



FIRE SERVICES
COMMISSIONER
VICTORIA

TOWARDS IMPROVED FIRE MANAGEMENT IN LANDFILL SITES

A review by I.R.S Services
July 2012

LEADERSHIP
INTEGRATION
ACCOUNTABILITY

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Introduction

This review has been conducted at the request of the Fire Services Commissioner in an effort to determine if the experiences at three significant landfill fires that occurred during January 2012 can help identify common features / issues that can be further considered to guide and inform future facility design, waste management practices and fire service procedures and practices.

Each year CFA and MFESB attend several fires at licensed landfill and transfer station sites. The nature of these fires varies from small surface fires to extensive and deep seated 'ground' fires. The characteristics of suppression efforts for fires at landfill sites are that they require large amounts of water, are usually difficult to extinguish and require resources to be committed for extensive periods.

Fires at these facilities take two main forms - surface fires or deep seated ground fires.

- The former are the most common and usually the result of an introduced source of ignition at or near the surface of the deposited waste.
- The latter generally occur due to decomposition of waste, the production of flammable gases and elevated temperatures deep within the deposited waste leading to self supported ignition.

Fire is identified as a risk factor associated with waste management and in particular at landfill sites¹. Significant changes have been made over the past two decades to treat this risk. They include a reduction in the number of landfill sites, more emphasis on recycling and the regular coverage of waste with inert material. Regardless of these changes fires in landfills are still events that are generally difficult to extinguish and invariably become resource intensive.

It is therefore appropriate to review current guidelines and practices in order to try and identify further changes and improvements that can be made to reduce the number of fires and the severity of any fire that does eventuate.

It is also desirable to review the activities of fire services associated with fires in landfills in order to inform the development of best practice fire management guidelines.

This review has found that there are opportunities for changes to be made by waste managers and by fire services. It has also identified issues that may require changes to legislation and license conditions relating to landfills.

¹ See Appendix 2 **SITING, DESIGN, OPERATION AND REHABILITATION OF LANDFILLS**

Terms of Reference

Using the landfill fires that occurred at Brooklyn, Knox and Werribee, the review shall

- examine the layout, design features and installed equipment at each premises,
- seek input from personnel that were present at the events about the effectiveness of suppression methods used, and
- examine available literature, legislation, and existing guidelines.

The output required is a report that records observations of the current situation, identifies possible changes that could be made to address perceived weaknesses or shortcomings and informs and guides the decisions and practices of fire agencies and regulators as they consider how to improve the management of the risk of fire in landfills.

Historical Perspective

Prior to the establishment of the Environment Protection Authority (EPA) in 1970 the presence of smoke at a rubbish tip, particularly smaller, isolated ones was considered almost normal since fire was often used as a means of reducing the volume of bulky dry wastes such as garden cuttings, builders waste, cardboard, etc prior to it being placed in the actual landfill.

In the mid 80's Victoria developed its first Industrial Waste Strategy as a consequence of increasing community concerns about occupational health and safety, the appropriate disposal of industrial waste products and pollution of the environment. This generated significant changes to regulatory controls on waste management and more restrictive design and siting guidelines for waste management facilities.

Today, waste management facilities must operate in accordance with the conditions specified in their license and adhere to a range of other Codes, Standards and Guidelines. As a consequence there has been a reduction in the number of fires attended.

This is a product of a combination of factors, including:

- There are fewer landfill sites because of the limited number of sites that fall within the approval and licensing requirements;
- More effective management of the area of exposed waste surface, improved compaction and daily coverage result from economies of scale at larger sites;
- The move to transfer station type operations facilitates greater supervision and reduces the likelihood and frequency of unwanted ignitions;
- Recyclables are deposited at separate locations within the site or are removed from waste by transfer station staff;
- Separation of materials known to cause decomposition / heating issues or that are possible ignition sources (eg. batteries).

Event Description

The three fires examined as a basis for this review are:

Brooklyn Landfill, Old Geelong Rd Brooklyn at 00:28 hrs on Monday 23rd January 2012

Knox Transfer Station at 251 George St Wantirna South at 13:11 hrs on Thursday 26th January 2012 (Australia Day)

Werribee Landfill at West Rd Werribee at 17:04 hrs on Friday 27th January 2012

A brief description, of each of these fires is set out in **Annexures A, B and C** to this report. The descriptions are supported by aerial views and images to provide a visual perspective.

