste Profiles

2.1 Introduction

This chapter describes the types of waste streams and volumes that are produced by natural disasters, and associated considerations and issues for their management.

Waste profiles have been developed for four disaster types:

- Bushfire (section 2.3)
- Earthquake (section 2.4)
- Severe storm (section 2.5)
- Flood (section 2.6)

These profiles identify the types and nature of waste generated, and provide estimates of likely waste volumes generated by potential disasters in SA for select scenarios. Scenarios were selected from risk assessments that have been recently completed by Hazard Leaders (e.g. 300 ARI bushfire in the Adelaide Mount Lofty Ranges).

Box 2.1

A **disaster debris calculator** has been developed, which provides order-of-magnitude estimates of waste volumes for different types of waste. This calculator is based on South Australian disaster debris metrics that were developed in this study. Whilst the calculator is not suitable for publication, it is intended it be further developed and refined into a more advanced tool that can be used by stakeholders across SA (and potentially Australia) to estimate disaster debris volumes.

Users of the tool are required to enter the following data into input fields;

- Disaster type (bushfire, flood, severe storm, earthquake)
- Square kilometres (km^2) of urban area affected by disaster
- Average vegetation density (low, medium, high) across affected urban areas
- Number of low-rise buildings in affected area
- Total floor area (m^2) of damaged high-rise building

The output table provides estimates of debris generated (in tonnes and cubic metres) by waste stream (masonry, metals, vegetative waste, hard waste, whitegoods, e-waste, soil and sediment, and vehicle bodies).

2.2 Waste streams and characteristics

The main types of waste generated by natural disasters are:

- Building materials from damaged building structures, roads and other infrastructure. These structures can include masonry materials, steel and timber and can include asbestos-containing materials.
- Building contents, including hard waste (such as carpets, timber, furniture, clothing, other personal items), whitegoods, electronic and electrical waste.
- Vegetative debris, such as fallen trees, and
- Soil and sediment

Other wastes generated by disasters, but generally smaller in volume, include putrescible wastes, vehicle bodies, and other hazardous wastes (such as household chemicals, paint, farm and industry chemicals).

Table 2.1 identifies waste streams generated by natural disasters and shows the relativity of waste volumes (low, medium and high) across different disaster types.

These waste streams are classified in Table 2.2 overleaf, and are further described below. This includes identification of issues that should be considered in management of these waste streams, which take into account lessons from past local, national and international events.

Table 2.1: *Waste streams generated by natural disasters (bushfires, earthquakes, floods and severe storms), and relativity of waste volumes (H – high, M – medium, L– low)*[3]

Waste stream category	Bushfire	Earthquake	Flood	Severe storm
Masonry	M-H	H	L-M	L
Asbestos containing waste	M-H	M-H	L-M	L-M
Metals	M	M	L	M
Vegetative waste	M-H	L	L-M	H
Hard waste	M	M-H	M-H	L-M
White goods	L-M	L-M	L-M	L-M
Electrical and electronic waste	L-M	L-M	L-M	L-M
Other hazardous wastes	L-M	L-M	L-M	L-M
Soil and sediment	L	L-H	M-H	L-M
Contaminated soil	L	L-M	M-H	L-M
Vehicle bodies	L-M	L-M	L-M	L-M
Putrescible waste	L	L-M	L-M	L-M
Medical waste	L-M	L-M	L-M	L-M

[3] For some waste streams a range of volumes is presented (e.g. medium-high) because the volume of waste generated depends on a number of factors. For example, the volume of soil generated by an earthquake depends on if liquefaction occurs, the volume of contaminated soil generated depends on if wastewater pipes burst, and the volume of hard waste depends on if buildings collapse or not (i.e. if furniture is salvageable).

Table 2.2: *Classification of waste streams generated by natural disasters (inc. bushfires, earthquakes, floods and severe storms)*

Waste stream category	Waste materials	Waste sources
Masonry	Concrete, bricks, stone, asphalt, and plasterboard	Damaged building structures, slabs, kerbing, roads.
Asbestos	Asbestos containing waste	Damaged building structures containing asbestos (e.g. in roof sheeting and capping, guttering, gables, eaves/soffits water pipe and flues, wall sheeting, vinyl sheet flooring, carpet and tiles underlays, zelemite backing boards to the switchboards, flexible building boards, imitation brick cladding, fencing, carports and sheds, waterproof membrane, telecommunications pits, some window putty, expansion joints, packing under beams, concrete formwork (Australian Government Asbestos Safety and Eradication Agency).
Metals	Ferrous (steel), aluminium and other non-ferrous	Damaged fencing, sheds, windows and doors, reinforced concrete, electrical cable, copper pipe.
Vegetative waste	Green waste	Fallen and/or burnt trees, broken branches, leaves and other vegetative material.
Hard waste	Mix of wastes - such as timber, furnishings, carpet and textiles	Damaged and/or displaced furniture, personal belongings and other items. Timber from damaged building structures.
White goods	Whitegoods (e.g. refrigerator, dishwasher)	Damaged and/or displaced whitegoods from households and businesses.
Electrical and electronic waste	Electrical and electronic material (e.g. TVs, computers, appliances)	Damaged and/or displaced electrical and electronic goods from households and businesses.
Other hazardous wastes	Chemicals, batteries, fluorescent lighting	Household hazardous wastes (e.g. fluorescent lighting, cleaning chemicals, batteries), farming waste (e.g. farming chemicals) and other industry wastes.
Soil and sediment	Clays, fines, rubble and soil	Clay, fines, rubble and soil that has been displaced.
Contaminated soil	Contaminated soil	Waste soil that has been contaminated with hazardous substances.
Vehicle bodies	Car, truck and other vehicle bodies	Damaged and/or displaced vehicle bodies.
Putrescible waste	Food waste, disposable nappies	Spoilt food from supermarkets, restaurants and households, and putrescible waste from post-disaster relief centres.
Medical waste	Pharmaceutical waste	Waste generated across hospitals from treatment of persons that were injured in the disaster.

Masonry materials

Masonry waste includes materials such as bricks, stones, concrete, and plasterboard which are generated from damaged building structures, roads and other public infrastructure. This waste is generally recyclable, and recycled materials can be used to rebuild cities where building codes permit (e.g. concrete & road base).

The amount of masonry waste produced by a disaster is largely a function of building size and materials. In SA, most dwellings are low-rise and are constructed of brick (double brick or brick veneer), with the average dwelling estimated to weigh over 160 tonnes (excluding building contents) – see Tables 2.3 & 2.4.

Masonry waste volumes are also affected by building vulnerability to damage, which is linked to building age. In the case of earthquakes, Australian design standards were introduced in 1979 for earthquake resistant buildings. Buildings constructed prior to the early 1980s are therefore considered more vulnerable than those constructed after this date (SA Department of Planning, Transport and Infrastructure, 2014).

The number of buildings demolished and, therefore, the amount of masonry waste generated by a disaster can also be affected by ownership of the waste stream by insurance levels and changes to building codes. For example, following the 2011 Christchurch Earthquake, many insurers decided to demolish damaged building structures rather than repair them. This was due to a combination of factors including the prevalence of full replacement type insurance policies, policy wordings requiring 'as new' reinstatement and increases in structural requirements for buildings. A demolition and rebuild option was chosen because it was often a more cost-effective option than repair. This led to greater volumes of masonry waste.

Asbestos

An important consideration for management of disaster waste is the prevalence of asbestos in damaged building structures. The average house in SA contains an estimated 100 kg of asbestos sheeting (see Table 2.4). Asbestos can pose a human health risk, and so requires specialised removal, transport and disposal.

***Table 2.3**: Dwelling structure, main materials of outside walls 2008 (Australian Bureau of Statistics, 2008)*

Dwelling structures	% of SA dwellings
Brick veneer	39.7
Double brick	39.1
Stone	9.8
Timber	1.7
Fibro cement	5.2
Concrete/besser blocks	1.4
Steel/Aluminium	0.9
Other	1.0
Did not know	1.1
Total	100.0

***Table 2.4:** Debris Metric - Estimated material composition of average SA dwelling (not including contents). Source: Rawtec*

Material	*Tonnes/ average dwelling*
Concrete, bricks, stones, footings	*144.0*
Asbestos sheeting	*0.1*
Fittings	*1.5*
Roof tiles	*9.4*
Plasterboard	*1.7*
Timber	*7.9*
Metals (from structures, sheds, fences, etc.)	*1.4*
Total tonnes	**165.8**
Total m^3	**207.3**

***Table 2.5:** Number and age of buildings in SA.* (Geoscience Australia, 2012)

	Residential	*Commercial*
Number	*593,780*	*15,379*
Pre 1980	*61%*	*48%*
Post 1981	*39%*	*52%*

In Australia, buildings constructed before the mid-1980s are highly likely to have asbestos containing products. This represents over 61% of residential and 48% of commercial buildings in SA (refer Table 2.5). Buildings constructed after this date may still contain asbestos. However, as a general rule those constructed after the 1990s are unlikely to have asbestos containing materials (Australian Government Asbestos Safety and Eradication Agency).

Where a building is in an unstable state (likely after an earthquake) or the damage is so severe it may be impossible or unsafe to separate asbestos from other waste materials and, therefore, all waste may have to be treated as contaminated. This was a significant factor following Hurricane Katrina in New Orleans (Brown, 2012).

Box 2.2

Victoria, like SA, has many buildings that have asbestos-containing materials. Persons involved with cleaning up debris following the Victorian bushfires in 2011 wore asbestos safety gear when removing debris from all damaged building structures as a precautionary measure.

Metal

Metal waste (sometimes mixed with masonry materials) is generated from damaged fencing, sheds, metal roofs and other structures, reinforced concrete, windows and doors, electrical cable and copper pipe. These materials are generally separated from other wastes for recycling due to their high resource value.

Vegetative debris

Vegetative debris includes fallen and/or burnt trees, broken branches, and other vegetation. These materials generally need to be cleared from power lines, roads, and drains before further clean-up and response activities can commence and to prevent secondary hazards. These materials can be recycled (composted, mulched or chipped) or used as firewood.

Much vegetative debris is generated on public land (such as fallen street trees), and in SA has been typically managed by local councils following bushfires and severe weather events. The amount of vegetative debris produced by a severe storm can be more than half of a council's annual green waste collection. These volumes can overwhelm council resources, requiring external resources (e.g. contracted labour) to assist with the management of this material.

Hard waste

Disasters can lead to significant damage and/or displacement of furniture, carpet, textiles and personal items. The 'hard waste' stream includes building contents, as well as timber from damaged building structures. Following a severe storm or flooding event, these materials may increase in weight due to moisture content, whereas following a bushfire these items can be turned to ash. In most cases, these materials are too damaged for recycling, and are suitable for disposal to landfill or energy recovery. The return and recovery of personal items, where possible, is an important part of the recovery for disaster affected community members and has been facilitated following a number of events, including the 2009 Black Saturday Bushfires in Victoria (Brown, 2012).

Table 2.6: *Debris Metric - Estimated average weight of contents in a typical home. Source: Rawtec*

Material	Tonnes / average dwelling
Furniture	*3.8*
Carpet	*0.1*
Electronic/ electrical equipment	*0.2*
Whitegoods	*0.2*
Total	***4.3***
Total m^3	***17.2***

E-waste and white goods

E-waste can contain hazardous substances, which are harmful to human health and the environment if not disposed of carefully (EMPA, 2015). Some whitegoods (such as refrigerators and air conditioners) require specialised handing due to the presence of refrigerants. These items are banned from disposal in SA under the Environmental Protection (Waste to Resources) Policy 2010. It is possible that these Policy bans may be subject to the exemption provisions of the EP Act for a disaster event (refer to Chapter 5).

Soil and sediment

Soil and sediment may be produced by disasters. This can include soil that has been displaced by a severe storm or flood, or liquefaction from an earthquake. It is possible that the soil may be contaminated, as a result of broken or overloaded sewerage systems and other hazardous materials mixing with the soil and other debris. Soils may need to be tested to identify contamination levels, with identified contaminated soil requiring specialised disposal.

Box 2.3

An estimated 500,000 tonnes of liquefaction silt was generated by the 2011 Christchurch Earthquake. This silt was largely collected from private properties by volunteers and placed on the kerbside for collection by council contractors. The collected silt was deposited at two designated disposal sites.

Vehicle bodies and vessels

Vehicle bodies from damaged and/or displaced cars, trucks, boats and vessels, and other vehicles are generated by disasters. Inappropriate management of these items can create hazards.

For example, following the Japan Tsunami, in some instances vehicle bodies were stacked without having fuel and oil removed, creating potential safety and environmental hazards (UNEP, 2012).

Waste managers also face challenges in expedient disposal of vehicles as disposal cannot be carried out until owners have been contacted.

Other hazardous waste

Other hazardous wastes that may be produced by a disaster include:

- Household hazardous wastes (e.g. fluorescent lighting, cleaning chemicals, batteries, paint)
- Farming waste (e.g. pesticides, other farming chemicals, CCA-treated posts) and
- Other industry wastes (such as PCBs)

These materials, whilst small in volume compared to other disaster wastes, may need to be separated from other streams for specialised storage and disposal.

Commercial and industrial waste

Most disaster waste streams from affected businesses and industries are captured in the above categories (e.g. damaged building structures, furniture and building contents, farming and industrial chemicals, etc.). However, additional industry-specific streams may be generated by disasters such as:

- Damaged machinery and equipment from manufacturing businesses. This stream may include metals, plastics and oils, etc. Metal machinery may be able to be salvaged by scrap metal recyclers. Oil may go to oil recyclers. Other materials (such as plastics) may be suitable for recycling, energy recovery or landfill.
- Damaged infrastructure from the electricity network, such as uprooted stobie poles, burnt plastic boxes, wire, porcelain insulators and metallic waste. This waste has been managed by SA Power Networks across its depots.
- Animal carcasses from farms, animal shelters and other industries (see Box 2.4). These are generally disposed through dry rendering at an abattoir or on-site burial.

Box 2.4

Large volumes of animal carcasses can be generated from bushfires in rural areas, or following an outbreak of disease.

Primary Industries and Resources SA (PIRSA) is currently undertaking a study on the disposal of mass carcasses to manage a potential outbreak of Foot and Mouth Disease.

Mass disposal of carcasses should be considered as part of the contingency planning process, and management strategies incorporated into disaster waste management plans.

- Spoilt food from affected restaurants and cafés, food retailers, food producers, manufacturers and warehouses. It is important to collect this waste as it is putrescible and can cause harm to human health if left to decompose. Further volumes of food waste may be generated post-disaster due to lack of refrigeration from power outages. This material may be suitable for composting if not contaminated with other materials.
- Medical and pharmaceutical waste from affected hospitals, medical facilities, pharmacies and aged care facilities. It is important to isolate this waste stream, which is potentially hazardous, and arrange for separate disposal at appropriate facilities.

These materials, whilst small in volume compared to other disaster wastes, generally need to be separated from other waste streams for specialised storage and disposal. If they are not separated then other wastes may become contaminated.

Post-disaster waste

Waste is generated by persons after a disaster across both relief centres and at dwellings as people return to their homes and places of work. It is important that systems are promptly re-established to collect this waste, especially given that it contains putrescible items (e.g. food scraps and nappies) that can cause harm to human health if left uncontained to decompose.

Although outside the scope of this study, the management of human faeces should to be considered in disaster waste management. In Christchurch, people that couldn't dig a long drop were initially disposing their faeces into the municipal rubbish collection.

Volumes of putrescible waste may also be produced following a disaster due to power outages. This is due to spoilt food being generated across households, cafés and food retail outlets due to lack of refrigeration.

Additional volumes of medical waste may be generated across hospitals and other medical facilities from treatment of disaster-related injuries and illnesses. Excess donations (food, clothing and other items) can also contribute to volumes of waste that need to be disposed (see Box 2.5).

Box 2.5

Excess in-kind donations including clothing, bedding and household goods were received following the 2009 Victorian bushfires. This added to waste volumes – contributing an additional 15-20 tonnes per week at the peak, reducing to 1-2 tonnes per week 6 months after the event.

(C. Brown M. M., 2010)

Other important considerations

The loss of life will impact upon the disaster waste management activities and needs to be considered. This would be managed by a specialist team under the guidance of the appropriate state authority.

2.3 Bushfire waste profile

Photo: Alex Demchenko and his dog Tessa. Mr Demchenko's Humbug Scrub house was destroyed by fire. Credit: Mark Brake (The Advertiser, 2015)

Waste streams

The main waste streams generated by a bushfire include:

- Masonry materials from burnt buildings in the form of mixed ash, concrete, stone, rubble, bricks and metals
- Burnt fences, sheds and vehicles in the form of metal, hard plastics and timber posts
- Burnt trees and other vegetative debris

Waste nature, recyclability and associated issues

Most waste from a bushfire is recyclable including masonry materials, metals, hard plastics and vegetative debris. However there are challenges involved with separating recyclables from asbestos containing materials, which require specialised disposal.

Bushfires often impact rural areas where agriculture is present. This brings additional waste streams, including farming chemicals, CCA-treated posts, perished animals/livestock which require specialised disposal.

Refer to Table 4.2 (Chapter 4) for debris disposal/ recycling options.

Waste volumes

Waste volumes were estimated for a 1 in 300 ARI bushfire in the Adelaide Mount Lofty Ranges.

An estimated 1.2 million tonnes of waste would be generated by a 1 in 300 year bushfire in the Adelaide Mount Lofty Ranges (see Table 2.7). This is based on a burnt area of 1,700 square kilometres and damage to 4,700 buildings (medium scenario). Estimates for small and large scenarios are also provided in Table 2.8 (refer to Appendix 5 for further information about assumptions underpinning these models)

***Table 2.7**: Fire disaster medium scenario (see footnotes)*

Disaster type	Bushfire
Scenario	1 in 300 year ARI bushfire in the Adelaide Mount Lofty Ranges
Estimated area affected	1,700 sq. km
Estimated number of damaged buildings	4,700
Industry in affected area	Primarily agriculture

1. No modelling has been undertaken on the extent of damage from this bushfire scenario (in terms of square kilometres burnt and number of buildings damaged in the Adelaide Mount Lofty Ranges).
2. Estimates of waste volumes generated by this bushfire scenario are based on a set of assumptions on the % of area burnt in the Adelaide Mount Lofty Ranges, and % of buildings in affected area damaged. These assumptions were developed in consultation with the CFS for the distinct purpose of estimating potential 'worst case' debris volumes from a 1 in 300 year type bushfire event. It is recognised that in reality this scenario is unlikely to play out, given the State's fire prevention strategies and firefighting practices and technologies.

***Table 2.8**: Estimated amount of debris from 300 ARI Bushfire in Adelaide Mount Lofty Ranges for medium, small and large scenarios.*

Modelled scenario	Tonnes	Cubic metres
Medium scenario	1,220,000	2,050,000
Small scenario	670,000	1,160,000
Large scenario	2,070,000	3,280,000

Other key streams include:

- Vegetative waste from burnt trees and other vegetation (452,000 tonnes)
- Hard waste, whitegoods and e-waste from damaged building contents and timber (together contributing 29,000 tonnes)
- Metals from damaged buildings, sheds, and car bodies (together contributing nearly 6,000 tonnes)

Additional volumes of materials (not estimated) may be generated, including:

- Damaged rural property fences (including CCA and other timber fencing)
- Volumes of food waste from damaged crops, and spoilt food generated due to power outages
- Smaller waste volumes (e.g. hazardous wastes from households and business)

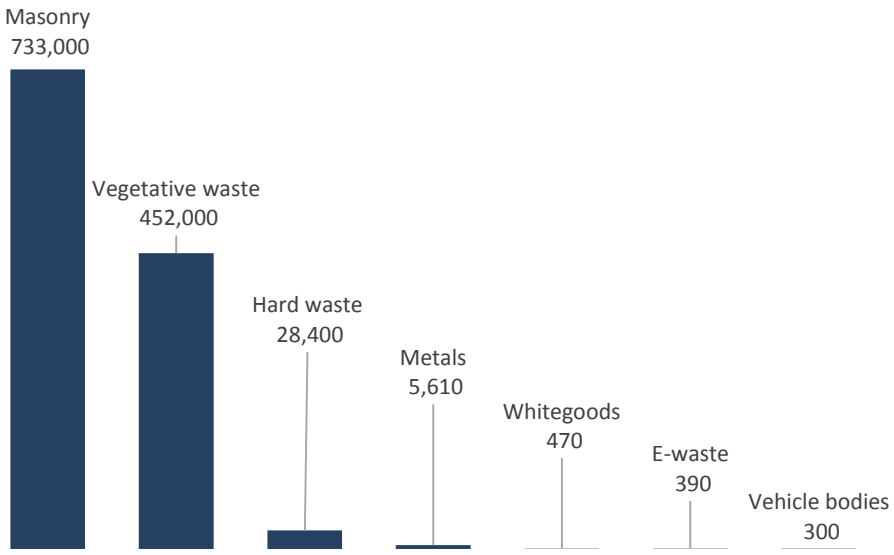


***Figure 2.1:** Breakdown of disaster debris by waste stream (in Tonnes) for 300 ARI bushfire in Adelaide Mount Lofty Ranges (medium scenario)*

2.4 Earthquake waste profile

Photo: 2011 New Zealand earthquake damage. Source: (Allianz)

Waste streams

The main waste streams generated by an earthquake are:

- Masonry materials, timber and metals from:
    - Damaged buildings (masonry wall collapse, toppling of brick chimneys, gable end wall and parapet wall collapse, failure of suspended street awnings and soft storey failure (SA Department of Planning, Transport and Infrastructure, 2014)).
    - Damaged public infrastructure such as gas and water pipelines, damaged roads, and other debris.
- Hard waste, e-waste, and whitegoods from damaged building contents.
- Damaged and displaced vehicles
- Asbestos and other hazardous materials

Waste nature, recyclability and associated issues

Most waste generated by earthquakes is recyclable including masonry materials, metals, hard plastics, timber and vegetative waste. However, collapse of building structures can lead to challenges in sorting of hazardous waste (e.g. asbestos) from recyclable non-hazardous (e.g. general building rubble). There are also additional challenges involved separating recyclables from asbestos containing materials, which require specialised disposal.

Further debris can be generated by simultaneous or subsequent events/phenomena that are caused by an earthquake including:

- Soil liquefaction, which can cause buildings to sink and tilt. Liquefaction

normally occurs only with Modified Mercalli intensities of 7 or greater.

- Landslides triggered by an earthquake, which can potentially cause millions of tonnes of debris with the potential to crush vehicles, buildings and people, or to sweep away roads, power, gas and telephone lines.
- Fires following an earthquake (due to natural gas leakages), which can destroy buildings and their contents.
- Hazardous material released by an earthquake from storage containment facilities, broken underground pipelines, toppling of elevated tanks, shifting and overturning of horizontal tanks, falling containers and shelves, and other storage vessel.
- Dam failure triggered by an earthquake, however noting that failure of a large dam due to a large earthquake is very rare
- Earthquake aftershocks, which can cause additional stress placed on already weakened or compromised support beams, columns or walls. For this reason buildings affected by an earthquake should be evacuated until they are inspected for damaged to determine their structural integrity.
- Other hazards such as rock fall, fault rupture and tsunami.

(SA Department of Planning, Transport and Infrastructure, 2014)

Refer to Table 4.2 (Chapter 4) for debris disposal/ recycling options.

Waste volumes

Waste volumes were estimated for two earthquake scenarios in Metropolitan Adelaide, including:

- 1 in 10,000 year ARI in Metro Adelaide
- 1 in 1,000 year ARI in Metro Adelaide

These scenarios, including the estimated number of damaged buildings and affected area, are described in Table 2.9.

It is estimated that:

- Close to 9 million tonnes of disaster debris would be generated by a 10,000 ARI earthquake in Metro Adelaide – see Table 2.10 (medium scenario).
- 670,000 tonnes of disaster debris would be generated by a 1,000 ARI earthquake – see Table 2.11 (medium scenario)

Table 2.9: *Earthquake scenarios*

Disaster type	Earthquake
Scenario 1	1 in 10,000 year ARI in metropolitan Adelaide.
Estimated area affected	Refer to map for earthquake scenario by Geoscience Australia in SA Earthquake Hazard Plan (SA Department of Planning, Transport and Infrastructure, 2014).
Estimated number of damaged buildings	67,200 buildings
Industry in affected area	Mix commercial and industrial (including offices, retail, schools/hospitals, industry)
Scenario 2	1 in 1,000 year ARI in metropolitan Adelaide
Estimated area affected	Refer to map for earthquake scenario by Geoscience Australia in SA Earthquake Hazard Plan (SA Department of Planning, Transport and Infrastructure, 2014).
Estimated number of damaged buildings	6,700 buildings
Industry in affected area	Mix commercial and industrial (including offices, retail, schools/hospitals, industry)

1. Geoscience Australia has undertaken modelling on ground shaking (Modified Mercalli Intensities - MMI) across Metropolitan Adelaide for both of these earthquake scenarios. DPTI provided the project team with estimates of % of buildings that would be damaged for these\ different ground shaking intensities, including differentiating between buildings constructed pre- and post-1980. This data was used by the project team (along with ABS data on the number of households across council areas, and building ages) to estimate the number of buildings that would be damaged by earthquake scenarios.

***Table 2.10**: Estimated amount of debris (in Tonnes and Cubic metres) from 10,000 ARI Earthquake in Metropolitan Adelaide for medium, small and large scenarios.*

Modelled scenario	Tonnes	Cubic metres
Medium scenario	8,800,000	12,400,000
Small scenario	6,070,000	8,480,000
Large scenario	15,530,000	22,190,000

***Table 2.11**: Estimated amount of debris (in Tonnes and Cubic metres) from 1,000 ARI Earthquake in Metropolitan Adelaide for medium, small and large scenarios.*

Modelled scenario	Tonnes	Cubic metres
Medium scenario	670,000	960,000
Small scenario	430,000	630,000
Large scenario	1,270,000	1,830,000

Estimates for small and large scenarios are also provided in Table 2.10 and 2.11 (refer to Appendix 5 for further information about assumptions underpinning these models)

For a 10,000 ARI Earthquake (medium scenario), it is estimated that the waste stream would include:

- Over 8 million tonnes of masonry materials from damaged buildings and public infrastructure
    - This is equivalent to about 8 times the volume of masonry waste (asphalt, bricks and concrete) generated by the South Australian construction and demolition industry each year (Zero Waste SA, 2014)
- 467,000 tonnes of hard waste, whitegoods and e-waste (from damaged building contents and timber)
- Over 80,000 tonnes of metal waste from damaged buildings, public infrastructure and car bodies
- 15,000 tonnes of vegetative waste from bulldozed/damaged trees and gardens
- See Figure 2.2 for breakdown of disaster debris by waste stream

For a 1,000 ARI Earthquake (medium scenario), it is estimated that the waste stream would include:

- Over 600,000 tonnes of masonry materials
- 42,200 tonnes of hard waste, whitegoods and e-waste (from damaged building contents and timber)
- 5,000 tonnes of metal waste from damaged buildings, public infrastructure and car bodies
- 500 tonnes of vegetative waste from bulldozed/damaged trees and gardens
- See Figure 2.3 for breakdown of disaster debris by waste stream

Additional volumes of materials (not estimated) may be generated, including:

- Soil (from liquefaction) – could potentially contribute another 100,000 to 500,000 tonnes for a 1 in 10,000 year earthquake
- Volumes of spoilt food due to power outages
- Smaller waste volumes (e.g. spoilt food, hazardous wastes from households and business)

A tabulated breakdown of disaster debris by material streams for small, medium and large earthquake scenarios is provided in Appendix 5.

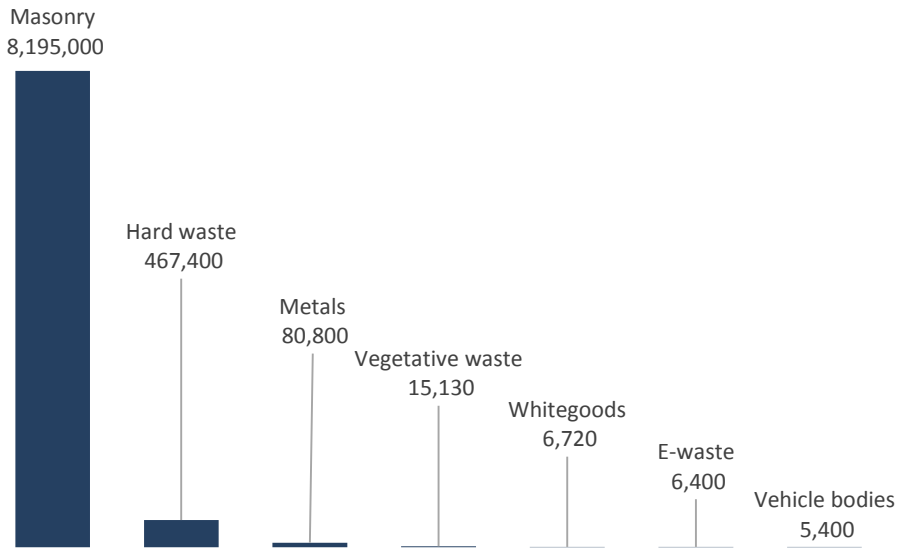


Figure 2.2 – *Breakdown of disaster debris by waste stream (in Tonnes) for 10,000 ARI earthquake in Metropolitan Adelaide (medium scenario)*

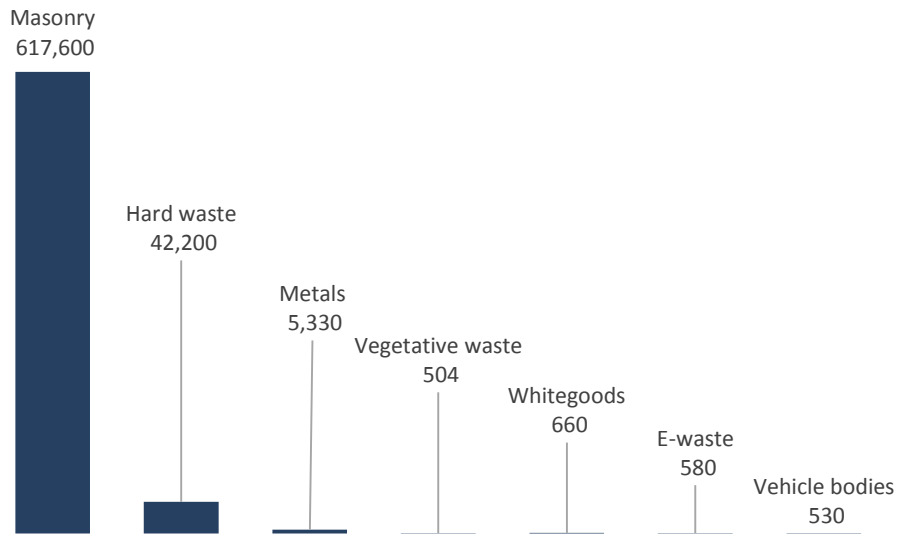


Figure 2.3 – *Breakdown of disaster debris by waste stream (in Tonnes) for 1,000 ARI earthquake in Metropolitan Adelaide (medium scenario)*

2.5 Flood waste profile

Picture: Household waste following the 2010 Queensland flood. Source (Asian Correspondent, 2011).

Waste streams

The main waste streams generated by a flood include:

- Timber, masonry materials (concrete, stone, brick, and plasterboard), and metals from damaged buildings, damaged roads and bridges
- Hard waste, e-waste and whitegoods from water-damaged building contents
- Displaced sand, soil and sediment
- Damaged and displaced vehicles
- Vegetative waste from uprooted trees
- Perished livestock depending on flood location

Waste nature, recyclability and associated issues

Masonry materials and metals from a flood are generally recyclable. However, timber, furniture and other items may be too water-damaged to recycle. If left to dry out these items may be suitable for energy-from-waste, otherwise landfill disposal may be the most suitable option.

Waste is often mixed with hazardous materials such as paints, pesticides and oils. Mud, clay and gravel may be mixed with hazardous materials, requiring further assessment before disposal (JEU, 2013).

Following a flood, widespread mould can affect cladding and boarding and potentially rot timber (JEU, 2010). This can lead to further generation of waste.

Plasterboard can also be problematic, as when disposed it releases hydrogen sulphide which is toxic in the right concentration.

Refer to Table 4.2 (Chapter 4) for debris disposal/ recycling options.

Waste volumes

Waste volumes were estimated for a 1 in 100 year flooding of the Brownhill and Keswick Creek Catchment.

These estimates are based on previous modelling undertaken by Worley Parsons, on the number of properties affected by the flood. This modelling suggests that 1,163 properties would be affected with over-floor flooding, and a further 914 properties with under-floor flooding (see Table 2.12). (Brown Hill Keswick Creek Stormwater Project, 2014)

***Table 2.12**: Flood disaster scenario*

Disaster type	Flood
Scenario	1 in 100 year ARI flooding of the Brownhill and Keswick Creek (BHKC) Catchment.
Estimated area affected	See map below.
Estimated number of damaged buildings	Total of 2,077 flood affected properties in BHKC catchment, including: • 1,163 properties with over-floor flooding • 914 properties with under-floor flooding (Brownhill Keswick Creek Stormwater Project, 2014)
Industry in affected area	7 hospitals, 8 aged care facilities, industrial suppliers and Adelaide Airport

***Table 2.13**: Estimated amount of debris (in Tonnes and Cubic metres) from 100 ARI flooding of the Brownhill and Keswick Creek Catchment for medium, small and large scenarios.*

Modelled scenario	Tonnes	Cubic metres
Medium scenario	25,000	67,000
Small scenario	13,000	33,000
Large scenario	35,000	93,000

An estimated 25,000 tonnes of waste would be generated by a 1 in 100 year flooding of the Brownhill and Keswick Creek Catchment (medium scenario). See Table 2.12.

Estimates for small and large scenarios are also provided in Table 2.13 (refer to Appendix 5 for further information about assumptions underpinning these models).

For the medium scenario, it is estimated that this waste stream would include:

- 12,500 tonnes of hard waste including timber, and damaged building contents.
- 9,300 tonnes of masonry waste from water damaged buildings that are subsequently demolished
- 2,300 tonnes of displaced soil and sediment
- 900 tonnes of whitegoods and e-waste
- 75 tonnes of metals from damaged fences, sheds, and car bodies
- See Figure 2.4.

Additional volumes of materials (not estimated) may be generated, including:

- Vegetative waste from damaged trees and gardens
- Masonry waste from damaged public infrastructure (such as bridges)
- Volumes of spoilt food due to flooding and/or power outages across food retail outlets
- Smaller waste volumes (e.g. hazardous wastes from households and business)

A tabulated breakdown of disaster debris by material streams for small, medium and large flood scenarios is provided in Appendix 5.

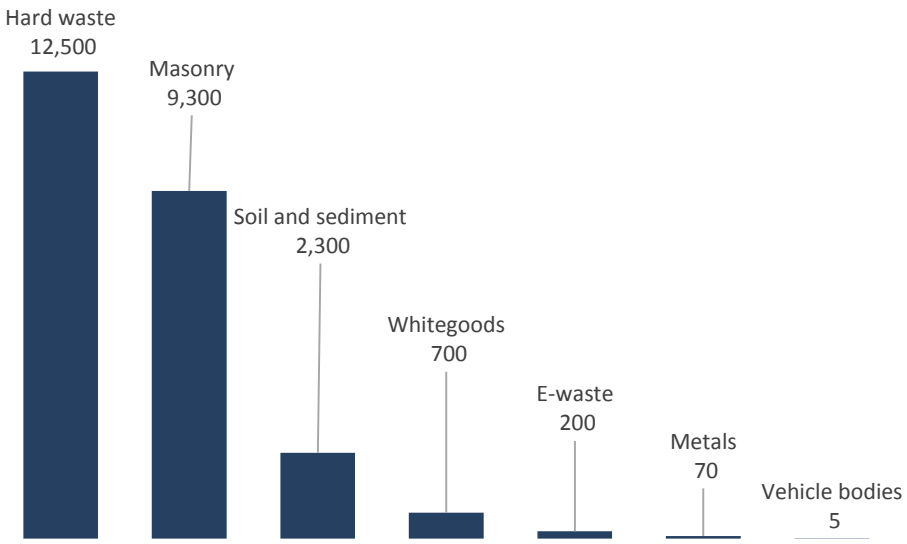


Figure 2.4 – *Breakdown of disaster debris by waste stream (in Tonnes) for 100 ARI Flood in Metropolitan Adelaide (medium scenario)*

2.6 Severe storm profile

Photo: Damage from severe storms in Port Broughton. 1979. Source: (EM Knowledge Hub, 2015)

Waste streams

The main waste streams generated by a severe storm include:

- Masonry materials, timber and metals from water/wind damaged and displaced structures (such as roofs, fences and sheds)
- Hard waste, e-waste and whitegoods from damaged and displaced building contents.
- Fallen trees and vegetative debris
- Displaced sand, soil and sediment
- Damaged and displaced vehicles

Waste nature, recyclability and associated issues

Most materials generated by a storm are recyclable (including masonry materials, hard waste, vegetative debris, damaged vehicles, soil). However, severe storms can generate a highly mixed waste stream, which needs to be sorted before it can be recycled.

Furthermore, wind can cause items to travel far distances from their source, making it difficult to identify ownership of waste items.

Like floods, waste from severe storms may be mixed with hazardous materials (such as household cleaning chemicals) bring additional challenges for recycling.

Refer to Table 4.2 (Chapter 4) for debris disposal/ recycling options.

Waste volumes

Waste volumes were estimated for a number of storm scenarios, including:

- 1 in 1,000 year ARI in Metro Adelaide
- 1 in 70 year ARI in Metro Adelaide

These scenarios, including the estimated number of damaged buildings and affected area, are described in Table 2.14.

It is estimated that:

- 290,000 tonnes of disaster debris would be generated by a 1,000 ARI severe storm in Metro Adelaide – see Table 2.15 (medium scenario).
- 40,000 tonnes of disaster debris would be generated by a 70 ARI severe storm – see Table 2.16 (medium scenario)

***Table 2.14**: Severe storm disaster scenarios*

Disaster type	Severe Storm
Scenario 1	1 in 1,000 ARI severe storm
Estimated area affected	76 sq. km
Estimated number of damaged buildings	7,700
Industry in affected area	Mixed industry including manufacturing, warehousing.
Scenario 2	1 in 70 ARI severe storm
Estimated area affected	38 sq. km
Estimated number of damaged buildings	770
Industry in affected area	Mixed industry including manufacturing, warehousing.

***Table 2.15**: Estimated amount of debris (in Tonnes and Cubic metres) from 1,000 ARI severe storm in Metropolitan Adelaide for medium, small and large scenarios.*

Modelled scenario	Tonnes	Cubic metres
Medium scenario	290,000	400,000
Small scenario	220,000	330,000
Large scenario	370,000	580,000

***Table 2.16**: Estimated amount of debris (in Tonnes and Cubic metres) from 70 ARI severe storm in Metropolitan Adelaide for medium, small and large scenarios.*

Modelled scenario	Tonnes	Cubic metres
Medium scenario	40,000	70,000
Small scenario	20,000	30,000
Large scenario	70,000	110,000

Estimates for small and large scenarios are also provided in Table 2.15 in 2.16 (refer to Appendix 5 for further information about assumptions underpinning these models

For a 1,000 ARI severe storm (medium scenario), it is estimated that the waste stream would include:

- 255,000 tonnes of masonry waste from damaged building structures.
- 25,600 tonnes of vegetative waste from fallen trees and other vegetation
- 4,500 tonnes hard waste including timber and items from damaged building contents
- 2,000 tonnes of metals from damaged buildings, sheds, fencing and car bodies
- 500 tonnes of whitegoods and e-waste from damaged building contents
- See Figure 2.5.

For a 70 ARI severe storm (medium scenario), it is estimated that the waste stream would include:

- 24,200 tonnes of masonry waste from damaged building structures.
- 12,800 tonnes of vegetative waste from fallen trees and other vegetation
- 2,000 tonnes of hard waste including timber and items from damaged building contents
- 210 tonnes of metals from damaged buildings, sheds, fencing and car bodies
- 60 tonnes of whitegoods and e-waste from damaged building contents
- See Figure 2.6.

Additional volumes of materials (not estimated) may be generated, including:

- Volumes of food waste from damaged crops, and spoilt food generated due to power outages

A tabulated breakdown of disaster debris by material streams for small, medium and large severe storm scenarios is provided in Appendix 5.