The following table summarises the resource commitments for each event. The Standard Response column is included as a comparison of the usual resource requirements for initial responses to every day fire calls such as car fire, house fire, or non structure fire. **Annexure D** contains more detailed tables that contain a list of individual resources, dispatch, in station² and time committed, crewing, and fire fighter hours involved.

Table 1. Resource Commitment Summary

Site	Brooklyn Landfill	Knox Transfer Station	Werribee Landfill	Standard Response
Appliances committed	6	27	14	2 - 3
Other vehicles	3	7	6	1 - 2
Step Ups³	3	Not recorded	Not recorded	nil
Total fire fighters	25	117	66	8 - 12
Total fire fighter hours	130	443.4	219.12	
Additional support resources alerted				
Personnel who responded to station		66 35 for strike team	30	
Strike Team formed but not required		21 personnel		

No attempt has been made to quantify the additional time involved in post incident activities such as maintenance of vehicles, hose, breathing apparatus and other equipment.

²“ in station” means the time when a vehicle and crew have actually arrived back at their normal fire station

³ A “step up” occurs when an appliance and crew are relocated to a station to cover the response areas of appliances committed to a fire.

Observations

Legislation, Codes and Guidance documents.

The *Environment Protection Act 1970* establishes the Environment Protection Authority (**EPA**) as the responsible authority for waste management. There are several sets of Regulations dealing with specific aspects of environmental management that impact on the waste management industry.(see **Appendix 1**)

There are no pieces of legislation that provide for or enable the fire services to have input to the planning, siting, design and infrastructure of a landfill facility.

EPA have produced a Best Practice Environmental Management (**BPEM**) document titled ***Siting, Design, Operation and Rehabilitation of Landfills***, for the guidance of landfill operators and managers in order to achieve compliance with the conditions of their license to operate. **Section 7.9** of the document contains specific references to fires and the provision of water supplies for fire fighting. A copy of the section can be found at **Appendix 2**.

The **BPEM** document also contains extensive guidance on the placement of waste (Section 7.6) and the coverage of that waste (Section 7.7) with inert material on a regular basis. A summary of the Objectives and Required Outcomes for these sections appears at **Appendix 3**.

Briefly, these sections are directed at limiting the area of uncovered waste and the compartmenting of waste into self contained cells to limit the spread of any ground fire that may occur. It also facilitates the collection of decomposition gases from the landfill.

It was observed that waste management practices deemed necessary and appropriate for normal daily operation during the week are not adhered to on weekends and public holidays. The **BPEM** guidelines and license conditions are presumed to apply to all periods of operation of a waste management facility and contain no reference to reduced requirements for weekends or public holidays.

The following table is an extract from **Section 7.9**. It provides a quick reference to the objective and required outcomes mentioned in the section and some suggested means of measuring compliance. The use of the word 'required' to describe the outcomes suggests an expectation of compliance with a minimum standard. The reality at the sites reviewed was partial compliance at best.

See **Annexures A, B and C** for specific comments on compliance for each of the sites included in the review.

Table 2. Objective, required outcomes and suggested measures relating to management of fires in landfills

Objective: <i>To prevent landfill fires and efficiently extinguish any that should occur.</i>	
Required outcomes of the BPEM	
Maintenance of a water supply capable of being delivered to any point on the landfill.	
No fires must be lit at the landfill or near areas where wastes have been or are being deposited	
That all practical steps have been taken to prevent landfill fires	
Suggested measures of the BPEM	Observations on Compliance
Develop a fire management plan in conjunction with the relevant fire authority.	No evidence of any plans having been developed. In at least one case (Werribee) there are meetings planned to commence the process.
Remove ignition sources such as hot coals and car and marine batteries from the waste at the tipping area	Largely achieved through use of transfer station approach and segregation of recoverable and recyclable wastes
Cover combustible wastes with inert material	Significantly better than in the past however the recommended maximum exposed areas are exceeded from time to time
Construct a firebreak around the perimeter of the landfill to the satisfaction of the relevant fire authority	No evidence that fire authorities have been consulted or that they were aware of this suggested performance measure
Where reticulated water supply is not adequate for firefighting purposes or available, maintain at least 50,000 litres of water on site.	The adequacy of water supplies is debatable. All sites had a water supply of some sort but none have appropriate arrangements for delivering water "to any point on the landfill."

Two of the three fires reviewed were located in transfer stations associated with landfill operations and occurred at times when waste management arrangements were compromised by reduced staffing and accumulation of waste. This highlights the risks associated with not maintaining the normal waste management regime during all periods of operation and suggests a need for inclusion in licensing documents of more definitive minimum requirements for any period when a facility is operating.

The landfill industry involves the operation of high value machinery powered by internal combustion engines. These machines are in close contact with what is essentially flammable material. Past experience indicates that such machinery is a potential source of ignition. Despite this there is a distinct lack of guidance or requirement for the provision of fire extinguishing equipment on these machines when

compared to similar situations. eg requirements in the CFA legislation when operating heat engines in contact with dry vegetation. (see **Appendices 4 and 5**)

Facility Management Practices and Procedures

It was apparent that a greater than normal accumulation of exposed waste was a factor in each of the fires examined. At Werribee the fire burnt an extensive area of uncovered waste on the actual landfill. At Brooklyn and Knox the fires occurred at the actual transfer sites (a trench/pit or slab) where there had been an accumulation of waste because transfer to the actual landfill had not taken place.

Each of the fires considered in this review occurred on a weekend or public holiday when the usual waste management practices are not adhered to; eg progressive transfer of material to landfill site. Consequently there is an accumulation of waste that compromises good practice and any resulting fire is potentially more serious and takes longer to extinguish because of the greater quantities of fuel available.

Selection of waste management techniques should involve a consideration of the risks involved. The Knox fire was caused by hot material from a mechanical hopper mulcher being deposited on shredded flammable solids – foam rubber and upholstery materials from mattresses. The machine is designed to shred or break up a wide range of materials in order to reduce their volume prior to deposit in the landfill.

Financial issues

The generally held view is that waste has no monetary value. Burning waste in a landfill is therefore not perceived to be destroying property. The extension of this line of thought is that a fire in a landfill facility is causing no loss. However there are significant costs associated with these fires and also significant potential for harm to the environment and to the community.

The costs are those associated with interruption to the normal operation of the site, any damage to infrastructure or machinery, as occurred at Knox and of course the significant costs associated with the fire suppression operations which are generally resource hungry and extended.

When fire service resources are committed to fires at landfill facilities they are not available to provide the essential services that they normally provide to the broader community. This can extend beyond the immediate area where the landfill is located due to movement of fire fighting vehicles from elsewhere to cover the gaps left by the vehicles at the landfill fire.

When CFA volunteers are involved in landfill fires, particularly during working hours, there are costs incurred by their employers through lost production or by the volunteers themselves if they are self employed.

Outside working hours there is still a social cost or opportunity cost because they are not able to undertake their usual activities.

This review did not examine whether landfill facilities hold fire insurance or whether they are charged for attendances by brigades.

Unless or until fire impacts significantly on operating costs of a facility it is unlikely that management will perceive it as a risk that requires more effective treatments and management than is currently the accepted practice. It appears that fire at landfill facilities is not a major concern of operators, perhaps best demonstrated by a reluctance to invest in more appropriate water supply systems at landfill sites despite the stated performance outcome contained in the best practice documentation. (refer **Table 2** on page 7)

Water supply

On site water supplies at each of the facilities were basic and certainly not compliant with the **BPEM** stated outcome requiring a fire fighting water supply 'capable of being delivered to any point on the landfill'. None of the facilities had any reticulation system, hoses or mobile tanker capable of providing water for firefighting. On site staff had no access to water to attempt to extinguish or control a fire despite that being part of the stated objective in relation to fires. ***"To prevent landfill fires and efficiently extinguish any that should occur."***

At each of the fires in the review fire services had to call for additional resources in order to establish adequate water supplies for control and extinguishment of the fires. The Resource Commitment Summary at **Table 1** provides an indication of the additional resources required when compared to a standard response.