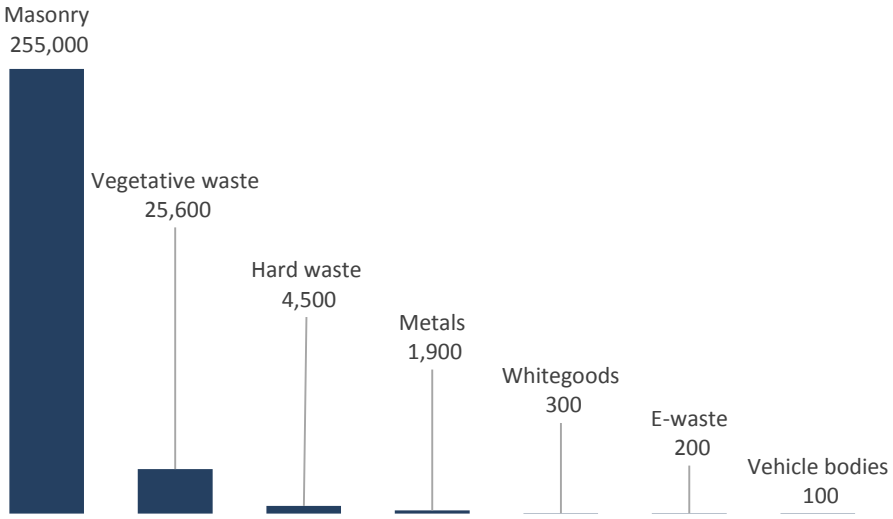


Figure 2.5 – *Breakdown of disaster debris by waste stream (in Tonnes) for 1,000 ARI severe storm in Metropolitan Adelaide (medium scenario)*

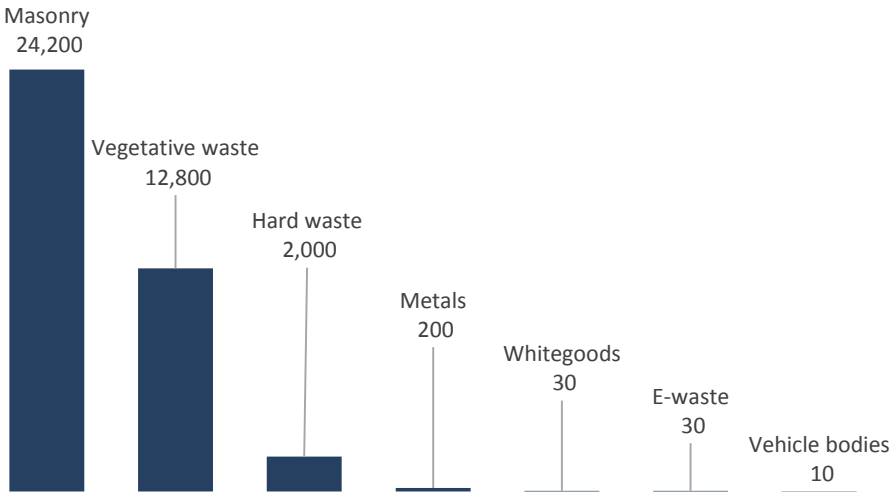


Figure 2.6 – *Breakdown of disaster debris by waste stream (in Tonnes) for 70 ARI severe storm in Metropolitan Adelaide (medium scenario)*

2.7 Data limitations

The following limitations apply to the disaster debris estimates presented in the above sections:

- Limited modelling has been undertaken for most of these scenarios in terms of the extent of damage that is likely to occur (e.g. number of buildings destroyed by the disaster).
- In absence of this modelling, a set of assumptions regarding the extent of damage to property and vegetation has been developed for this study for the distinct purposes of estimating disaster debris volumes (refer Appendix 5).
- It is unlikely that one of these exact scenarios would play out in practice, given the large number of variables that can affect how much waste is produced by a disaster.
- The disaster debris estimates presented in this report do not consider additional volumes generated by secondary events, such as a fire following an earthquake causing further volumes of debris, or a power outage causing volumes of spoilt food to be generated.
- The disaster debris estimates provide ‘order of magnitude’ volumes, and compositions, of waste expected to be generated for each of the scenarios studied, which can be used for contingency planning purposes.

CHAPTER 3

Skills, administration and equipment needs

3.1 Introduction

This chapter provides an overview of skills, administration and equipment that may be needed to manage waste from a major disaster. It covers the following activities:

- Strategic management and coordination of overall disaster waste management response, including waste identification and characterisation.
- Communications with the public and other stakeholders on waste management issues.
- Collection and transport of waste.
- Operation of temporary waste storage facilities.
- Operation of facilities for processing, recycling and disposal of waste.
- Collection of post-disaster waste, including collection from relief centres, and resuming standard waste collections to households and businesses following the disaster.

Potential existing suppliers are identified, and the opportunity to develop panels of pre-approved of suppliers is explored.

Whilst the focus of this chapter is on managing waste from a major disaster, similar skills, administration and equipment may be required to deal with waste from a smaller-scale event.

3.2 Skills, administration & equipment needs

Strategic management & coordination

A Disaster Waste Management Task Force may be assembled by the State Government to provide strategic management and coordination of disaster waste management activities.

This team would require suitable skills and administrative support to undertake the activities, such as:

- Initially identify the scale of the waste management response and clean-up needed:
    - Determine geographical presence of waste through a range of sources (GIS, news, governmental sources – see Box 3.1 overleaf)
    - Waste identification, e.g. to identify asbestos, hazardous waste and medical waste
    - Characterise waste including identifying streams, quantities, and any potential issues.
    - Map location of identified waste
- Develop a debris removal strategy that prioritises areas where waste should first be cleared. For example, begin with clearing debris for search and rescue purposes, clearing obstructions to major roads and infrastructure, and removing waste hazards (e.g. trees fallen on power lines)
- Identify suitable temporary storage facilities for aggregation of waste prior to disposal/recycling

- Determine extent of local authority / state responsibility and private landowner responsibility
- Oversee the collection of disaster debris and its disposal for local authority or state-led operations (in line with the strategy)
    - Appoint and oversee contractors for the collection of waste to suitable facilities
    - Appoint and oversee contractors for disposal/recycling of waste
    - Coordination with insurance and demolition companies
- If people remain in the affected area, then facilitate / provide options for collection of household waste.
- If people leave the affected areas, facilitate authority to act on homeowner's behalf to remove wastes.
- Develop a communications plan and oversee its implementation

Equipment needed to undertake these activities includes ICT equipment and office space. Equipment may also be needed to undertake for field trips (e.g. vehicles, cameras, GPS).

Communications

A suitably skilled and authorised team will be required to undertake communication activities, including:

- Issue media releases that provide information to the public on waste management issues, such as public safety
- Take calls from the public, council and other stakeholders
- Refer queries from public to relevant sources of information (which may sit within government departments)
- Coordinate responses with stakeholders (councils, state emergency services, and other) to provide consistent messaging to the public
- Feed relevant information back to Disaster Waste Management Task Force

Equipment needed for these functions includes phones, other ICT equipment and office space.

Box 3.1 Technology

The potential role of technology to assist with disaster waste management activities should be considered.

The State Recovery Office and the Department for Communities and Social Inclusion led the Rapid Impact Assessment Solution Project (RIASP). This project delivered a prototype of a digitised rapid impact assessment form and associated reporting system for the benefit of state emergency management agencies and communities affected by a disaster. The prototype, which was tested "live" during the Sampson Flat bushfire, enables inspectors to record observed property damage (e.g. number of damaged homes and vehicles). Information entered into the system is fed into a geographic information system (ArcGIS) to provide locational information on damage from the disaster. The tool can also identify whether damaged buildings are likely to contain asbestos.

The Local Government Association of SA has developed an Emergency Assessment Reporting System (EARS), which primarily for reporting on emergency hazards and impacts to public infrastructure after an emergency. It includes a smart phone app for taking reports in the field and an "EARS Console" for viewing those reports in a map format and exporting data for other systems.

These tools could potentially be adapted to record, locate and estimate types and quantities of disaster waste.

Waste collection and transport

Waste collection contractors would be appointed to remove disaster debris from sites and transport it to a temporary storage facility or to a waste or recycling facility.

These contractors would need to be suitably trained and licensed in the safe removal and transport of waste, including materials such as asbestos.

Contractors would supply their own equipment, such as personal safety gear, bobcats, excavators, cranes, skip bins, mobile shredders, and waste collection vehicles (e.g. semi-tippers, hook-lift trucks and other vehicles).

Operation of temporary waste storage facilities

Contractors may need to be appointed for management and operation of temporary waste storage sites.

These contractors would need to:

- Manage operation of the site, including receival of incoming and outgoing waste volumes, documenting, processing, sorting and storage of the waste volumes.
- Manage stockpile heights
- Maintain site security
- Minimise risks to human health and the environment associated with activities.

Equipment required at temporary storage sites may include bobcats, excavators, skip bins, security equipment, wash-room facilities and fencing.

Private contractors may wish to operate private waste storage facilities also. Regulation and monitoring of these operations would be required.

Operation of disposal and recycling facilities

Contractors would need to be appointed for the disposal or recycling of disaster waste streams at facilities.

The skills and equipment needed across these sites are highly site-specific, and are in place across existing facilities. However, additional training may be required to manage disaster-specific issues.

Post-disaster waste collection

Contractors may need to be appointed for collection of post-disaster waste. This would include collection of waste generated across relief centres, and resuming collections from waste generated across households and businesses.

Contractors would require skills and administrative support to undertake the following activities

- Roll-out bins across relief centres, and replace any damaged bins across households and businesses, or areas where temporary waste disposal areas have been set up.
- Coordinate with emergency services for road closures, location of hazards, which may impact collections.
- Undertake collections of waste from these sites, where safe to do so, and without obstructing emergency services from performing their duties.
- Communicating with ‘communications team’ to convey messaging back to the public.

Equipment required to undertake these activities includes bins (mobile garbage bins, skip bins), waste collection vehicles (side, rear and front-lift trucks), and ICT.

3.3 Potential suppliers

Table 3.1 identifies suppliers that may possess the skill-sets and equipment needed to undertake disaster waste management activities. This includes councils, government departments and agencies, private contractors and consultants.

The strategic management and coordination of the overall waste management response may be undertaken by a government agency/department or an appointed private actor. In Victoria following the 2009 bushfires, the Victorian Bushfire Reconstruction and Recovery Authority (VBRRA) appointed a private contractor (Grocon) to undertake operational management of the waste management response. In other jurisdictions (e.g. Japan), the government has appointed staff and expert consultants to carry out these functions. It is recommended that roles and responsibilities are determined, and that organisations (or suitable contractors) are identified for these roles, as part of the contingency planning process. Where possible emergency roles should be part of peace-time job descriptions.

***Table 3.1**: Description of potential providers /suppliers for disaster waste management functions. Refer to Appendix 4 for list of potential suppliers.*

Function	Description of potential providers / suppliers
Strategic management and coordination, including waste identification and characterisation	▪ The Disaster Waste Management Task Force may be comprised of suitably qualified and authorised personnel from Government (staff from government departments, local councils and other agencies). ▪ The team may also appoint waste specialists and consultants, as required, to provide expertise across specialise areas, such as characterising waste, and providing advice throughout the debris removal and disposal process. ▪ The team may appoint private contractors to undertake some of the operational management functions (e.g. coordination of demolition contractors).
Communication	▪ The communications team may be comprised of suitably qualified and authorised personnel from either: o Government (suitably skilled and qualified staff from government departments, local councils and other agencies) o An appointed private contractor
Waste collection & transport	▪ Waste collectors and transporters such as construction and demolition contractors, skip-bin hire businesses. (note additional licencing may be required)
Operation of temporary waste storage facilities	▪ Suitably qualified contractors from waste facilities (see below), and/or council staff
Operation of disposal and recycling facilities	▪ Waste facility operators (e.g. councils, private organisations). Refer to Appendix 2 for a list of waste disposal and recycling facilities that may be available to manage disaster wastes.
Post-disaster waste collection	▪ Municipal and commercial waste collection contractors collections

3.4 Panel of pre-approved suppliers

Establishing a panel of pre-approved suppliers for disaster waste management, where possible, can have a number of benefits:

- Identify contractors that are suitably skilled, licensed, and willing to undertake disaster waste management activities
- Build capacity within South Australia for managing disaster wastes through requiring that pre-approved contractors undertake specialised training modules for disaster waste, and keep their personnel up-to-date with training.
- Reduce the response time for mobilising resources following a disaster, and reduce associated risks to health, safety and the environment.
- Assist with determining response costs and budgets and the identification and 'benchmarking' of potential funding sources.

It is recommended that South Australia establish panels of pre-approved suppliers for disaster waste management, as part of the contingency planning process. This may include panels for:

- Disaster waste collection and transport
- Waste facility contractors for:
    - Temporary disposal sites
    - Waste and recycling facilities
- Disaster waste management experts and consultants (for specialist advice to disaster waste management teams where required)

Box 3.2. The role of insurance companies in disaster waste management

Insurance companies play a key role is disaster waste management. They make decisions on behalf of their clients (e.g. homeowners) on whether a damaged building is demolished or repaired, and make subsequent arrangements for the removal of debris and its disposal/recycling. There is no centralised management across the insurance industry for appointment of waste contractors. Rather each insurance company (or group) is responsible for making their own arrangements.

The Insurance Council of Australia (ICA) is the representative body of the general insurance industry in Australia. During disasters the ICA acts as the conduit between emergency departments and insurance companies. They deploy a task force following a disaster to collect data on the number and value of claims made, and provide an 1800 number to assist the public with queries about the insurance.

There may be opportunity for the ICA to provide information to its members about a SA government panel of pre-approved suppliers of disaster waste management services (should it be established). This would provide insurance companies with a list of suppliers that are suitably skilled, licensed, and willing to undertake disaster waste management activities. It may also reduce response time for mobilising resources following a disaster, and reduce associated risks to health, safety and the environment. It is recommended that the SA government continue dialog with the ICA to further explore this opportunity.

These panels may be established for use by both government and non-government organisations (such as insurance companies – see Box 3.2) to appoint contractors for the collection, transport, disposal and recycling of disaster debris. This measure would minimise the risk of unsuitably qualified or rogue operators from undertaking disaster waste management activities. Additional resources / personnel needed to meet the waste management needs following the event could work under the supervision of these approved contractors.

Whilst several organisations in SA possess the skills and equipment to undertake several disaster waste management activities, they may require specialised training to minimise disaster waste risks and respond to issues. For example:

- Demolition contractors may need training on managing distressed homeowners during recovery of personal belongings or assisting with urban search and rescue.
- Waste collection and transport contractors may need advice for coordinating with emergency services for road closures, location of hazards, which may impact collections, and to ensure that their operations do not impede state emergency services.

Training on disaster waste management may be delivered through these panels to build capacity for managing disaster waste.

CHAPTER 4

Sites and facilities for storage, transfer, disposal and recycling

4.1 Introduction

This chapter describes the sites and facilities that may be used to manage disaster waste volumes in SA. This includes:

- Selection criteria for establishing temporary waste storage sites
- The potential role of transfer stations in disaster waste management, and their locations
- Options for recycling and disposal of disaster waste, identification of facilities in SA, their capacities, and locations.

Existing waste and recycling facilities in SA have been mapped using GIS software. This has been integrated with mapping of other infrastructure (e.g. access roads), and may be used to locate potential disaster waste management facilities.

4.2 Temporary debris storage sites

Temporary debris storage sites can be established following a disaster to manage waste volumes. These sites provide an area where the waste can be aggregated and possibly segregated before a decision is made about where the material will be sent for disposal or recycling.

Following the 2010 Queensland floods, establishment of temporary sites:

> *… enabled the rapid removal of debris and waste from streets and contributed significantly to the speed of the cleanup.* (Brisbane City Council, 2011, p. 25)

Waste can be sorted into piles of different materials at these sites.

Table 4.1 provides a summary of criteria that can be used to assess the suitability of a site for temporary storage of disaster waste. Considerations include:

- Planning approvals
- Environment impacts
- Proximity to disaster affected area, and transport networks
- Storage capacity
- Business model
- Site security, and
- Site facilities (e.g. electricity, water)

Closed landfills and quarries in SA may be suitable sites for temporary storage of disaster waste, given that many are generally located in industrial zones, and have suitable environmental controls and storage capacity. Some potential sites for assessment include closed landfills, currently operating landfills, large vacant land or vacant industrial sites. To name a few, such as:

- Closed landfills (such as Garden Island, ARR and ResourceCo)
- Lot 201 & 202, Hanson Road

- Current operating landfills, including IWS at Dublin, TPI at Inkerman, Southern Waste ResourceCo and SRWRA at McLaren Vale.

These potential temporary debris storage sites are mapped in Figures 4.1 and 4.2 overleaf.

Appendix 3 provides a list of closed landfill sites in the state. It is recommended that sites for temporary storage of disaster waste are identified and assessed for each Emergency Management Zone in SA, as part of contingency planning process.

Section 5 identifies relevant regulations and permits for establishing these temporary storage sites.

***Table 4.1**: Site selection criteria for the establishment of a temporary debris storage site*

Considerations	**Site-selection criteria**
Planning approval	▪ If possible, locate in an industrial zoned area (rather than a residential area), due to the nature of activities undertaken and the resulting loss of amenity (increased noise, traffic, etc.) ▪ If possible, locate on public rather than private land, as approval is generally easier to obtain
Environment impacts	▪ Sites will need to be assessed in terms of their potential impacts and key mitigation measures identified. Particular attention should be paid to surface and groundwater contamination, soil contamination, odour, dust and impacts to vegetation. ▪ To reduce the risk of water contamination: o Locate at a suitable distance from groundwater, potable water wells and rivers, lakes and streams o Do not locate in a floodplain or wetland ▪ Have controls in place to mitigate stormwater runoff, erosion, fires and dust
Heritage/cultural considerations	▪ Consider heritage and cultural issues when selecting site, e.g. a site's significance to Aboriginal people.
Proximity to disaster affected area, and transport networks	▪ Locate close to disaster affected area to minimise travel distances for carting of waste ▪ Ensure there are suitable transport networks between: o Disaster affected area and temporary storage site, o Temporary disposal site & end disposal and recycling facilities
Storage capacity	▪ Ensure there is adequate room for storage of expected waste volumes, and keep in mind maximum stockpile heights
Business model	▪ Determine how the facility will be operated and funded, including: who can use the facility, who will pay for facility operation (e.g. fully government funded or private disposal fees), how will disposal rate be determined, waste ownership (particularly of personal items recovered). ▪ Ideally use publicly owned land to avoid costly leases and other potential legal complications
Site security	▪ Fence site and limit site access to permitted personnel. ▪ If possible, install cameras and other security provisions.
Site facilities and design	▪ Large open sites are needed for any type of debris staging activity. Paved sites are best. Semi-paved or large parking lots paved in stone dust or gravel is the next best option. Meadows are least desirable because they may be inaccessible because of saturated soils after extended and heavy precipitation ▪ Provide an undercover area for storage of potentially hazardous materials ▪ Disaster waste management sites should be designed to handle particular waste streams - i.e. whitegoods may need a smaller area, than say, green waste. ▪ Make sure site has access to water and electricity (for lighting, administration and staff amenities).

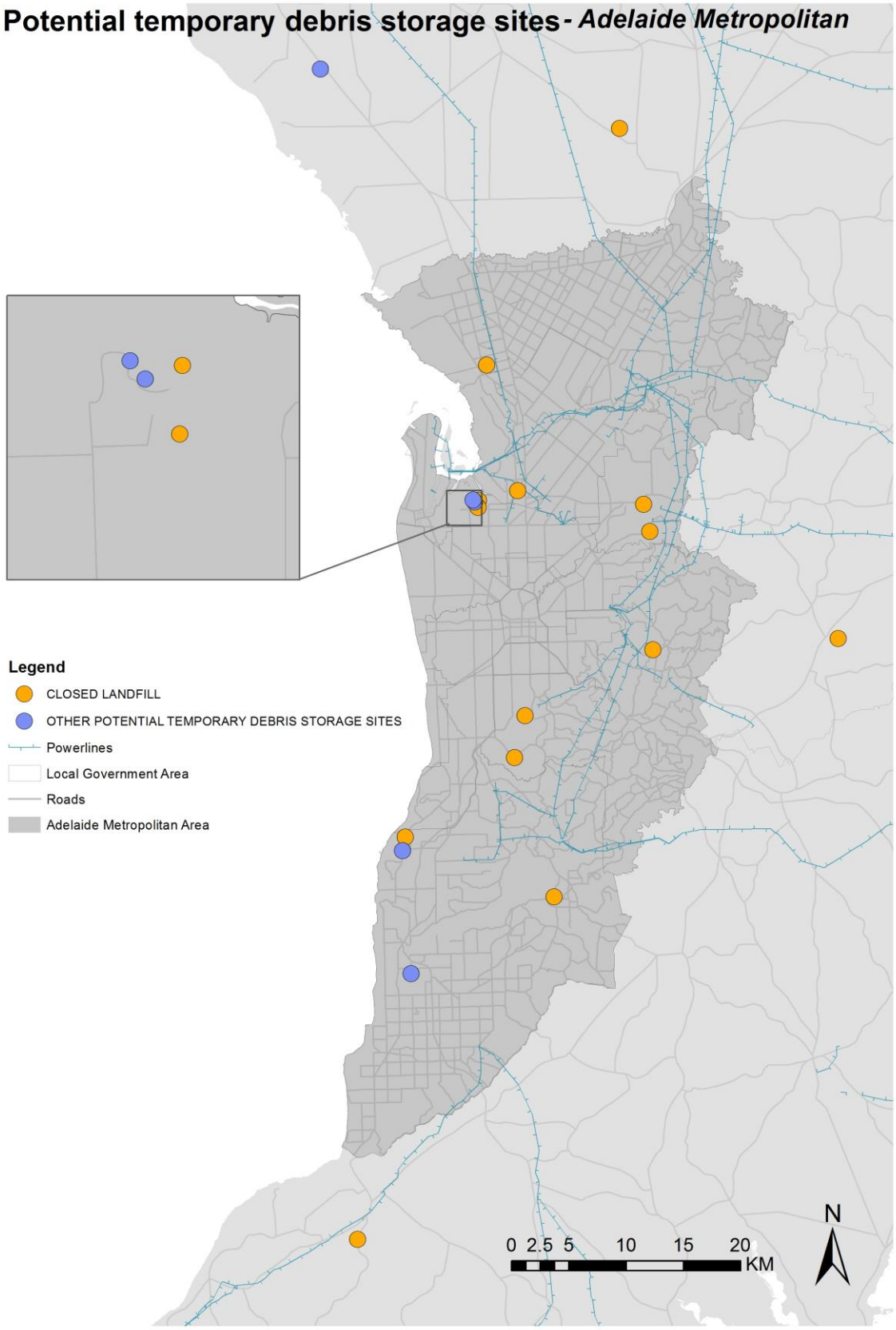


***Figure 4.1**: Locations of potential debris storage sites in Metropolitan Adelaide. Map produced by the Office of Green Industries SA.*