At Werribee, fire service pumps made use of pondage water near the base of the landfill that probably contained leachates⁴. The mix of leachates depends on the content of the landfill. Using leachate contaminated water supplies exposes all persons in attendance to the possibility of exposure to mists and sprays that may increase the potential for the development of health issues.

Fire Protection Installations

None of the premises reviewed had fire water installations that met the requirement for delivery of water to all parts of the site. As a consequence it was not possible for on site staff or first arriving fire crews to quickly access water to contain and extinguish the fires. The existing **BPEM** guidelines with regards to water supplies are too open to interpretation or compliance is not enforced.

⁴ leachates;- the liquid produced in a landfill and containing soluble material from the decomposition of waste within the landfill through which that liquid has passed

Fire is an identified risk associated with landfills and other waste management locations, hence the inclusion of a specific section dealing with fires in the **BPEM** guidelines document . Despite this there is no legislated provision that enables a Chief Officer of a fire service to specify their fire safety and fire management requirements as would be the case in the structural environment. However, it is interesting to note that the **BPEM** guidelines expect that operators of landfills will consult the relevant fire service about the development of fire management plans (refer **Table 2**). A more prescriptive approach coupled with compliance inspections by **EPA**, as the licensing authority, would ensure that water was available for initial action when fire is discovered.

The availability, or lack, of appropriate fire extinguishers at landfill facilities should be addressed. There is currently no specific requirement for the provision of fire extinguishers. Other industries that handle or store flammable material or that operate powered machinery in close contact with flammable materials are subject to regulations that require the provision of fire extinguishers. For instance, the farming community must equip tractors and machinery operating in contact with vegetation with fire extinguishers⁵.

Fire Prevention/Preparedness

The **BPEM** guidelines include performance measures requiring consultation with the 'relevant fire authority' in the development of a fire management plan and for the construction of firebreaks around the perimeter of a facility. No evidence of this having been done was apparent at any of the sites examined.

There was no evidence of any pre-planning activity having been undertaken by fire services. This is consistent with the broadly held perception that landfill fires 'will happen' and that they present no immediate threat to life or property. Fire service personnel were also unaware that landfill managers were required to consult with them about fire management planning.

Fire Fighting Practices and Procedures

The most commonly used tactic to extinguish landfill fires can be described as "soak, separate and soak again". Water is applied to contain and reduce the intensity of the surface fire so that machinery can then be used to pull apart and overturn waste. Water is again applied until all signs of burning material have gone.

Water supply is generally found to be a major issue complicating the selection of initial actions and this allows the fire to become more established before adequate containment efforts can be implemented. This extends the time required to extinguish the fire.

⁵ refer to Country Fire Authority Act s50 at Appendix 4

The initial responses by the fire services to the three events examined were found to be consistent with a standard first response to a structure or non structure fire. Additional resources were requested after an initial assessment of the extent of the fire. The resource allocation data in Appendix D, illustrate that initial assessments made on arrival and during the event tend to under estimate the additional resources required. The turnout time groupings indicate a progressive escalation of additional resources. A pre-determined response approach based on past experiences is more likely to generate an appropriate initial response, particularly since we know that water supply will be a significant issue at most landfills.

An appropriate level of resources sent as a first response is more likely to achieve early control of the fire, reduce the time required for resources to be in attendance and reduce or avoid the need to call additional resources.

The response by MFB to the Brooklyn fire was based on their pre-determined response system (GARS). The one request for additional resources was also consistent with GARS and proved to be adequate because of the existence of a hydrant point on a public main near the front gate.

An appropriate level of first response resources should be determined as part of the pre-planning process and consideration of past experiences.

'A' Class foam⁶ was used by crews at the Werribee and Knox fires, however it is difficult to verify whether the use of the foam actually reduced the time required to extinguish the fires. The perception of those present was that use of foam did assist their efforts. This perception is based on their experiences in using the foam on mulch fires, haystacks and other closely packed fuels.

Hose lines are difficult to lay and move about at landfill sites because of the debris that usually exists on these sites. The hoses are also exposed to damage by sharp objects when being moved about as are the tyres of appliances moving about the scene.