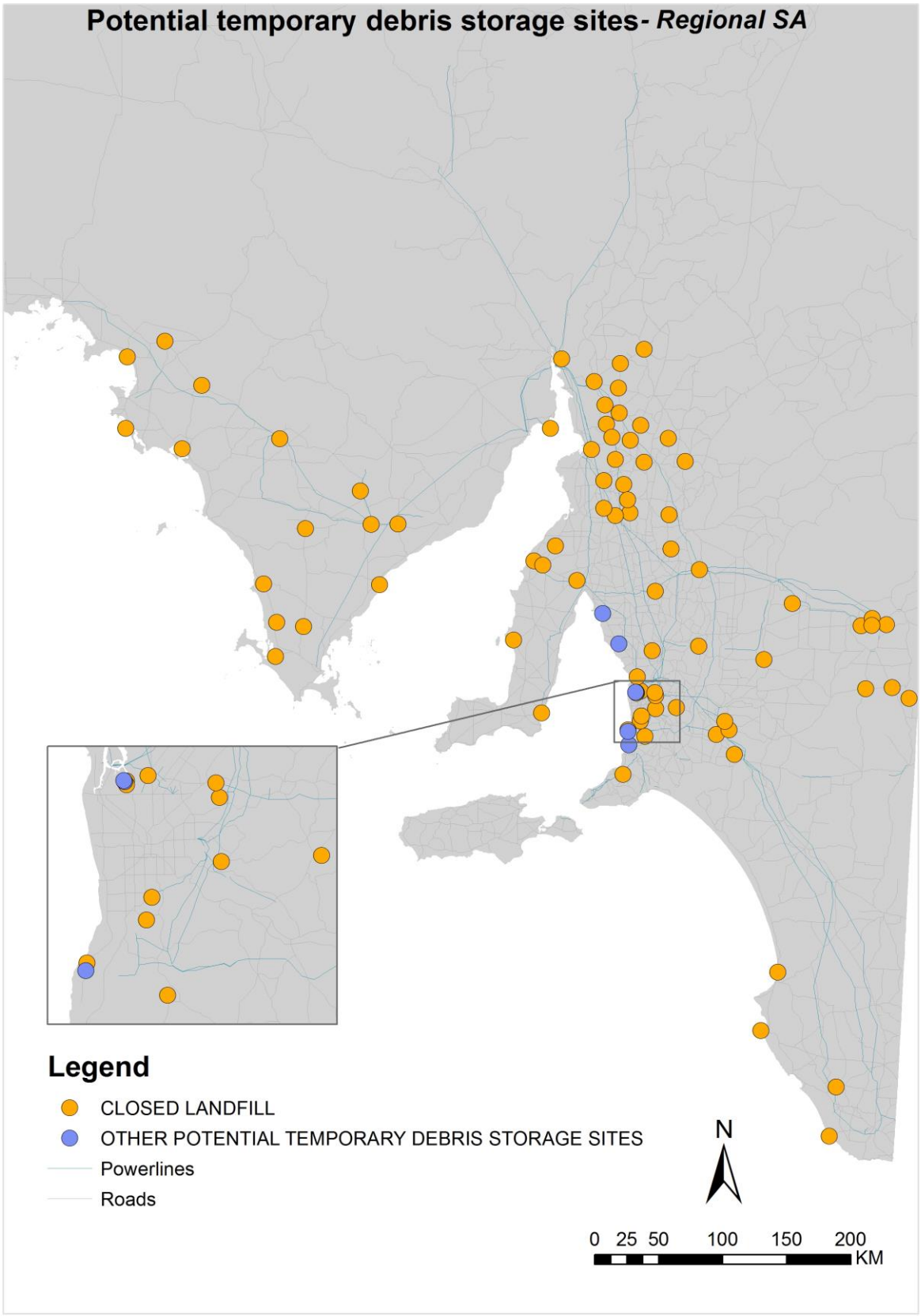


***Figure 4.2**: Locations of potential debris storage sites in regional SA. Map produced by the Office of Green Industries SA.*

4.3 Transfer stations

Transfer stations (also commonly referred to as resource recovery facilities) are permanent sites that are set-up to receive, aggregate, process and store waste prior to final disposal or recycling.

There are 149 transfer stations across SA (refer to Figures 4.3 and 4.4 overleaf), which are geographically spread across major towns and population centres.

It is expected that these facilities may be used (along with temporary storage sites) to receive and sort disaster wastes prior to being sent to a disposal or recycling facility, given that:

- Many transfer stations already have equipment and established operations for managing volumes.
- They are geographically spread across most major towns and population centres in the state. Therefore, sorting and aggregating waste at a regional transfer station (following a local regional disaster) would enable the waste to be transported in bulk to a disposal or recycling facility (which are mostly located in metropolitan Adelaide and a few regional centres), leading to greater transport efficiencies and potential cost savings.

It is recognised that there may be limitations to what types of materials these facilities are licensed to receive. It is possible that exemptions or emergency authorisations may be granted following a disaster (refer Chapter 5) to enable debris to be managed. Furthermore, these sites may have capacity limitations, which may limit them from receiving disaster waste volumes.

It is recommended that transfer stations are identified, assessed and nominated for management of disaster waste in each Emergency Management Zone across SA, as part of the contingency planning process.

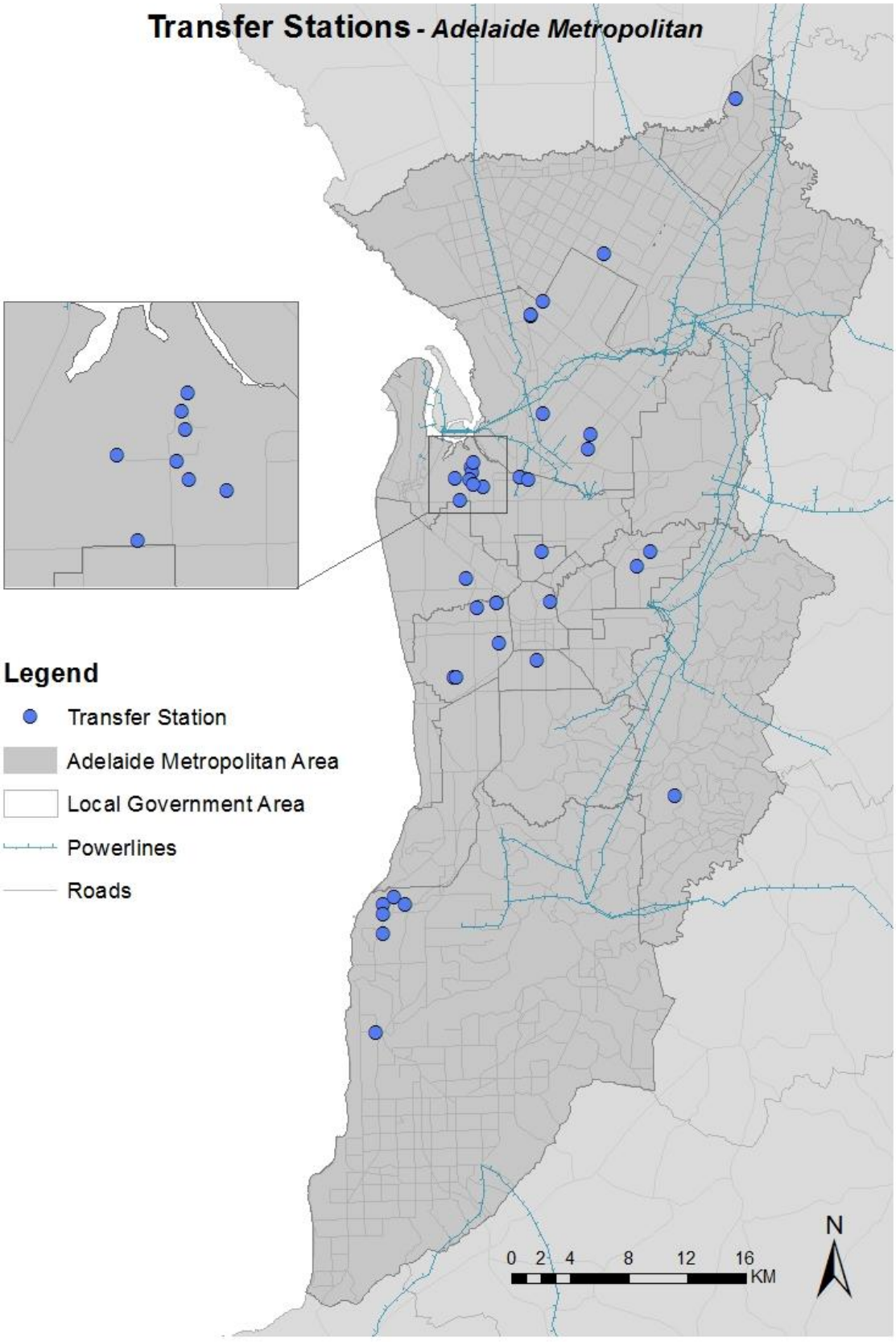


***Figure 4.3**: Locations of transfer stations in Metropolitan Adelaide. Map produced by the Office of Green Industries SA.*

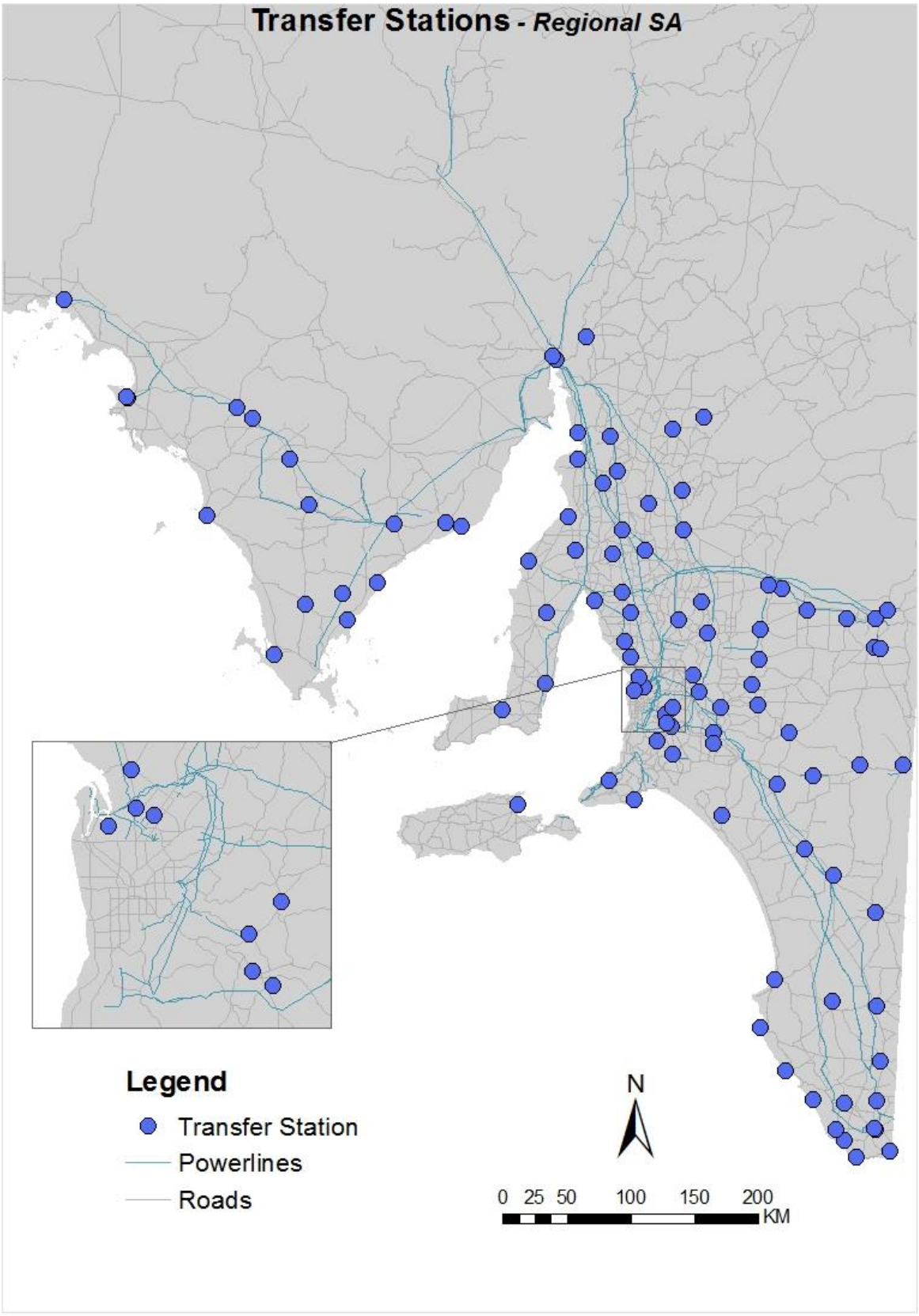


***Figure 4.4**: Locations of transfer stations across regional SA. Map produced by the Office of Green Industries SA.*

4.4 Disposal and recycling facilities

Selecting a disposal or recycling option

A number of factors should be considered when selecting a recycling or disposal option for disaster waste, including:

- **Nature of the waste stream**. Such as whether it is hazardous or non-hazardous, mixed or segregated. For example, soil that is contaminated with hazardous wastes would need to be disposed of at a specially licensed facility or remediated rather than being directly reused.
- **Laws and regulations**. Including whether there are specific disposal requirements (refer Chapter 5). For example, the Environmental Protection Policy (Waste to Resources) 2010 bans certain items from disposal to landfill (such as e-waste), and has requirements for minimum levels of resource recovery.
- **Local waste industry capabilities**. Including what types of facilities are available in the SA market for disposal of the waste, and their capacity to receive and process/dispose of waste volumes (such as available landfill space, and throughput).
- **Facility locations.** Including how far the recycling/disposal facility is located from the debris (which impacts travel time and transport costs), and available road access which may be impeded by the disaster.
- **Cost**. Including the price paid to the facility operator for disposal or recycling of disaster waste. This factor is closely linked to the resource value of recovered waste, and its nature (e.g. whether it is segregated or mixed beyond practical separation). Materials that are separated into a single stream and have a high-value (e.g. metals) are generally more cost-effective to recycle. The cost of sending waste to landfill is affected by the landfill levy (currently adding $52 per tonne for waste disposed in Metropolitan Adelaide). However, it is possible that a waiver of the Waste Levy for disaster waste could change the comparative costs of recycling vs disposal in favour of disposal.
- **Pre-processing opportunities or requirements**. Including whether the waste stream requires or is suitable for processing prior to final disposal/recycling. Volume reduction techniques (such as shredding) may be used to improve waste management efficiencies and minimise impacts on landfill capacities. Some streams (e.g. masonry materials) may require processing to identify and remove contaminants. Following both the Sichuan Earthquake in China (2008) and the 2008 conflict in Gaza, poor screening of building rubble resulted in public health risks during crushing operations due to the undetected presence of asbestos.
- **Social and economic considerations.** Such as impacts on local employment, and the speed of recovery. Recycling of materials is generally more labour-intensive than landfill disposal, and can create more jobs, which can contribute to the recovery of a city following a disaster. Employment outcomes can also depend on the technology employed for recycling/disposal. An over-reliance on extremely mechanised and sophisticated approaches can restrict employment opportunities (Japan). On the other hand, mobilising local communities to be engaged in DWM activities such as screening and segregating waste

products, albeit in a very basic fashion, can be very efficient and create significant short-term employment that also assists with the local recovery process (China). However, when considering the potential for disaster waste management activities to provide local employment it is important to ensure that:

- Employment transition is considered for those who may lose their jobs once processing of disaster waste is complete
- There are end-markets for recycled products to make recycling activities financially viable
- There are regulations in place to prevent rogue operators from distorting the waste disposal market (through accepting materials below market value, and then abandoning received materials leaving them for someone else to manage)

It is also important to consider how long it will take to process the waste. The slow clean-up following Hurricane Katrina caused several social, public health and environmental problems (refer to Box 4.1).

The speed of clean-up is affected by a number of factors including:

- Whether waste is recycled, which generally takes more time than landfill disposal or incineration
- Regulations, which specify processes and procedures for management of waste
- The presence of hazardous materials in the waste, which need to be removed
- Whether a new recycling/disposal facility needs to be established, which involves time taken for development application, licensing and construction of a new facility
- Overall management and resourcing of disaster waste management

Decisions on the disposal/recycling for disaster waste typically involve trade-offs. For example, the decision to recycle waste may lead to improved environmental and employment outcomes, but at the cost of a longer recovery period. Decision makers need to weigh-up the relative advantages and disadvantages of available options for the disposal/recycling of disaster waste, taking into account the above considerations.

These decisions may be made by either the public sector (e.g. authorised government staff) and/or the private sector (e.g. insurance companies). Decisions made by the latter group may not consider public costs or benefits (such as employment outcomes), and are more likely to focus on minimising private waste management costs. To maximise overall benefits to society, it is recommended that the government develop a set of guidelines for management of disaster waste (refer Box 4.2).

The following section provides information on waste and recycling facilities available in SA that could potentially recycle or dispose of disaster waste, including their:

- Locations
- Waste streams accepted
- Current and potential throughput (tonnes/unit of time)

Box 4.1 - Speed of debris removal and management – The contrasting experiences of US and China

Extracts from Planning for Disaster Debris Management. (C. Brown a. M., pp. 2, 5)

Following Hurricane Katrina, the Solid Waste Association of North America (SWANA) recommended that debris managers select a debris removal program that was quick to implement, with the least amount of exposure to any hazardous or toxic materials. The presence of large quantities of asbestos in the debris, however, presented a conflict in achieving this goal as standard asbestos handling and disposal procedures were identified as a contributing factor to the slow debris removal process.

The debris management contributed to a plethora of social, environmental and economic issues, including:

- *Looting and rioting allegedly partly due to road clearance*
- *Public health concerns over toxic sediment handling*
- *Slow residential rebuild and repatriation*
- *Illegal waste dumping by residents frustrated by slow clean-up*
- *Slow home demolition processes due to presence of asbestos*
- *Environmental concerns and public complaints over inappropriate land disposal*
- *Significant volumes of rotting food due to prolonged power outages*
- *Delicate debris removal from sensitive marsh areas*

In contrast, the meticulously fast debris management process following the Sichuan Earthquake drew criticism from some Chinese. Parents of children that perished in collapsed school buildings have accused the government of covering up a corrupt building sector. In some cases, bodies of some children have still not been formally identified a year after the event and some parents believe many were never recovered from the rubble.

Box 4.2 - Guidelines for disaster debris management – The Japan experience

Following the Great East Japan Earthquake, the Japanese Ministry of the Environment developed guidelines to ensure consistency in the overall approach to the clean-up, segregation, offsite transportation and final disposal of debris. The guidelines:

- Emphasised the importance of maximizing recycling opportunities.
- Requested local governments to ensure efficiency in contract management and maximise local employment in disaster debris management.
- Promoted collaboration between municipalities at the prefecture level, as well as cross-jurisdictional involvement between prefectures.

Together with the technical experts deployed in the field, these guidelines essentially formed the foundation for the post-disaster debris management operation.

(UNEP, 2012, pp. 14-15)

Facility types and locations in SA

Table 4.2 shows the types of facilities in SA where disaster waste streams can potentially be disposed or recycled.

Table 4.2: *Potential local disposal options for waste materials generated by disaster event*

Waste stream category	Waste materials	Types of facilities in SA where disaster waste stream can potentially be disposed or recycled		
Masonry	Concrete, bricks, stone, asphalt	Construction & demolition recycler	Landfill	
Asbestos	Asbestos-containing waste	Specially licensed landfill		
Vegetative waste	Green waste	Local chipping or mulching	Organics processing facility	Landfill
Metals	Ferrous (steel), aluminium and other non-ferrous	Metal recycler	Landfill	
Hard waste	Mix of wastes - such as timber, furnishings, carpet and textiles.	Waste to energy facility	Landfill	
White goods	Whitegoods (e.g. refrigerator, dishwasher)	Metal recycler		
Electrical and electronic waste	Electrical and electronic material (e.g. TVs, computers, appliances)	E-waste recycler		
Vehicle bodies	Car, truck and other vehicle bodies	Metal recycler	Landfill	
Other hazardous wastes	Chemicals, batteries, fluorescent lighting	Hazardous waste treatment/ disposal facility		
Putrescible waste	Food waste	Organics processing facility	Landfill	
Soil and sediment	Clays, fines, rubble and soil.	Options include reuse, remediation if contaminated, landfill disposal, treatment prior to landfill disposal. Options are determined by SA EPA conditions of licence, Waste Derived Fill Standards (SA EPA, 2013) and conditions of Development Approval.		

The main types of facilities likely to handle disaster waste volumes in SA include:

- Landfills
- Landfills that are specifically licenced to receive asbestos
- Construction and demolition recyclers
- Waste-to-energy facilities
- Organics processing facilities
- Metals recyclers

There are 30 major[4] waste or recycling facilities in SA across these categories. These are mapped in Figures 4.5 and 4.6 overleaf. Other smaller operations exist across the state, however they would be unlikely to handle large volumes of disaster waste given their size.

4 Major facilities are defined as large facilities that together process more than 75% of SA's waste volumes.

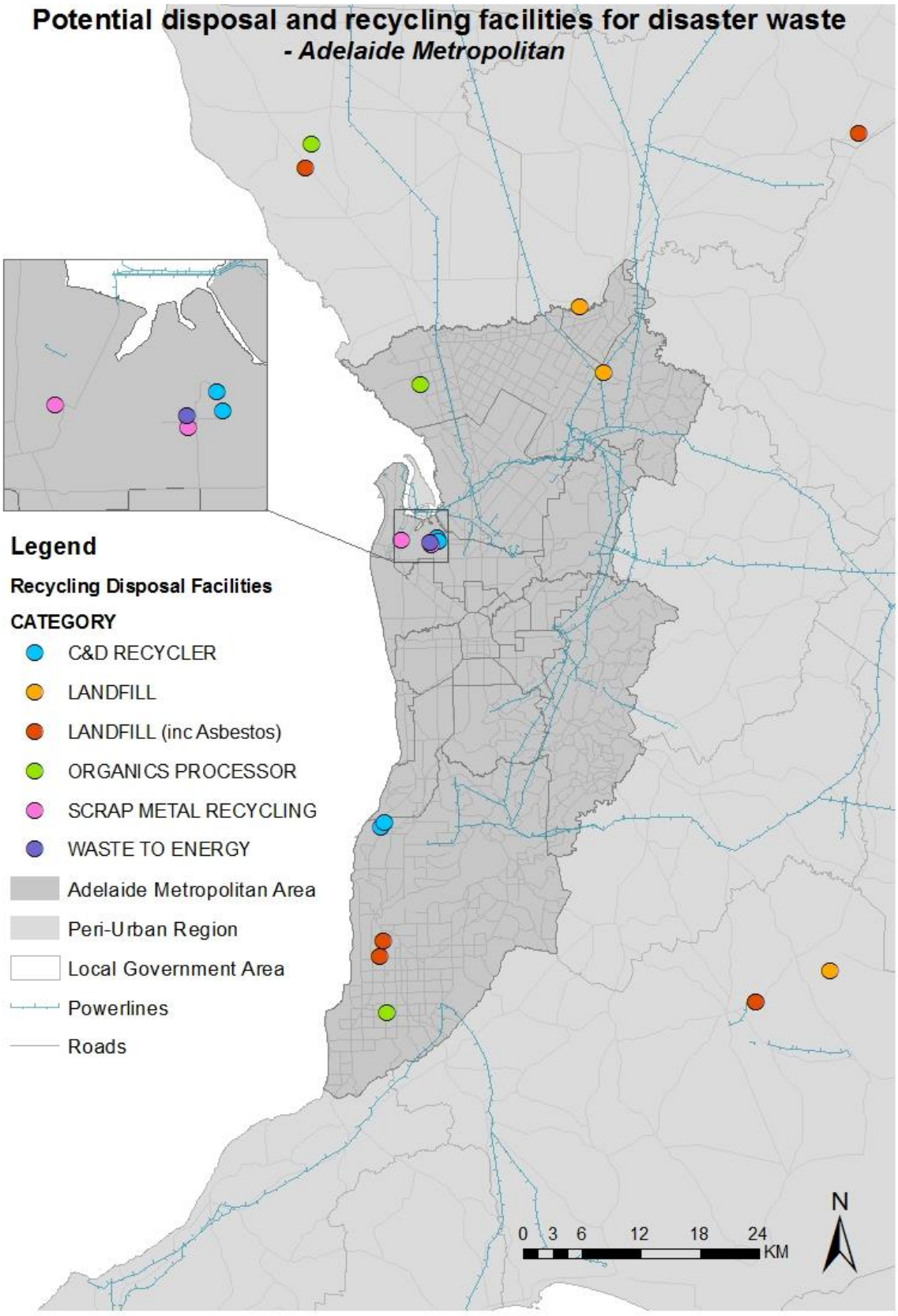


***Figure 4.5**: Locations of recycling and disposal facilities in Metropolitan Adelaide. Map produced by the Office of Green Industries SA.*

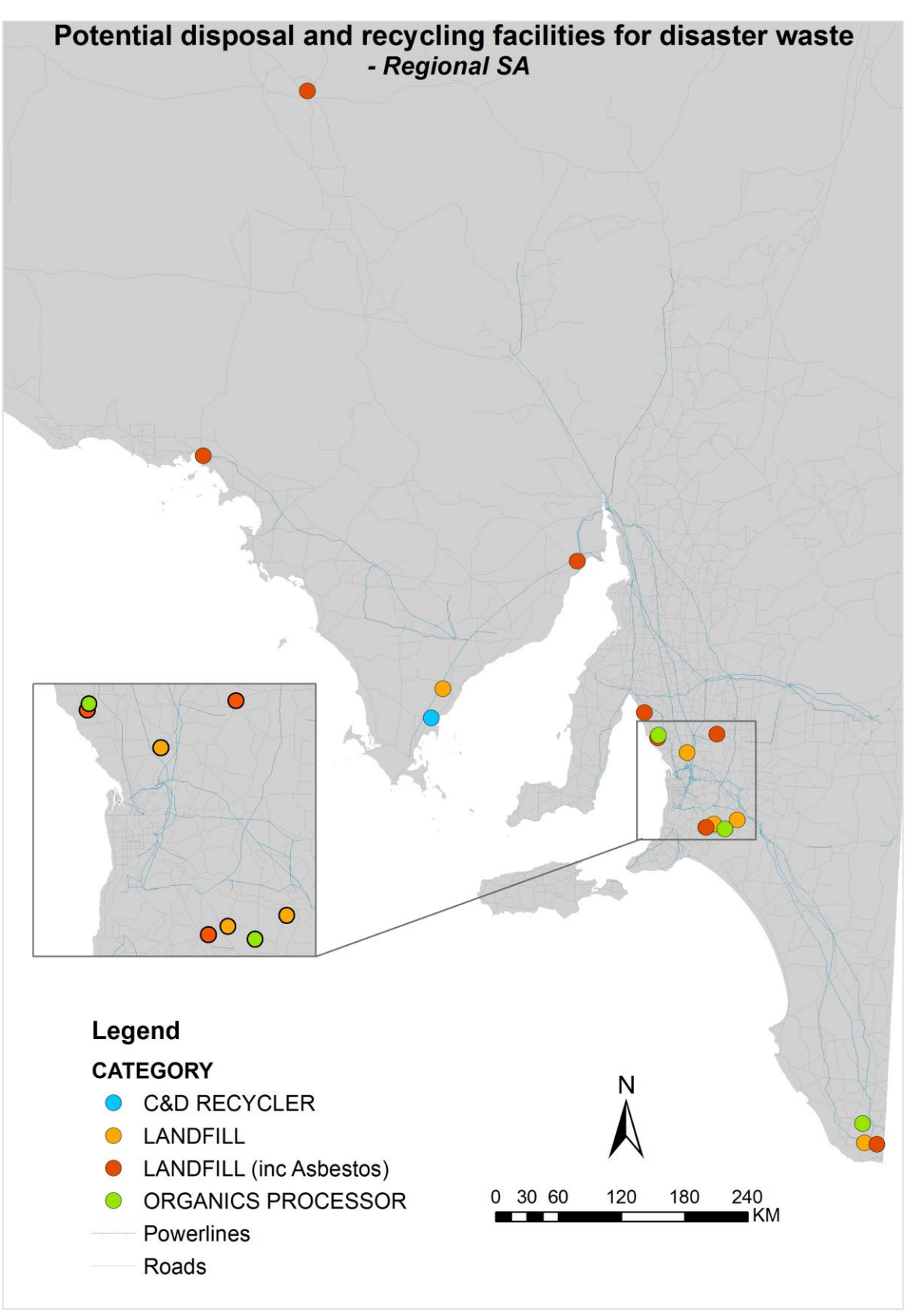


***Figure 4.6**: Locations of recycling and disposal facilities across regional SA. Map produced by the Office of Green Industries SA.*

Facility capacities

Most major facilities in SA operate around 48 hours per week. Following a disaster, it is likely that many of these sites could increase their hours of operation (subject to health and safety considerations, licensing conditions and approval from local planning authorities and councils) to process more materials.

SA's landfills and C&D recycling facilities have a combined maximum capacity of 10 million tonnes per annum. This is similar to estimated waste quantities generated by a 1 in 10,000 year earthquake in Metropolitan Adelaide (refer to section 2.4), which means it could take about one year to process debris volumes from an event of this scale using all available capacity in SA. In practice, it is unlikely that the State's total facility capacity would be fully available to manage disaster waste given:

- Facilities still need to manage business-as-usual waste volumes from households and businesses (which includes about 1 million tonnes per year across C&D recyclers, and 1 million tonnes across landfills)
- The locations of facilities relative to the disaster region (For example, it is unlikely that waste generated in metropolitan Adelaide would be transported to a landfill on the Eyre Peninsula for disposal)
- Landfill space is valuable and takes time to develop new landfill cells. Sufficient on-going landfill space needs to be available

Taking the above into consideration, the estimated amount of waste generated by a 1 in 10,000 year earthquake would likely take several years to process at existing facilities. In the meantime, disaster debris could be held at a temporary debris storage site.

The next sections describe SA's waste and recycling facilities types in more detail, and provide information on their combined potential annual capacity (for both normal operating hours, and if facilities were willing and able to operate 24 hours/ 7 days per week).

A facility list (Appendix 1) has been developed for this project that provides information about each of the main facilities in SA that might handle disaster waste. This includes information about each individual facility including its location, EPA licence number, waste streams received, and capacity.

This facility list can be filtered by waste stream accepted, location and other data fields.

Landfills

There are 16 major landfills across SA. Waste disposed at these sites is buried in a suitably constructed engineered cell.

Asbestos and asbestos-containing materials can be disposed of at specifically licensed landfills (10 are licensed to dispose of asbestos). Asbestos is wet down to avoid dust, wrapped in heavy duty 200 µm (minimum thickness) polythene sheeting, and sealed (if friable within a sealed and air tight steel or heavy duty plastic container), and stored in a designated area that is clearly signed.

Major landfills in SA together have capacity to receive over 1.7 million tonnes of waste per

annum, or an average of 33,000 tonnes per week.

If operating 24/7, the combined capacity of these facilities is estimated at 6.3 million tonnes per annum.

When considering the rate at which a landfill can receive and dispose of waste, it is also important to consider the average size of a landfill cell and the time taken to construct a new cell. Typical cell sizes range from 200,000 - 1,000,000 cubic metres of air space (approximately 180,000 – 950,000 tonnes), and the build time is 3-6 months.

The total amount of materials that can be disposed at a landfill is also limited by its remaining total capacity. These capacity limitations are provided on a site-by-site basis in the Appendix 2.

	No. of facilities	Maximum annual throughput *(Tonnes per year)*	
		Normal operating conditions	Operating 24/7
Landfills	6	670,000	2,600,000
Landfills licensed to receive asbestos	10	1,035,000	3,700,000
Total	16	1,705,000	6,300,000

Construction and demolition recycling facilities

Mixed masonry materials can be sorted, crushed, screened and processed to a product specification.

Recycled bricks and concrete can be recycled into road base, drainage or construction fill. Soil can be recycled into road base, batters/bunds, compost (bulking agent) or for quarry rehabilitation.

There are 6 major construction and demolition recycling facilities in SA, together have capacity to process 1.2 million tonnes of waste per annum. This averages to 24,000 tonnes per week.

If operating 24/7, the combined capacity of these facilities is estimated at 4.4 million tonnes per annum.

	No. of facilities	Maximum annual throughput *(Tonnes per year)*	
		Normal operating conditions	Operating 24/7
Construction and demolition recycling facilities	6	1,200,000	4,400,000

Waste to energy facility

Dry waste materials can be sent through a waste-to-energy facility, where valuable materials (such as metals) and inerts are separated, and the remaining combustible fraction is converted into a waste-derived fuel. This fuel is used locally as a fuel replacement in cement production.

There is 1 waste-to-energy facility in the state.

Similar to C&D recyclers, it is possible that annual throughput could be increased at this facility by increasing operational hours. However, the amount of material processed is likely to be limited by the needs of its single end-user.

	No. of facilities	Maximum annual throughput *(Tonnes per year)*	
		Normal operating conditions	Operating 24/7
Waste-to-energy facility	1	Not disclosed	Not disclosed

Organics processing facilities

Green waste can be chipped or mulched. End product can be used for playgrounds, landscaping and other uses.

Alternatively, green waste can be composted (with food waste and other organic materials). Recycled products may include composted soil conditioners, potting mixes and mulches.

There are 5 major organics processing facilities across SA, which have a combined capacity of 740,000 tonnes per annum (to process timber, garden waste and food waste volumes).

If operating 24/7, the combined capacity of these facilities is estimated at 2.1 million tonnes per annum.

	No. of facilities	Maximum annual throughput *(Tonnes per year)*	
		Normal operating conditions	Operating 24/7
Organics processing facilities	5	740,000	2,100,000

Metal recycling facilities

Metals can be sorted, shredded, and baled by metals recyclers.

Whitegoods, such as refrigerators and air conditioners, need to be degassed (to remove refrigerants) prior to shredding.

Recycled ferrous can be used in foundries, and the production of many products such as car parts, general rods and sheet. Recycled aluminium can be used to make metal valves and extrusions, consumer products, automotive parts, building industry and aluminium cans. Recycled other non-ferrous materials can be used to make many end products, such as batteries, cables, valves and extrusions.

There are two major metal recycling facilities in SA, which have a combined capacity of 400,000 tonnes per annum.

If operating 24/7, the combined capacity of these facilities is estimated at 1.8 million tonnes per annum.

	No. of facilities	Maximum annual throughput *(Tonnes per year)*	
		Normal operating conditions	Operating 24/7
Metals recycling facilities	2	400,000	1,800,000

Other specialised and hazardous waste facilities

There are a number of other facilities that may be used to manage (store, treat, recycle or dispose) smaller, more specialised, disaster wastes volumes such as:

- Clinical and Pharmaceutical waste
- Oils
- Pesticides
- PCBs
- Containers and drums with residues containing hazardous substances
- Paints, resins, inks and organic sludges
- Fluorescent lighting
- E-waste
- Other hazardous wastes

The locations of these facilities (not mapped above), are provided in the facility database (Dataset B).

CHAPTER 5

Regulatory framework

5.1 Introduction

This chapter provides a high-level review of SA's regulatory framework, including regulations, approvals and requirements relevant to disaster waste management.

Regulation and policies can help facilitate improved outcomes for disaster waste management through:

- Requiring individuals and organisations to take measures to prevent, minimise or eliminate harm to people and the environment.
- Penalising inappropriate and/or illegal behaviours (e.g. illegal dumping of waste, unsafe handling of hazardous wastes).
- Achieving policy objectives, such as reducing waste to landfill.

However, ambiguity and/or inadequacy in both policy and regulations can bring challenges for disaster waste management. For example, in Christchurch following the 2010-2011 earthquakes, emergency legislation was introduced that facilitated business moving their operations to new sites. This inadvertently led to a number of poorly operated disaster waste storage facilities being operated (refer Box 5.1)

The SA EPA is the lead agency responsible for regulating waste and resource recovery activities. Consultation was undertaken with the EPA to identify waste regulations and legislation that may affect management of disaster waste in SA. This review also examined the potential for the SA regulatory framework to have any unintended consequences for disaster waste management.

Box 5.1- Policy loopholes - The Christchurch experience

To help businesses get up and running following the 2010-2011 Canterbury earthquakes, new legislation was put in place to allow 'temporary accommodation'. Amongst other things, this allowed for storage of materials associated with business operations. A number of demolition contractors used this piece of legislation to set up temporary waste storage and sorting facilities. The sites, in general, were poorly controlled and managed. In at least one case, after being paid to receive hundreds of tonnes of waste, the contractor abandoned the operation and the local council was left to clean-up the site.

5.2 Review of regulatory framework

South Australia has a strong regulatory framework for waste management and resource recovery. Table 5.1 lists relevant legislation, regulations and guidelines which may be applicable to disaster waste management activities, including for:

- Transport of disaster waste
- Establishment and operation of temporary waste storage area
- Establishment of new facilities, and/or change of activities at existing facilities to process and dispose or recycle volumes of disaster wastes
- Disposal or recycling of disaster waste
- Resuming domestic waste collections from occupied homes and businesses

These regulations are further described below. This framework can help facilitate good outcomes for disaster waste management through requiring operators are licensed, penalising behaviours (such as illegal dumping), providing guidelines for management of hazardous wastes, and encouraging recovery of recyclable materials.

Relevant regulations

The SA Government regulates the waste and resource recovery industry primarily through the Development Act 1993, Environment Protection Act 1993 (the Act), and subordinate legislation including the Environmental Protection (Waste to Resources) Policy 2010 (W2R EPP).

These regulations include:

- Requirements for development approvals for waste and recycling depots.
- Licensing requirements for waste transport, storage, disposal and recycling activities. These licences set conditions to ensure that potential impacts and risks to the environment are minimised.
- Landfill bans, and resource recovery processing requirements for certain waste materials
- Levies on waste disposed to landfill
- Requirements for management hazardous wastes
- Requirements for minimum frequencies of domestic waste collection
- General requirements for individuals and organisations to take measures to prevent, minimise or eliminate harm to people and the environment, and
- Penalties for non-compliance.

The SA EPA has also developed guidelines for management of certain waste streams, which may arise following a disaster. This includes guidelines for CCA-treated timber waste, wastes containing asbestos, and medical waste. These guidelines are not directly enforceable; however, may be used to help the EPA interpret the general environmental duty for a particular situation, and may be enforced through issuing an Environment Protection Order, a condition of licence, or a condition of a development approval.

Other regulations relevant to disaster waste management include:

- Work Health and Safety Regulations 2012 and Code of Practice for Safe Removal of Asbestos
    - Contractors removing more than 10m^2 of non-friable asbestos require a relevant license issued by SafeWork SA.
    - Asbestos removal must be carried out in accordance with the Work Health and Safety Regulations 2012, the Code of Practice for the Safe Removal of Asbestos. If asbestos-containing materials are discovered within or actively mixed with other wastes, the entire load is deemed as an asbestos waste and must be managed appropriately. For example, where a stockpile of waste soil is contaminated with asbestos-containing material the entire stockpile is deemed to be asbestos waste and must be managed per EPA guideline, conditions of EPA License or remediated to remove the asbestos-containing material.
- National Environment Protection (Movement of Controlled Waste Between States and Territories) Measure provides a national framework for the management of the movement of controlled wastes between States and Territories, including ensuring that the controlled wastes are properly identified, transported and handled in ways that are consistent with environmentally sound practices.
    - NEPM is applicable in the event that controlled waste (such as asbestos or fire debris generated by a disaster) is transported interstate for recovery or disposal.
- Australian Code for the Transport of Dangerous Goods by Road and Rail

Table 5.1: Relevant legislation, regulations and guidelines which may be applicable to disaster waste management activities

Disaster waste management activity	Relevant regulations
Waste removal and transport of disaster debris from affected areas to waste management facilities	▪ Asbestos removal must be carried out in accordance with the Work Health and Safety Regulations 2012, the Code of Practice for the Safe Removal of Asbestos. ▪ The W2R EPP includes risk management requirements applicable for any person who transports waste (licensed or unlicensed) with penalties of up to $30,000 for non-compliance. ▪ Under the Act, an EPA licence and compliance with all licence conditions are needed for the transport of certain wastes for fee or reward. ▪ Under the Act, Waste transport certificates (WTCs) are needed for transport of listed wastes (Part B of Schedule 1), including waste streams such as asbestos and contaminated soil. ▪ NEPM requires suitable licences and national minimum standards for all interstate transporters of controlled wastes (e.g. asbestos, fire debris).

Disaster waste management activity	Relevant regulations
Establishment and operation of temporary waste storage areas	▪ Under the Act, EPA licenses are required for waste or recycling depot that stores waste. This excludes temporary storage at the place at which the waste is produced while awaiting transport to another place. ▪ The Waste to Resources EPP includes controls for illegal dumping and unauthorised stockpiling, with penalties of up to $250,000.
Establishment of new facilities, and/or change of activities at existing facilities to process and dispose or recycle volumes of disaster wastes	▪ Under the Act, EPA licenses are required for waste or recycling depot that receive, store, treat or dispose of waste.
Disposal or recycling of disaster waste streams	▪ Under the Act, Waste disposed to landfill is subject to the landfill levy. ▪ The W2R EPP limits or specifies how certain waste streams can be disposed or recycling. This includes: o Landfill bans for hazardous waste, lead acid batteries, liquid waste, medical waste, oil, tyres, aggregated recoverable materials, e-waste, whitegoods and fluorescent lighting. o Waste from metropolitan Adelaide (subject to exemptions) is required to be subject to resource recovery processes prior to disposal at landfill. o Treatment or disposal methods for medical waste may be approved by the EPA ▪ The EPA has developed guidelines for certain waste streams (which may arise following a disaster) including CCA timber waste, wastes containing asbestos, and medical waste. o Copper chromate arsenate (CCA) timber waste—storage and management o Wastes containing asbestos – removal, transport and disposal o Medical waste —storage, transport and disposal
Resuming domestic waste collections from occupied homes and businesses	▪ Weekly collection of domestic waste is mandated for metropolitan councils under the W2R EPP.

Ambiguity in policy and regulation

Ambiguity and/or inadequacy in both policy and regulations can bring challenges for disaster waste management.

This potential for the SA regulatory framework to have any unintended consequences for disaster waste management was examined. The following uncertainty was identified for disaster waste management in SA.

- EPA licenses are not required for transport of construction and demolition waste (which is a key disaster waste stream) or if waste is not transported for fee or reward.

Passive regulation through guidance and advice may mean there is greater potential for harm to the environment and human health to occur from these activities if ill-informed or rogue operators are present.

It is noted that under the W2R EPP there are requirements for all transporters of waste (licensed or not):

- Take all reasonable and practicable steps to cover, contain or secure the waste to ensure that it remains on or in the vehicle throughout the course of transportation; and
- Ensure that the vehicle being used to transport the waste is designed and sufficiently well maintained so as to prevent the spillage or leakage of the waste; and
- Take all reasonable and practicable steps to prevent spillage or leakage of the waste during loading and unloading of the waste; and not cause any danger or potential danger by transporting volatile waste in the passenger compartment or transporting incompatible kinds of waste in the same container, or in close proximity in or on the vehicle; and
- Waste transporters (person who receives fees or reward for transport of waste) to have on the vehicle an emergency spill kit of a kind suitable for waste of the kind being transported; and
- Comply with all reasonable directions of the operator of a licensed depot at which the waste is received; and
- Comply with the provisions of the Australian Code for the Transport of Dangerous Goods by Road and Rail, Seventh Edition published by the National Transport Commission, as amended from time to time.

Furthermore, the Act includes a General Environmental Duty which states that ‘a person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practical measures to prevent or minimise resulting environmental harm’.

However, without active regulation e.g. via licensing requirements, operators may not be as aware of the risks involved with transporting and storing of waste, or of their obligations under the law. It may be difficult to enforce regulations with a potentially large number of unlicensed operators undertaking these disaster waste management activities.

It is recommended that the SA EPA review strategies to expand the passive regulation of disaster waste management. Part of the solution may be to introduce guidelines for the transport of C&D waste, which clearly outline:

- Suitable procedures (e.g. how to load the waste) and equipment (e.g. truck type) for transport
- Suitable facilities where waste can be transported to (e.g. a licensed C&D recycler).

Other potential challenges under current regulatory framework

Other potential challenges that may arise for disaster waste management under the current regulatory framework include:

- Increased cost of debris management due to resource recovery requirements and landfill levy
- Slowing down the speed of recovery due to time involved with getting development approvals and licensing to establish new facilities, and/or change approved activities at existing facilities to process and dispose or recycle volumes of disaster wastes. Timely approval processes will be important in the event of a major disaster.

Furthermore, circumstances created by a disaster can make compliance with some regulations unsafe or impractical. For example, it may not be safe or practical for councils to provide weekly domestic waste collections to residents due to limited road access and safety hazards.

These potential impacts were discussed with the SA EPA. It was found that the SA EPA has powers to respond to waste management needs following a disaster. This includes:

- **Waive the waste levy**. The Minister for the Environment can authorise to waive the waste levy on disaster waste as a measure to reduce the cost of cleaning up waste following a disaster.
- **The ability to grant exemptions** (in cases when a licensee is unable to comply with the Act). The time taken to grant these exemptions depends on available resources. In some cases these exemptions can be granted by an authorised officer instantly, with paperwork to follow.
- **Emergency powers** (see below)

The SA EPA has internal operating procedures to guide decision-making to determine when exemptions and emergency powers would be enforced. It is recommended that that the SA EPA undertake a review of the internal operating procedure using the Sampson Flat Bushfire as a test case to assess its effectiveness.

Emergency powers under the 1993 Environment Protection Act (the Act)

Note: the following is not a legal interpretation of the Act.

Section 105 of the Act provides the Authority (SA EPA) and authorised officers (can include police officers, local government staff, and EPA staff) with emergency powers when:

a. circumstances of urgency exist such that it is not practicable for the person to obtain an exemption; and
b. authorisation of the act or omission is justified by the need to protect life, the environment or property.

Emergency powers may be activated by the SA EPA or by request from another party[5].

Emergency powers enable the Authority and authorised officers to grant emergency authorisations for persons to undertake activities that would normally need to follow the standard development approval or license application process.

In the context of disaster waste management, this may include authorisations to:

- Become a transporter of waste
- Establish a new site to undertake waste management activities (e.g. set up a temporary waste storage site or a landfill facility)
- Undertake new activities at an existing site that would require a variation to an existing license (e.g. undertake processing of construction and demolition waste at a site that was only licensed to store waste)

A person that has been granted an authorisation under Section 105 is exempt from liabilities to a penalty under the Act (in respect of an act or omission authorised under Section 105).

These authorisations may be subject to conditions as the Authority or authorised officer considers appropriate and specified in the authorisation. These authorisations may include conditions that limit the length of time that the authorisation is valid, such as a beginning and end date, and/or provisions that must be met by the authorisation holder.

However, it is important to note that these emergency authorisations are limited to times when circumstances of urgency exist or when the authorisation is justified by the need to protect life, the environment or property. Disaster waste management activities extend well beyond these periods: for example, in Christchurch the state of emergency was 12 weeks and the debris operations are still continuing 4 years after the 2011 earthquake. A transition between these temporary approvals and longer term provisions is inevitable.

Collaborative planning between the SA EPA, Office of Green Industries SA, DPTI, local councils and the waste industry is needed to identify potential sites/facilities to manage disaster waste. Specifying the types of disaster waste that may be received at a given site, and planning for how the disaster waste would be managed, may reduce the amount of time taken to obtain an emergency authorisation following a disaster.

[5] In the event of a disaster, the SA EPA would set up one point of contact (e.g. a nominated personnel) to receive all queries regarding disaster waste management. Any person or organisation requesting an emergency authorisation could contact the SA EPA (e.g. via phone, email, in person, or other) and would be directed to the designated point of contact. The SA EPA would then follow its internal operating procedures to make a decision on whether to grant an emergency authorisation.

CHAPTER 6

Planning methodology

6.1 Introduction

Experience around the globe demonstrates that it is essential to prepare a disaster waste management plan (DWM Plan) well in advance of any natural disaster.

The DWM Plan should seek to identify best technical and operational options for waste collection, recycling, and final disposal. Undertaking these tasks prior to the onset of a disaster will provide numerous advantages including: e.g. speeding up response and recovery activities; reducing waste generation (e.g. through building standards); and making financial savings.

Disaster waste management is a major component of every disaster response and recovery operation. Much of the debris generated from natural disasters is non-hazardous in nature with soil, building material, and green waste making up the bulk of the material.

The DWM Plan should facilitate efficient and timely waste removal, which helps to facilitate response and recovery operations, while most of the waste can be recycled into useful commodities, create local employment opportunities, and help to conserve precious natural resources.

6.2 Key lessons learnt

Based upon the consultant team's first-hand experience in responding to numerous natural and man-made disasters around the globe the following are considered as key learning points for the development of a DWM Plan.

- During the initial response to a large natural disaster considerable time and resources can be lost if organisations (both national and international) do not have clear roles and responsibilities with clear lines of communication. Good disaster response planning, and in particular a robust DWM Plan, can significantly improve efficiency and speed up the recovery process.[6]
- Inter-community/municipality cooperation and sharing of infrastructure and expertise significantly enhanced the DWM performance.[7]
- Mobilising the resources and expertise of the local private sector is an important step in the DWM process.[8]
- Poor screening of building rubble resulted in public health risks during crushing operations due to the undetected presence of asbestos.[9]

[6] Based on experience with DWM following Sichuan Earthquake in China.

[7] Based on experience with DWM following Yolanda Typhoon in Philippines.

[8] Based on experience with DWM following the Great East Japan Tsunami.

[9]Based on experience with DWM following Sichuan Earthquake in China & man-made disaster in Gaza.

- Optimising employment opportunities for the affected communities is a key consideration within the DWM response. An over-reliance on extremely mechanised and sophisticated approaches can restrict employment opportunities.[10]
- Mobilising local communities to be engaged in DWM activities such as screening and segregating waste products, albeit in a very basic fashion, can be very efficient and create significant short-term employment that also assists with the local recovery process.[11]
- Identifying suitable local contractors, along with their capacities, equipment and fees as part of the planning stage significantly enhances mobilisation efficiencies following a disaster.[12]
- Trying to identify locations for waste transfer stations and interim disposal sites following a disaster is extremely problematic and can lead to secondary problems. Stockpiling and processing of building rubble in inappropriate sites can lead to pollutants, such as hydrocarbons and chemicals, migrating to sensitive areas.[13]
- Having a well-established recycling sector in advance of a disaster will significantly enhance the DWM process – as the majority of disaster waste can be recycled.[14]

6.3 Developing a disaster waste management plan

Content development

Work needs to be undertaken at the State-level first to determine how disaster waste management should be dealt with under the SA's emergency management framework. This may include the development of a Disaster Waste Management Support Plan under the State Emergency Management Plan. This Plan should include the following information, considerations and frameworks for disaster waste management, e.g.:

- DWM roles and responsibility framework
- DWM funding and payment mechanisms (including access to state and Commonwealth funding sources)
- Applicable regulations for management of disaster waste
- DWM functions, roles and responsibilities across response and recovery phases
- Estimates of likely disaster waste types and volumes disaster scenarios
- Pre-selected DWM temporary storage sites
- Pre-identified DWM waste disposal/recycling options and storage/processing capacities of existing infrastructure

[10] Based on experience with DWM following the Great East Japan Tsunami.

[11] Based on experience with DWM following the Sichuan Earthquake in China.

[12] Based on experience with DWM following Hurricane Tomas in St Lucia.

[13] Based on experience with DWM following man-made disasters in Gaza and Lebanon.

[14] Based on experience with DWM following the Great East Japan Tsunami.

- Staff and equipment resourcing needs
- Potential disaster waste management suppliers
- Considerations for operation and final closure of DWM sites
- DWM Communications Plan

Consideration should then also be given to if a further stage of planning for Emergency Management Zones is required or of benefit. An option is to test the state-wide Support Plan for a given Emergency Management Zone to assess its effectiveness and subsequently update the Support Plan where required.

It is important that content for these plans be developed by the key stakeholders that they will be responsible for implementing them, given that:

- The process of planning itself builds capacity within these individuals and organisations to successfully implement the plan; and
- These stakeholders have access to much of the information needed to develop these plans

Available tools and resources

A number of tools and resources developed in this study may be used to assist with the development of the DWM Plan. This includes:

1. **DWM Plan 'Table of Contents'** (see Appendix 7) - which provides an overview of elements to be included in the Plan.
2. **SA disaster debris estimation tool** (see Appendix 1) - to estimate potential disaster waste volumes. This calculator is not ready for publication, but it is intended it be further developed and refined into a more advanced tool that can used by stakeholders across SA (and potentially Australia) to estimate disaster debris volumes.
3. **Database of SA recycling/disposal facilities** (see Appendix 2) - which can be used to identify sites and facilities that can potentially manage disaster waste.
4. **Site selection criteria for the establishment of a temporary disaster debris storage site** (see Section 4.2) - which can be used to guide the selection of temporary disaster waste storage sites.
5. **Preliminary list of potential suppliers for disaster waste management functions** (see Appendix 4) – who could be invited to provide a tender response to join a panel of pre-approved suppliers for disaster waste management activities.
6. **List of regulatory contacts** (see Appendix 5) - who may be contacted regarding regulatory considerations for disaster waste management.

This list of available tools and resources is not comprehensive, as further areas of work need to be undertaken to inform the development of DWM plans, including:

- Integration of responsibilities for disaster waste management into SA Emergency Management Arrangements
- Determination of roles and responsibilities for strategic management and coordination of

disaster waste management activities

- Development of State guidelines for removal and management of disaster waste
- Development of a decision-making guide to determine when regulatory exemptions and emergency powers would be enforced.

Section 7.2 provides recommendations regarding implementation of these areas of work.

Planning methodology

Key steps, and associated activities, when developing a Disaster Waste Management Plan (DWM plan) are outlined in the following series of boxes.

1. Determine the objectives of the DWM plan
2. Agree on the main approaches for the DWM plan
3. Agree on roles and responsibilities
4. Disaster waste calculations
5. Identify disaster waste temporary storage sites
6. Identify clean-up phases
7. Identify disaster waste disposal/recycling options
8. Pre-disaster contract preparation
9. Develop a communications plan
10. Prepare for increased outreach and enforcement staffing needs
11. Manage for the potential of human remains
12. Plan for operations at DWM sites
13. Plan for closure of DWM sites

This planning methodology does not seek, at this preliminary stage, to provide all of the tools required to develop a DWM Plan. Rather, it seeks to provide a framework to guide practitioners in commencing the development process. The format in which this methodology is presented (in boxes) is suitable for modelling/role playing in group training exercises.

Box 6.1 - Determine the Objectives of the DWM

- A first step is to determine clearly the objectives of the DWM Plan, which should include but, not necessarily be limited to, the following:
  - The provision of a framework for state agencies and municipalities to facilitate the proper management of waste generated by a natural disaster.
  - Ensure, to the extent possible, the protection of public health and natural resources.
  - Plan for the most likely, worst-case disaster scenarios facing the state.
  - Be prepared in compliance with Commonwealth and state legislation
  - DWM Support Plan to the State Emergency Management Plan.
  - Implementation of the DWM Plan coordinated through the State's Control Agency and through the State Emergency Centre (SEC).

Box 6.2 - Agree on the Main Approaches for the DWM Plan

- Agree on the main approaches to be applied in implementing the DWM Plan, which may include:
    - Calculate the amount and type of disaster waste likely to be generated – and the necessary equipment and infrastructure to handle this waste;
    - Design for potentially significant increases in tonnage in line with the most likely, worst-case disaster scenario facing the state;
    - Divert as much material from disposal as possible through recycling, composting and other legitimate diversion options;
    - Utilise volume reduction techniques to improve waste management efficiencies and minimise impacts on landfill capacities;
    - Use SA's existing disposal capacity for disposal of disaster debris as efficiently as possible,
    - Consider alternative technologies for managing portions of the debris waste stream, in-state or out-of-state (i.e. biomass facilities); and
    - Use approved temporary disaster waste storage sites for processing debris for recycling and/or final disposal.
- The DWM Plan shall be reviewed annually and this process shall be led by State Emergency Management Committee (SEMC) and any necessary changes made whether due to lessons learnt or changes in governmental protocol.
- The revised DWM Plan could be made available on the SEMC's websites.

Box 6.3 - Agree on Roles and Responsibility

- Clarify who does what, and in what sequence – including Commonwealth, state and local governments.
- Develop and provide organisational chart illustrating relationship of different entities.
- Provide detail of eligible Commonwealth and state funding for DWM activities and specific eligibility clauses and conditions.
- The need to identify and liaise with all government stakeholders, including**:**

Commonwealth

- Potentially a number of Commonwealth authorities with various responsibilities.
- The lead Commonwealth agency with responsibility for preparedness, response and recovery and management of grant assistance to State and local government.

State

- Identification and liaison with the numerous primary and supporting State agencies.
- Establishment of a Disaster Waste Management Task Force (DWMTF) who should oversee:
    - Disaster waste management and monitoring activities including appointing and supervising private contractors.
    - Coordinate waiver and permitting applications for vehicles and infrastructure.
    - Evaluating situation reports.
    - Coordinating support to local governments.

Local

- Acting as first responders.

- Coordination of local contractors and data management.
- Identification of DWM sites.

Box 6.4 - Disaster Waste Calculations

- For planning purposes, it is essential to estimate the amount and type of DW generated by differing types of natural disasters – specifically: bushfires; earthquakes; severe storms; and floods.
- The types of disasters selected should be based upon up-to-date risk assessments conducted by appropriately qualified and experienced experts.
- Pre-disaster modelling and waste projections provide volume estimates for preparation of DWM sites, estimating vehicle and equipment requirements; pre-positioning of resources and contract preparation.

Box 6.5 - Identify Temporary Disaster Waste Storage Sites

Key considerations:

- Following a severe natural disaster it can be expected that SA's solid waste management infrastructure will be quickly overwhelmed.
- It is essential that temporary disaster waste storage sites are pre-identified, by both State and municipal authorities, and ready for use in the event of a disaster.
- The temporary storage sites should serve as additional space needed to accommodate the disaster waste generated, as well as a place to segregate and process the waste in preparation for recycling.
- Once identified and screened, State authorities should issue Emergency Authorisation for the site.
- If municipal DWM sites are not sufficient, The State will also need to identify and operate temporary storage sites – particularly for DWM operations for waste originating from state highways, roads and state properties.

Box 6.6 - Identify Clean-up Phases

- Clarify the numerous, inter-related, phases of clean-up and key associated tasks – including:
  - **Phase 1:**
    - Typically occurs during and immediately after the event and is commonly referred to as the first 70 hours.
    - Phase consists of clearing the debris that hinders immediate lifesaving actions and that poses an immediate threat to public health and safety.
  - **Phase 2:**
    - Implemented within seven days of the event.
    - Consists of removing and disposing of the debris that hinders the orderly recovery of the community and poses less immediate threats to health and safety.
    - Activating pre-agreed contracts and notifying citizens of debris removal procedures.
    - Phase 2 covers DW removal, storage, and processing and final disposal activities.

Box 6.7 - Identify Disaster Waste Disposal/Recycling Options & Facilities

State guidelines should be developed that provide information on waste disposal/recycling options.

- Volume reduction methods are essential to any clean-up operation. This should include grinding and chipping, and in the most serious situations burning or incineration – although this will require authorization from the State authorities. Grinding and chipping of suitable wastes will typically reduce waste volumes by some 75%.
- Recycling should be considered as a priority early in the debris clearance, removal and disposal operation as it presents the best opportunity to reduce the overall costs of clean-up.
- For the purposes of the Disaster Waste Management Plan, construction and demolition waste (C&D) resulting from damage to buildings, bridges, roads etc. will likely constitute the largest waste volume and will comprise: aggregate (concrete, brick, block), wood (both clean and treated), roofing and siding materials, plaster-board, metals, carpeting and flooring etc. Before this is moved it should be examined by an appropriate authority and certified not to be containing hazardous materials such as asbestos and hydrocarbons.
- Hazardous waste streams, such as asbestos, and asbestos contaminated material (ACM) must be collected, properly contained, and disposed of as quickly as possible.
- Other hazardous wastes must be handled separately from other debris in order to ensure public and worker safety and in order to prevent portions of the waste stream which can be recycled or disposed as solid waste from being contaminated with hazardous wastes.
- Metals, green waste, aggregate and sediment/soils are prime candidates for recycling.
- For grinding/chipping of organic waste the end product should have a pre-identified end use – such as wood-chips being used for mulch, landscaping, or even as a fuel.
- Due to high transportation costs, green-waste, such as trees and bushes, should be treated close to the point of generation – but a larger storm, for example, would require larger, more expansive sites that could accommodate both state and municipal debris.

Box 6.7 - Pre-Disaster Contract Preparation

- **Contract Preparation**
  - Commonwealth assistance is designed only to address situations where the level of debris is catastrophic in scale, or where the capabilities of the State and/or local government are overwhelmed
  - Therefore, State and local governments must plan for and expect to manage DW operations following a major natural disaster.
  - They should establish pre-disaster contracts and/or arrangements with local contractors to facilitate the immediate availability of coordinated waste handling, transportation and processing operations following a disaster.
  - Contracting must ensure DWM operations that are efficient, effective, and, where appropriate, eligible for Commonwealth grant funding.
  - A data-base of local contractors, their contact details, available equipment and tariffs should be

generated and updated each year.

- DWM operations must be subject to appropriate levels of monitoring and documentation to ensure that costs incurred are appropriate, transparent and accountable.
- A DWM Operational Plan must be developed to govern what steps will be taken by SA, municipalities and local contractors.

Box 6.8 - Develop a Communication Plan

- A key component of any DWM Plan is communication with the general public.
- A communications plans should be developed in advance of any disaster.
- Direction and control of media liaison activities and public information shall be the responsibility of a relevant government agency (to be determined).
- To the greatest extent possible, all State agencies shall coordinate disaster public information activities with this agency to avoid contradictory, confusing, incomplete or erroneous information being given to the public.
- SEMC will prepare public announcements to serve as guidance for the public in their cleanup activities.
- Guidance on communications shall be forwarded to each municipality and it shall be placed on SEMC's website.
- Depending on the type and severity of the natural disaster, however, a community might lose electricity, telephone service, radio-broadcasting capability, or newspaper service. Therefore, all appropriate means of communication shall be used throughout the disaster and the clean-up phase, including newer technology such as mobile phone apps.
- Authorities should discuss with local media companies the use of free advertising time and space to communicate instructions in the event of a disaster.
- Key messages to be communicated to the general public will vary over time as the circumstances evolve, but central to communications should be:
  - 24-hour emergency "hot-line" numbers to use where advice is required.
  - Any particular health and safety requirements and concerns.
  - Days and times of collection within given communities.
  - Points of waste collection – if served by large community containers, for example.
  - Waste segregations requirements to assist with sorting, recycling and ultimate disposal.
  - Identification of, and procedures for, handling hazardous waste such as food waste; household chemicals and medicines.

Box 6.9 - Prepare for Increased Outreach and Enforcement Staffing Needs

- In the aftermath of a natural disaster, waste management staff must handle an increased number of telephone calls and requests concerning waste removal.
- State and municipal authorities require more staff to for a variety of tasks including:
  - Train and monitor waste collection, processing and disposal contractors;
  - Enforce disposal restrictions;
  - Help solve implementation problems;
  - Respond to inquiries from the general public.

- Identify sources of temporary labour and, if your community is culturally diverse, consider the use of a multilingual telephone bank.

Box 6.10 - Manage for the Potential of Human Remains

- Depending upon the severity of a natural disaster, it may be necessary to make contingency plans for dealing with managing human remains.
- If suspected human remains are found during the debris removal process all activities should terminate in the area where the remains were found and measures taken to secure the area from further disturbance.
- The state and local law enforcement officials shall be informed of the situation along with the SEMC.
- Strong coordination efforts are needed in response to this sensitive issue.
- The law enforcement officials, with support of the State's medical examiner, if necessary, will properly document the situation and collect the remains and other items deemed appropriate.
- Operations may resume once the law enforcement officials notify the SEMC that the site has been released.

Box 6.12 - Plan Operations at disaster waste management sites

- As a minimum, the disaster waste management sites should have the following:
    - Storm water controls, such as silt fences, to prevent discharge of contaminated runoff into water bodies where such discharge may cause violations of State regulations.
    - Some method to control the off-site migration of dust, wood chips, or other debris residuals from vehicular traffic and from the handling of debris and ash.
    - An adequate supply of water to ensure that the debris is adequately wet during the segregation, processing and/or packaging of the waste to prevent risk of fire and/or dust migration.
    - Some type of access control to prevent unauthorised dumping and scavenging.
    - Monitoring staff to correctly identify and segregate waste types, especially hazardous waste from non-hazardous waste, for appropriate management.
    - Secondary containment for portable fuel tanks, drums, and other fluids for operating equipment and vehicles.
- When staging debris other than green waste, if possible:
    - Install wells and perform groundwater sampling;
    - Conduct spot soil sampling at potentially problematic areas such as household hazardous waste (HHW), ash, other waste types;
    - Provide specific fuel storage areas;
    - Take videos, photos of the site before operations begin
    - Periodically sketch/map layout including —hotll areas; and prepare quality assurance reports, spill reports, etc. as part of the overall project.

Box 6.13 - Final Closure of DWM Sites

- Final closure of DWM sites shall be undertaken in compliance with all State regulations and Commonwealth laws. The following shall apply:
  - The owner/operators of the DWM sites will be responsible for closure of the site in accordance with state and Commonwealth requirements, including environmental sampling, if needed.
  - All disaster related debris must be removed by the expiration of the Emergency Authorization and/or General Permit, unless otherwise authorised by SEMC.
  - Mulch and wood chips produced from processing uncontaminated green waste may be left on-site if prior approval is obtained from the EPA.
  - Areas that were only used to stage uncontaminated green waste, or ash from authorised burning of solely vegetative debris, will not require any environmental sampling after the debris or ash is removed unless there is reason to believe that the area may have become contaminated (e.g., significant visible staining or known contaminant releases in the area).
  - Areas that were used to stage mixed waste, or ash from burning mixed waste, will normally require environmental sampling after the debris or ash is removed, unless there is reason to believe that no contamination in the area occurred (e.g., the area is paved with asphalt or concrete and there is no visible evidence of staining or known contaminant releases).
  - Areas that were used to stage household hazardous waste and hazardous waste will require environmental sampling after all material has been removed from the site.
  - When sampling of soils and groundwater is needed, it should typically include at least four soil samples and one groundwater sample collected from a monitoring well or direct sampling method in areas showing significant visible staining or areas believed to be impacted by the stockpiled waste.
  - Unless otherwise approved by SEMC these samples should normally be analysed for the range of heavy metals, volatile organic compounds and semi-volatile organic compounds using approved methods and protocols.
  - SEMC State authorities may also require other approaches to conducting environmental sampling at waste handling/processing areas on a case-by-case basis.
  - SEMC should be informed in writing when all closure activities at the DWM site area are completed. If environmental sampling was conducted as part of the closure activities, then the closure notice should include the results of this sampling.

6.4 Responsibility framework for operation of the DWM plan

General

Depending upon the nature and scale of a natural disaster the response may necessitate the involvement of multiple stakeholders including municipal, state and Commonwealth government entities, along with local communities, the private sector and voluntary organisations. Managing the relationship and interface between these numerous and often diverse groups should be a key component of the DWM Plan.

For the DWM Plan to be operationalised, it is essential to have a good understanding of the organisational structure within which it will sit, who will be responsible for developing and implementing the plan, and the roles of, and relationships with, other key actors.

The responsibilities of the key government actors are outlined in the following sectors.

Commonwealth government

The Australian Constitution states that each of the States and Territories is responsible for the protection of its citizens. The Australian Government has a role to assist where a State or Territory is unable to meet a need or seeks assistance, but the primary role lies with the respective States/Territories.

Therefore, disaster response in general, and disaster waste management specifically, is the responsibility of the Government of South Australia. In support of the state, the Australian Government is committed to developing national and state emergency management capabilities and to assist the States in their disaster response initiatives.

Emergency Management Australia (EMA) is the Australian Federal Government agency tasked with coordinating governmental responses to emergency events. EMA currently sits within the Federal Attorney General's Department.

Further, in recognition of the significant cost of natural disasters, the Australian Government established the Natural Disaster Relief and Recovery Arrangements (NDRRA) to alleviate the financial burden on the states and to facilitate the early provision of assistance to disaster affected communities.

Through the NDRRA, the Australian Government provides financial assistance directly to the states to assist them with costs associated with certain disaster relief and recovery assistance measures. The Commonwealth government provides financial assistance up to 75 per cent to the states in respect of eligible expenditure on relief and recovery assistance.

State government

In compliance with the Australian constitution, all emergency management arrangements in South Australia are governed by the Emergency Management Act, 2004 (the Act).

The Act establishes the State Emergency Management Committee (SEMC) which is responsible for the preparation and on-going review of the State Emergency Management Plan (SEMP) which outlines responsibilities, authorities and the mechanisms to prevent, or if they occur manage, and recover from, emergencies and disasters within South Australia. Therefore, the disaster waste management plan must be developed and implemented through the structure of the SEMP.

The SEMP relies on strong cooperative, coordinated and consultative relationships among State Government agencies and Local Government who are also required to maintain effective relationships with other service and equipment owners and operators to ensure that an efficient and coordinated response can be made to any emergency or disaster.

Per the SEMP, a State Emergency Centre (SEC) is established to coordinate the State's response. The role of the SEC is to meet the information needs of the State Coordinator and facilitate with other agencies through the Functional Services which are a group of agencies that perform roles that support response and recovery activities during an emergency.

Transport Functional Service is responsible for movement of earth fill and debris. The Engineering Functional Service will provide engineering support when the control agency or functional service capability has been exhausted or as requested.

One potential option is to integrate responsibilities for disaster waste management into SA's emergency management framework via the development of a Disaster Waste Management Support Plan under the State Emergency Management Plan. Consideration could then be given to whether a further stage of zone-level DWM planning is required or of benefit.

Other Government Assistance

Both state and local governments should consider entering into mutual aid agreements with other state and local governments prior to any disaster.

Such an agreement could provide for either binding commitments or nonbinding intentions of support by state and local governments to assist one another in the event of a disaster. Through these agreements, communities can loan equipment and personnel with specific expertise or experience.

Box 6.14 Mutual Aid Agreements

The Southern Regional Emergency Management Assistance Compact is an example of a mutual aid agreement originally signed by 17 states of the USA, Puerto Rico, and the Virgin Islands. The resolution supporting this pact now has been offered to all states throughout the USA and includes model legislation for state legislatures. The compact also contains broad language and a legal framework addressing authority, liability, licensing, reimbursement, injury or death benefits, and use of the US National Guard.

CHAPTER 7

Key findings & recommendations

7.1 Key findings

Status of disaster waste management in SA

South Australia has experienced a number of severe weather events and fires in recent years that have destroyed properties and generated thousands of tonnes of debris. The extent of damage from these past disaster events has been relatively small compared to some disasters experienced elsewhere.

A review of SA's disaster waste management practices across 3 past events found that:

- There is no set framework for managing disaster waste in SA.
- To date, little pre-planning for disaster waste management has been undertaken. Rather disaster waste management practices have been largely reactive.
- The responsibility for managing waste volumes remains that of the landowner, which is not always clear-cut (for example, when private items e.g. trees or trampolines are transported onto public land).
- Local councils have played a key role in disaster waste management, including:
    - Collecting and disposing/recycling large quantities of waste generated on public land (e.g. fallen trees).
    - Providing extra support to their residents including: information on waste disposal options; additional waste collection services; and (in one case) fully funding and collecting disaster waste from affected households.
- A number of other organisations and individuals (government, private and not-for-profit) have also provided waste management assistance to affected communities through undertaking various activities, e.g. such as clearing debris from roads.
- Whilst waste management has been carried out effectively through the joint efforts of these organisations/individuals, these activities have not been centrally coordinated.
- Several challenges have arisen for management of disaster waste, which have been dealt with by stakeholders as they arose.
- The destination of waste volumes, including recycling and cost outcomes, has varied across events, which have been shaped by:
    - Time urgency to remove debris
    - On-hand information about waste disposal options
    - Availability of local waste facilities/arrangements/services at time of disaster
    - Community demands/expectations

SA's waste management responses and systems haven't yet been tested to handle millions of tonnes of debris from a single disaster event, such as the volume produced by the 2011 Christchurch Earthquake. Should SA face a major disaster event, it is expected that greater challenges would arise requiring greater pre-planning, more centralised management and coordination of activities, and additional resourcing.

Disaster waste types and volumes

The main types of waste generated by natural disasters are:

- Building materials from damaged building structures, roads and other infrastructure. These structures can include masonry materials, steel and timber and can include asbestos-containing materials.
- Building contents, including hard waste (such as carpets, furniture, clothing, other personal items), whitegoods, electronic and electrical waste.
- Vegetative debris, such as fallen trees, and
- Soil and sediment

Other wastes generated by disasters, but generally smaller in volume, include putrescible wastes, vehicle bodies, and other hazardous wastes (such as household chemicals, paint, farm and industry chemicals).

Asbestos needs special consideration given it is hazardous and prevalent in many building structures across SA. Other challenging waste streams include CCA-treated posts, which are common across farming areas.

Additional volumes of disaster waste may be generated post-event, including spoilt food due to power outages, and greater volumes of waste across hospitals and relief centres.

Disaster debris metrics and a calculator tool have been developed for this project, which can be used to estimate order-of-magnitude waste volumes. These were used to estimate disaster debris volumes for select disaster types and scenarios in SA (refer Table 7.1.).

An estimated 9 million tonnes of debris would be generated by a 1 in 10,000 year earthquake in Metropolitan Adelaide. This is close to twice the annual volume of total waste generated across the whole state (Zero Waste SA, 2014). Without undertaking contingency planning for disaster waste management, the volumes of waste produced by this event would overwhelm waste management infrastructure.

***Table 7.1.**: Summary of debris volume estimates for select disaster types and scenarios in SA*

Disaster type	Scenario	Estimated volume of debris (tonnes)
Bushfire	300 ARI Bushfire in Adelaide Mount Lofty Ranges	1,220,000
Earthquake	10,000 ARI Earthquake in Metropolitan Adelaide	8,800,000
	1,000 ARI Earthquake in Metropolitan Adelaide	670,000
Flood	100 ARI flooding of the Brownhill and Keswick Creek	25,000
Severe Storm	1,000 ARI Severe Storm in Metropolitan Adelaide	290,000
	70 ARI Severe Storm in Metropolitan Adelaide	40,000

Skills, administration and equipment needs

Skills, administration and equipment are needed across the following disaster waste management activities:

- Strategic management and coordination of overall disaster waste management response, including waste identification and characterisation.
- Communications with the public and other stakeholders on waste management issues.
- Collection and transport of waste.
- Operation of temporary waste storage facilities.
- Operation of facilities for processing, recycling and disposal of waste.
- Collection of post-disaster waste, including collection from relief centres, and resuming standard waste collections to households and businesses following the disaster.

The strategic management and coordination of the overall waste management response may be undertaken by a government agency/department or an appointed private actor.

Panels of pre-approved suppliers can be established for disaster waste management activities. The benefits pre-approved panels include:

- Identifying contractors that are suitably skilled, licensed, and willing to undertake disaster waste management activities
- Building capacity within South Australia for managing disaster wastes through requiring that pre-approved contractors undertake specialised training modules for disaster waste, and keep their personnel up-to-date with training.
- Reducing the response time for mobilising resources following a disaster, and reduce associated risks to health, safety and the environment.
- Assisting with determining response costs and budgets and the identification and “benchmarking” of potential funding sources.

Sites and facilities for storage & transfer of disaster waste

Temporary debris storage sites can be established following a disaster to manage waste volumes. These sites provide an area where the waste can be aggregated and possibly segregated before a decision is made about where the material will be sent for disposal or recycling. The following factors should be considered when selecting the suitability of a site for temporary storage of waste:

- Planning approvals
- Environment impacts
- Proximity to disaster affected area, and transport networks
- Storage capacity
- Business model
- Site security, and
- Access to facilities (e.g. electricity, water)

Transfer stations can potentially be used (along with temporary storage sites) to receive, sort and aggregate disaster wastes prior to being sent to a disposal or recycling facilities.

Sites and facilities for disposal/recycling of disaster waste

The main types of facilities likely to handle disaster waste volumes in SA include:

- Landfills
- Landfills that are specifically licenced to receive asbestos
- Construction and demolition recyclers
- Waste-to-energy facilities
- Organics processing facilities
- Metals recyclers

There are 30 major waste or recycling facilities in SA across these categories. Information about SA facility locations, waste streams received, operating hours, and capacities is provided in a database that was developed for this project.

A number of factors should be considered when selecting a recycling or disposal option for disaster waste, including; the nature of the waste stream, laws and regulations, local waste industry capabilities, waste facility locations and costs. A range of social and economic factors should also be considered, including; impact of debris management on the speed of recovery, employment and outcomes for health, safety and the environment. These decisions sometimes involve trade-offs. For example, the decision to recycle waste may lead to improved environmental and employment outcomes, but at the cost of a longer recovery period. Decision makers need to weigh-up the relative advantages and disadvantages of available options for the disposal/recycling of disaster waste, taking into account these considerations.

Regulatory framework

A high-level review was undertaken of SA's regulatory framework for disaster waste management. South Australia has a strong regulatory framework for waste management and resource recovery. SA's regulations and policies can help facilitate improved outcomes for disaster waste management through:

- Requiring individuals and organisations to take measures to prevent, minimise or eliminate harm to people and the environment.
- Penalising inappropriate and/or illegal behaviours (e.g. illegal dumping of waste, unsafe handling of hazardous wastes).
- Achieving policy objectives, such as reducing waste to landfill.

On the other hand, potential challenges may arise for disaster waste management under the current regulatory framework including:

- Increased cost of debris management due to resource recovery requirements and waste levy (unless this is waived).
- Slowing down the speed of recovery due to time involved with getting development approvals and licensing to establish new facilities, and/or change approved activities at existing facilities

to process and dispose or recycle volumes of disaster wastes. Timely approval processes will be important in the event of a major disaster.

- These potential impacts were discussed with the SA EPA. It was found that the SA EPA has powers to respond to waste management needs following a disaster. This includes:
    - The ability to grant exemptions (in cases when a licensee is unable to comply with the Act)
    - Emergency powers
- Collaborative planning between the SA EPA, Office of Green Industries SA, DPTI, local councils and the waste industry is needed to identify potential sites/facilities to manage disaster waste. Specifying the types of disaster waste that may be received at a given site, and planning for how the disaster waste would be managed, may reduce the amount of time taken to obtain an emergency authorisation following a disaster.

An uncertainty was identified for disaster waste management, i.e. EPA licenses are not required for transport of construction and demolition waste (which is a key disaster waste stream) or if waste is not transported for fee or reward.

Without active regulation, operators may not be as aware of the risks to human health and the environment involved with transporting and storing of waste, or of their obligations under the law. Passive regulation through guidance and advice may mean there is greater potential for harm to the environment and human health to occur from these activities if ill-informed or rogue operators are present. It may be difficult to enforce regulations with a potentially large number of unlicensed operators undertaking these disaster waste management activities.

7.2 Recommendations and next steps

A number of recommendations are provided for further stages of contingency planning for disaster waste management. These include:

- Integrate responsibilities for disaster waste management into SA's emergency management arrangements via the development of a Disaster Waste Management Support Plan under the State Emergency Management Plan. Consideration should then be given to whether a further stage of Zone-level planning is required or of benefit.
- Identify funding and payment mechanisms for disaster waste management
- Assign roles and responsibilities for strategic management of disaster waste management activities
- Develop State guidelines for debris removal and management
- Establish and maintain panels of pre-approved suppliers, including provision of training
- Further develop SA debris metrics and calculator tool
- Develop register of tools and resources that may be used for disaster waste management

These actions/projects have been classified by priority level (high or medium), with further descriptions are provided in Tables 7.2 and 7.3.

***Table 7.2**: High-priority actions/projects for disaster waste management contingency planning*

Action/project	Description
Integrate responsibilities for disaster waste management into SA's emergency management arrangements via the development of a Disaster Waste Management Support Plan under the State Emergency Management Plan.	▪ Identify how disaster waste management can best fit within SA's emergency management framework. ▪ Formally integrate it by updating the State Emergency Management Plan to reflect the new responsibilities, and developing a Support Plan for disaster waste management ▪ Consideration should then also be given to if a further stage of zone-level planning is required or of benefit. Should zone-level plans be developed these may: o Identify likely waste types and volumes based on local disaster types and scenarios o Identify local resources for disaster waste management including assigning roles and responsibilities o Identify local waste and recycling facilities for disaster waste, their capacities (including for temporary storage, disposal and recycling). ▪ An option is to test the state-wide Support Plan for a given Emergency Management Zone to assess its effectiveness and subsequently update the Support Plan if and where required.
Identify funding and payment mechanisms for disaster waste management	This would involve: ▪ Review funding mechanisms for disaster waste management (which may vary according to the scale of the disaster) ▪ Identify mechanisms for payment of contractors that undertake disaster waste management activities (such as waste handling and removal, transport, disposal, recycling, etc.)
Assign roles and responsibilities for strategic management of disaster waste management activities	▪ Identify and assign a team of personnel that are suitably qualified/skilled to undertake strategic management and coordination of disaster waste activities.
Develop State guidelines for debris collection and management	▪ Work with stakeholders to develop State guidelines for management of disaster wastes, including for: o Handling of disaster wastes (including hazardous waste such as CCA-treated posts, asbestos) o Managing for the potential of human remains. o On-site processing and sorting of disaster waste (e.g. concrete crushing) o Transport of waste (e.g. tracking, loading and transport procedures) o Establishment and operation of temporary disposal facilities o Waste facility management, monitoring and reporting o Closure of disaster waste management sites

Table 7.3: *Medium-priority actions/projects for disaster waste management contingency planning*

Action/project	Description

Establish and maintain panels of pre-approved suppliers	▪ Work with stakeholders to develop panels of pre-approved suppliers for:
	  ○ Disaster waste removal and transport
	  ○ Waste facility contractors
	  ○ Disaster waste management experts and consultants
	▪ The above would involve development of a technical specification and response schedules, evaluating responses and selecting successful applicants
	▪ The panels could be used as a platform to build capacity within SA for disaster waste management. For example, training could be delivered to panel members on guidelines for debris removal and management.

Further develop SA debris metrics and calculator tool	This would include: ▪ Undertake further work to develop SA debris metrics ▪ Further refinement of debris volume estimator tool in collaboration with other stakeholders (e.g. other potential users)
Develop register of tools and resources that may be used for disaster waste management	▪ Review potential tools and resources available for disaster waste management (e.g. may include LGA app) ▪ Develop a list of available tools and resources for disaster waste management activities

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APPENDIX 1: SA disaster debris estimation calculator

Appendix 1 (SA disaster debris calculator) is provided as a confidential attachment to the Office of Green Industries SA. This tool provides order-of-magnitude estimates of waste volumes for different types of waste, and is based on South Australian disaster debris metrics that were developed in this study. Whilst the calculator is not suitable for publication, it is intended it be further developed and refined into a more advanced tool that can used by stakeholders across SA (and potentially Australia) to estimate disaster debris volumes.

APPENDIX 2: SA waste/recycling facilities database

Please see Attachment for Appendix 2. This dataset identify key sites and facilities across South Australia which may be able to receive and dispose of disaster wastes (e.g. debris from an earthquake, bushfire, severe storm or flood). It includes the following information:

- Facility name
- Address
- GPS coordinates
- EPA license number
- Waste streams accepted
- Disposal type (recycling, energy recovery, treatment of landfill)

Facility lists can be filtered by data fields such as suburb, waste stream accepted, and disposal type.

A confidential version of this database (not available for public release) has also been provided to the Office of Green Industries SA containing further information on facility throughputs, capacities, operating hours and other information.

APPENDIX 3: List of closed landfills in SA

EPA #	Organisation	Address
226	Corporation of the City of Adelaide	Wingfield Road
232	Corporation of the City of Mitcham	Colebrook Drive
236	Corporation of the City of Port Augusta	Western Plains Road
239	Corporation of the City of Prospect	Allotment 51, Kidman Road
250	District Council of Copper Coast	Section 2916, Alford Road
289	Berri Barmera Council	Section 200, Hundred of Loveday
292	Berri Barmera Council	Sections 534, 718 and 719, Henwood Road
294	District Council of Loxton Waikerie	Section 92, Hundred of Kekwick
295	Regional Council of Goyder	Site Adjacent to Section 885, Hundred Ayers
296	District Council of Barunga West	Part Section 660, North Terrace
297	District Council of Orroroo Carrieton	Section 324, Belton Road
303	Port Pirie Regional Council	Section 337, Bowman Road
305	Adelaide Hills Council	Allotments 1 & 2, Ridge Road
311	Northern Areas Council	Section 421, Hundred of Tarcowie, Government Road
317	Kingston District Council	Allotment 4, Rubbish Dump Road
321	District Council of Lower Eyre Peninsula	Allotment 11, Harder Street
333	District Council of Mount Remarkable	Section 631, Hundred of Appila
336	District Council of Copper Coast	Section 686, Hundred of Kadina
337	Adelaide Hills Council	Harrison Road
344	Port Pirie Regional Council	Lot 10, Hundred of Napperby
347	District Council of Grant	Pieces 4-8 (FP 194932), Hundred Kongorong
349	District Council of Robe	Sections 32 and 33, Evans Cave Road
351	Northern Areas Council	Section 360, Dump Road
363	District Council of Yankalilla	Road Reserve, Adjacent Allotment 174 F164893, James Track
364	District Council of Yorke Peninsula	Sections 133, 432 & 440, Kooraka Road
694	Clare & Gilbert Valleys Council	Allotment 2, Government Road
985	The Rural City of Murray Bridge	Section 815, Hundred of Brinkley
1702	Light Regional Council	Section 16, Haydon Road
1935	Mid Murray Council	Section 165, By-Pass Road
1951	The City of Salisbury	Coleman Road
1956	District Council of Loxton Waikerie	Section 977, Murdko Road
1992	District Council of Cleve	Section 386, Kimba Road
1993	District Council of Cleve	Section 91, Cowell-Lock Road
1997	District Council of Cleve	Section 57, Reservoir Road
2000	District Council of Tumby Bay	Section 101, Hundred of Dixson
2004	District Council of Loxton Waikerie	Section 95-96, Hundred of Allen
2005	District Council of Loxton Waikerie	Section 130, Nance Road, Hundred of McGorrery
2016	Regional Council of Goyder	Sections 7, 8 & 142, Hundred of Hanson
2019	Northern Areas Council	Part Section 328, Main North Road
2020	Northern Areas Council	Allotment 560, Ameys Road
2022	Northern Areas Council	Between Sections 92 & 392, Hundred Bundaleer
2024	District Council of Peterborough	Section 467, South Terrace

2025	District Council of Barunga West	Section 509, Adelaide Road
2027	Regional Council of Goyder	Part Section 449, Hundred of Terowie, Government Road
2037	District Council of Elliston	Section 31, Murdinga-Murlong Road
2039	District Council of Elliston	Section 44, Flinders Highway
2054	Regional Council of Goyder	Section 296, Hundred of Apoinga and Section 18, Hundred of Bright
2070	District Council of Mount Remarkable	Adjacent Piece 93 (FP204383), Hundred of Coonatto
2079	Renmark Paringa Council	Part Section 89, Gurra Road, Hundred of Paringa
2080	Wudinna District Council	Section 13, Hundred of Wannamana
2083	District Council of Lower Eyre Peninsula	Allotment 1 (D19068), Flinders Highway
2084	District Council of Lower Eyre Peninsula	Allotment 161, South Terrace
2085	District Council of Lower Eyre Peninsula	Sections 66,67,77 & 91, Shepperd Road
2094	District Council of Mount Remarkable	Lot 768 (FP184850), Hundred of Booleroo
2096	District Council of Mount Remarkable	Adjacent Section 17, Hundred of Wongyarra
2097	District Council of Mount Remarkable	Adjacent to Section 84, Hundred of Wongyarra
2099	District Council of Mount Remarkable	Section 189, Hundred of Willowie
2100	District Council of Mount Remarkable	Section 626, Hundred of Willochra
2101	District Council of Mount Remarkable	Section 265, Hundred of Appila
2103	The Rural City of Murray Bridge	Lot 891 Section 330, Rocky Gully Road
2106	District Council of Streaky Bay	Section 68, Hundred Walpuppie
2110	District Council of Streaky Bay	Section 48, Franceys Road, Hundred Karcultaby
2111	District Council of Streaky Bay	Section 82, East Terrace, Hundred of Haslam
2113	The Rural City of Murray Bridge	Section 424, Hundred of Burdett
2115	The Rural City of Murray Bridge	Section 734, Hundred of Mobilong
2144	Corporation of the City of Mitcham	Beagle Terrace
2162	Berri Barmera Council	Section 857, Chapple Road
2164	Santos Limited	Port Bonython Road
2169	District Council of Streaky Bay	Section 219, Hundred of Wrenfordsley
2465	Port Pirie Regional Council	Sections 368, 369, 370, Hundred of Koolunga, Fifth Street
2466	Port Pirie Regional Council	Section 828, Redhill Terrace
2522	District Council of Yorke Peninsula	Section 280 Hundred of Wauraltee, Bray Road
2982	SA Recycling Centre Pty Ltd	144-150 Wingfield Road
13616	Wattle Range Council	Mount Burr Road
13787	The Barossa Council	Lot 101, Warburton Road
14252	City Of Onkaparinga	Allotment 3, Jackson Road
15145	Highbury Landfill Authority	Torrens Road
15362	MSP Property Holdings Pty Ltd	Smart Road
20064	Northern Areas Council	Allotment 6 (FP 5377), Springbank Road
23782	Resourceco Pty Ltd	Piece 50, Meyer Road

APPENDIX 4: List of potential suppliers

Table A4.1: provides a list of suppliers that could potential undertake disaster waste management activities in SA.

***Table A4.1**: Potential suppliers for disaster waste management*

Function	Role	Supplier Description	Potential suppliers
Strategic management & coordination	Disaster Waste Task Force to strategically manage and coordinate disaster waste management activities	Suitably qualified/skill staff from a government department/agency	To be determined
	Consultants to provide expertise and advice to Disaster Waste Task Force as needed (e.g. advice on management of hazardous waste streams)	Disaster and local waste experts and consultants	Rawtec Resilient Organisations (NZ overseas) Resources & Waste Advisory Group (UK overseas) Mike Haywood SRS
	Contracted labour to provide operational support to Disaster Waste Task Force (e.g. monitoring operation of sites, coordinating demolition contractors)	Major Engineering Firms, Auditors and other private contractor(s)	Arup Adelaide Environmental Controls Coffey Environmental GHD Grocon MUD Environmental Tonkins Consulting
Communications	Communications team to implement the communications strategy	Suitably qualified/skill staff from a government department/agency	To be determined
	Contracted labour to support roll out of communications strategy	A private contractor(s) specialising in public communications (e.g. contracted call centres)	Contact Centres Australia

Function	Role	Supplier Description	Potential suppliers
Waste collection and transport	Contracted labour to collect and transport disaster waste to suitable interim storage and end disposal/recycling facilities	Construction and demolition waste transporters	A&V Contractors AC Demolition Adelaide House Demolition D&V services DPC Demolition & Salvage G&F Silvestri Southern Demolition & Asbestos Removal McMahon Services Adelaide Asbestos Removal Specialists Gambier Earthmovers Old Red Brick Company Deconstruct Royal Park Salvage SA Demolitions Seuz Environnement (Sita) Transpacific Veolia
Operation of temporary waste storage facilities	Council or contracted labour to manage and operate temporary waste storage facilities	Suitably skilled/qualified staff from local councils	To be determined
		A private contractor that specialises in waste storage and management	Adelaide Resource Recovery Integrated Waste Services ResourceCo SITA Transpacific Veolia
Operation of waste and recycling facilities	Council or contractors to receive and recycle/dispose of disaster waste	A private contractor that operates suitable facilities	Refer to facility list in separate Database in Appendix 2
Post-disaster waste collection	Council or contractors to resume collection of domestic waste from occupied homes and businesses	Councils and/or municipal and commercial waste collection contractors	Local councils Solo Transpacific Seuz (Sita) Veolia East Waste

APPENDIX 5: Disaster debris estimates for scenarios modelled

Introduction

This appendix provides further detail on estimated volumes of disaster debris generated by different scenarios in SA. This includes modelling and assumptions underpinning these estimates.

300 ARI bushfire in Adelaide Mount Lofty Ranges

Table A5.1 below provides estimates of disaster debris for a 300 ARI bushfire in the Adelaide Mount Lofty Ranges. The region is 3,227 sq. km and has an estimated 116,953 dwellings.

No modelling has been undertaken to date on the extent of damage from this scenario (in terms of number of properties affected and area burnt). In absence of this modelling, assumptions have been made on the extent of damage caused by a bushfire of this magnitude.

Medium, small and large scenarios for bushfire debris volumes are based on the following set of assumptions

- Medium scenario
  - 4,700 buildings are destroyed (or 4% of total dwellings in region)
  - 1,775 sq. km is burnt (or 55% of total region)
- Small scenario
  - 2,300 buildings are destroyed (or 2% of total dwellings in the region)
  - 1,129 sq. km is burnt (or 35% of total region)
- Large scenario
  - 9,400 buildings are destroyed (or 8% of buildings in the region)
  - 2,098 sq. km is burnt (or 65% of total region)

***Table A5.1**: Estimated volumes of disaster debris from 300 ARI bushfire in Adelaide Mount Lofty Ranges.*

	Medium scenario		Small Scenario		Large Scenario	
	tonnes	m3	tonnes	m3	tonnes	m3
Masonry	733,200	917,000	366,600	458,000	1,466,000	1,833,000
Metals	6,000	14,000	2,810	7,000	11,000	28,000
Vegetative waste	452,284	1,005,000	287,678	639,000	535,000	1,189,000
Hard waste	28,400	114,000	14,200	57,000	57,000	228,000
Whitegoods	500	1,200	230	600	900	2,000
E-waste	400	1,000	200	500	800	2,000
Soil and sediment	-	-	-	-	-	-
Vehicle bodies	300	750	150	380	600	2,000
Total	**1,221,000**	**2,053,000**	**670,000**	**1,162,000**	**2,071,000**	**3,284,000**

Earthquake scenarios for Metropolitan Adelaide

Tables A5.3 and A5.4 provide estimates of disaster debris for a 10,000 ARI earthquake and 1,000 ARI earthquake in Metropolitan Adelaide, respectively. The amount of waste generated by an earthquake is dependent on the number of buildings in the affected area, their susceptibility to damage (linked to building age), and the intensity of ground shaking caused by the earthquake.

Modelling of these earthquake scenarios (of ground shaking intensities across Metropolitan Adelaide) has been undertaken by Geoscience Australia. Based on this modelling and NEXIS data, the project team estimates that 440,700 low-rise buildings are in the earthquake-affected area across Adelaide, including 260,000 constructed pre-1980, and 180,000 constructed post-1980.

Buildings constructed prior to 1980 are more susceptible to damage from an earthquake. Table A5.2 below provides estimates of the % of buildings damaged by building age for different levels of earthquake ground shaking intensities, based on information provided by DPTI.

***Table A5.2**: Estimated % of buildings damaged by building age for different earthquake ground shaking intensities. Source: DPTI*

	Pre-1980	Post- 1980
V	2%	1%
VI	6%	2%
VII	15%	5%
VIII	30%	10%

These factors were used to estimate the number of low-rise buildings in Metropolitan Adelaide that would be damaged under each earthquake scenario.

In addition, for a 10,000 ARI earthquake it was estimated that:

- 30% of floor area across high-rise buildings in the Adelaide CBD would be damaged
- 2,000,000 tonnes of public infrastructure would be damaged

For the 1,000 ARI earthquake it was assumed that the amount of damage to high-rise buildings and public infrastructure would be one thirtieth of that generated by the 10,000 ARI earthquake.

Medium, small and large scenarios for earthquake debris volumes are based on the following set of assumptions:

- Medium scenario - 50% of materials from earthquake-damaged buildings and infrastructure would become part of the waste stream
- Small scenario - 30% of materials from earthquake-damaged buildings and infrastructure would become part of the waste stream

- Large scenario- 100% of materials from earthquake-damaged buildings and infrastructure would become part of the waste stream

***Table A5.3**: Estimated volumes of disaster debris from 10,000 ARI earthquake in Metropolitan Adelaide.*

	Medium scenario		**Small Scenario**		**Large Scenario**	
	tonnes	m3	tonnes	m3	tonnes	m3
Masonry	8,195,000	10,240,000	5,701,000	7,126,000	14,430,000	18,040,000
Metals	81,000	202,000	64,000	160,000	122,000	310,000
Vegetative waste	15,000	34,000	15,000	33,000	15,000	33,000
Hard waste	467,000	1,870,000	280,000	1,120,000	935,000	3,740,000
Whitegoods	7,000	17,000	4,000	10,000	13,000	33,000
E-waste	6,000	16,000	4,000	10,000	13,000	33,000
Soil and sediment	-	-	-	-	-	-
Vehicle bodies	5,000	13,000	5,000	12,500	5,400	14,000
Total	**8,800,000**	**12,400,000**	**6,100,000**	**8,470,000**	**15,500,000**	**22,200,000**

***Table A5.4:** Estimated volumes of disaster debris from 1,000 ARI earthquake in Metropolitan Adelaide.*

	Medium scenario		**Small Scenario**		**Large Scenario**	
	tonnes	m3	tonnes	m3	tonnes	m3
Masonry	618,000	772,000	397,000	496,000	1,170,000	1,463,000
Metals	5,300	13,300	3,700	9,000	9,000	23,000
Vegetative waste	500	1,000	10,000	22,000	500	1,000
Hard waste	42,000	169,000	25,000	100,000	85,000	340,000
Whitegoods	700	1,650	400	1,000	1,300	3,000
E-waste	600	1,500	350	900	1,200	3,000
Soil and sediment	-	-	-	-	-	-
Vehicle bodies	500	1,330	500	1,250	500	1,000
Total	**670,000**	**960,000**	**440,000**	**630,000**	**1,270,000**	**1,830,000**

100 ARI flooding of the Brownhill Keswick Creek

Table A5.5 provides estimates of disaster debris for a 100 ARI flooding of the Brownhill Keswick Creek.

Modelling has been undertaken by Worley Parsons on the number of properties affected by the flooding, which includes:

- 1,163 properties with over-floor flooding
- 914 properties with under-floor flooding

Medium, small and large scenarios for flood debris volumes are based on the following set of assumptions:

- Medium scenario - 100% of properties with over-floor flooding will incur damage.
- Small scenario – 80% of properties with over-floor flooding will incur damage.
- Large scenario – 100% of properties with over-floor flooding, and 50% of properties with under-floor flooding will incur damage.

Of the properties damaged, it was assumed that 100% of building contents and 5% of building structures would be damaged and become part of the disaster waste stream.

Table A5.5: *Estimated volumes of disaster debris from 100 ARI flooding of the Brownhill Keswick Creek*

	Medium scenario		**Small Scenario**		**Large Scenario**	
	tonnes	m3	tonnes	m3	tonnes	m3
Masonry	9,300	12,000	4,700	6,000	13,000	16,000
Metals	70	200	30	-	100	-
Vegetative waste	-	-	-	-	-	-
Hard waste	12,500	50,000	6,300	25,000	17,400	70,000
Whitegoods	700	1,750	400	1,000	970	2,000
E-waste	200	480	100	300	300	1,000
Soil and sediment	2,300	2,400	1,100	1,200	3,200	3,000
Vehicle bodies	5	10	-	-	10	-
Total	**25,000**	**67,000**	**13,000**	**34,000**	**35,000**	**92,000**

Severe storm scenarios for Metropolitan Adelaide

Tables A5.6 and A5.7 provide estimates of disaster debris for a 1,000 ARI and 70 ARI severe storm in Metropolitan Adelaide, respectively.

No modelling has been undertaken to date on the extent of damage from these scenarios (in terms of the area and number of properties affected). In absence of this modelling, assumptions have been made on the storm-affected area, and the extent of damage for these scenarios.

It has been assumed that two northern council areas (Salisbury and Playford) would be affected by a severe storm in Metropolitan Adelaide. These councils together have nearly 80,000 properties (source: NEXIS) and cover an area of 504 square kilometres.

For a 1,000 ARI severe storm, the following set of assumptions regarding the extent of damage were used to estimate medium, low and high scenarios for storm debris volumes:

- Medium scenario
    - 7,700 buildings are damaged (or 10% of total buildings across the council areas)
    - 76 sq. km is affected by the storm (or 15% of the council areas)
- Small scenario
    - 6,160 buildings are damaged (or 8% of total buildings across the council areas)
    - 25 sq. km is affected by the storm (or 5% of the council areas)
- Large scenario
    - 9,200 buildings are damaged (or 12% of total buildings across the council areas)
    - 151 sq. km is affected by the storm (or 30% of the council areas)

For a 70 ARI severe storm, the following set of assumptions regarding the extent of damage were used to estimate medium, low and high scenarios for storm debris volumes:

- Medium scenario
    - 770 buildings are damaged (or 1% of total buildings across the council areas)
    - 38 sq. km is affected by the storm (or 8% of the council areas)
- Small scenario
    - 385 buildings are damaged (or 0.5% of total buildings across the council areas)
    - 13 sq. km is affected by the storm (or 3% of the council areas)
- Large scenario
    - 1,0 buildings are damaged (or 1.5% of total buildings across the council areas)
    - 76 sq. km is affected by the storm (or 15% of the council areas)

Of the buildings damaged, it was assumed that 20% of building contents and structures would be damaged and become part of the disaster waste stream.

Table A5.6: *Estimated volumes of disaster debris from 1,000 ARI severe storm in Metropolitan Adelaide.*

	Medium scenario		**Small Scenario**		**Large Scenario**	
	tonnes	m3	tonnes	m3	tonnes	m3
Masonry	260,000	319,000	200,000	250,000	310,000	388,000
Metals	2,000	4,600	1,000	3,000	2,000	5,000
Vegetative waste	26,000	57,000	9,000	20,000	51,000	113,000
Hard waste	5,000	18,000	6,000	24,000	8,000	32,000
Whitegoods	310	780	250	600	370	1,000
E-waste	260	650	210	500	310	1,000
Soil and sediment	-	-	-	-	-	-
Vehicle bodies	120	300	100	250	150	-
Total	**290,000**	**400,000**	**220,000**	**300,000**	**370,000**	**540,000**

Table A5.7: *Estimated volumes of disaster debris from 70 ARI severe storm in Metropolitan Adelaide.*

	Medium scenario		**Small Scenario**		**Large Scenario**	
	tonnes	m3	tonnes	m3	tonnes	m3
Masonry	24,000	30,000	12,000	15,000	36,000	45,000
Metals	200	500	100	-	300	1,000
Vegetative waste	13,000	28,000	4,300	10,000	26,000	58,000
Hard waste	2,000	8,000	1,000	4,000	3,000	12,000
Whitegoods	30	80	20	100	50	-
E-waste	30	80	10	-	40	-
Soil and sediment	-	-	-	-	-	-
Vehicle bodies	10	30	10	30	20	-
Total	**40,000**	**67,000**	**20,000**	**30,000**	**70,000**	**120,000**

APPENDIX 6: Regulatory contact list

Table A6.1 provides a list of key regulatory contacts for disaster waste management in SA.

***Table A6.1**: Key regulatory contacts for disaster waste management*

Organisation	Position	Contact
Safework SA	Principal Inspector – Scientific, Dangerous Substances Team	Mike Scrutton E: michael.scrutton@sa.gov.au P: (08) 8226 4465
Safework SA	Chief Officer, Dangerous Substances Team	Ewa Jaruzelski E: jaruzelski.ewa@dpc.sa.gov.au P: (08) 8226 4785
SA EPA	Manager Waste Reform	Steven Sergi E: Steven.Sergi@epa.sa.gov.au P: (08) 8204 2038
SA EPA	Manager, Licensing and Regulatory Services	Kelvin Vogelsang E: Kelvin.Vogelsang@epa.sa.gov.au P: (08) 8204 9119
SA EPA	Team leader and Emergency Response Team Coordinator, Investigation & Tactical Support Branch	Kevin Rowley E: Kevin.Rowley@epa.sa.gov.au P: (08) 8204 1986

APPENDIX 7: Table of Contents for DWM Plan

Chapter 1 Objectives of the DWM Plan

Chapter 2 DWM responsibility framework

Chapter 3 DWM funding and payment mechanisms

Chapter 4 Applicable regulations

Chapter 5 Types and estimated volumes of disaster debris volumes for local disaster scenarios

Chapter 6 DWM functions, roles and responsibilities across response and recovery phases

Chapter 7 Pre-selected disaster waste management temporary storage sites

Chapter 8 Pre-identified DWM waste disposal/recycling options, and storage/processing capacities of existing infrastructure

Chapter 9 Additional staff and equipment resourcing needs

Chapter 10 Potential disaster waste management suppliers

Chapter 11 Considerations for operation and final closure of DWM sites

Chapter 12 DWM Communications Plan

Appendix 1 State guidelines for collection and management of disaster debris:

- Disaster debris and rubble prevention measures
- Identification and management of hazardous wastes
- Managing for the potential of human remains
- Selection of disposal/recycling options
- On-site processing and sorting of disaster waste (e.g. concrete crushing)
- Transport of waste (e.g. tracking, loading and transport procedures)
- Establishment and operation of temporary storage sites
- Waste facility management, monitoring and reporting
- Closure of disaster waste management sites

Appendix 2 Database of pre-approved suppliers for disaster waste management activities

Appendix 3 Database of potential DWM sites and facilities