Whilst not an issue at the fires examined for this review, attending deep seated ground fires in landfills can also expose crews and appliances to the potential for collapse of the landfill surface due to combustion of the underlying waste.

The area involved in fires at a landfill can be quite extensive. It can also be quite high, making the use of large streams of water essential in order to achieve coverage over these large areas. Personnel must then resort to use of ground or vehicle mounted monitors⁷. This necessitates the availability of a plentiful and reliable water supply.

⁶ 'A' Class foam is a detergent like agent that reduces the surface tension of water and improves its ability to both penetrate and cling to the surfaces of fuels

⁷ A monitor is a piece of equipment designed to direct a large stream of water without the need for personnel to physically hold the hose and nozzle producing the stream.

Heavy machinery

Use of heavy machinery located on site to pull burning material apart or to smother it with inert material is considered an essential component of dealing with landfill fires. As this is undertaken by landfill site staff, their safety and that of the machinery must be considered. Most machinery working at landfills will be equipped with enclosed cabins and air conditioning due to the dusty environment in which they operate on a daily basis, however if it is necessary to work within the smoke plume, then operators may need to wear breathing apparatus (BA).

The site Fire Management Plan should detail how operators will be trained so that they can wear BA should that be necessary. Fire authorities may need to facilitate that training.

Generally, the effectiveness of cooperation between site management and fire services was not an issue, however pre-planning might improve the timeliness of response by staff to operate machinery when fires occur out of hours.

Health & Safety issues

Fire service personnel are aware of the potential toxicity and hazards of the smoke plume from landfill fires. Fire Service personnel required to work in or near the smoke plume were wearing BA, however monitoring of the content of the smoke plumes is not undertaken as a standard practice irrespective of the unknown nature of the content of the landfill.

The assumption seemed to be that only 'clean' waste will be in a public landfill or transfer station so the smoke was considered no worse than at a structure fire.

Decontamination of personnel and equipment is not undertaken as a routine practice.

Workplace health and safety obligations suggest that monitoring and tracking the smoke plume should be a routine activity at any landfill fire. Fire services also have obligations to inform the community about threats to their safety or health due to a fire event.

These activities could be included in an Aide Memoire/Checklist to prompt Incident Controllers to at least consider whether they should be undertaken.

Community Impact and Warnings

Given the potential for noxious products of combustion, or at the least a visible, smelly smoke plume there is a need to advise the public of the fire and to inform them of the level of concern about potential for health issues.

Inappropriate wording may cause unnecessary levels of concern or confusion. Therefore, it would be prudent to develop a suite of standard messages for fires involving potentially toxic smoke plumes. These could then be authorised by the Incident Controller and issued when required in the same way as standard bushfire warning messages.

Possible Changes and Improvements

Legislation / Regulation / Licenses/ Guidelines

Landfills and other waste management facilities should be required to provide, install and maintain firefighting equipment in a similar way to the requirements applying to buildings and major hazard facilities. The potential for fire is always present during the operation of a site as a landfill. The potential continues after a site is closed and capped due to the generation of flammable gases within the landfill.

The existing licensing regime and **BPEM** guidelines require strengthening to highlight the importance of provision of water supplies, a means of getting water to all points of the site and provision of appropriate firefighting equipment that will facilitate action by on site personnel when a fire is detected.

Were the same waste handling activity conducted inside a building that building would be required to meet specified requirements based on the class of occupancy. Considering the fire history related to landfill facilities a more appropriate legislative approach would include the relevant fire service as a referral authority during the planning process prior to the issue of a site license so that the Chief Officer may specify their minimum requirements as they do for a range of other industrial situations.

Section 50 of the *Country Fire Authority Act 1958* requires provision of a fire extinguishing capability on tractors and heat engines when in contact with dry vegetation during a fire danger period . Perhaps there would be benefit in the inclusion of a similar provision in the relevant legislation requiring provision of fire extinguishing capability on heat engine powered machinery working at waste handling facilities.

Section 48 of the *Country Fire Authority Act 1958* allows the CFA Chief Officer to direct an owner/occupier to extinguish a fire. This provision is often used for fires in haystacks, windrows, etc so that fire brigade resources can be scaled down or even totally released once there is little danger to life or property. Given the time and resource intense nature of landfill fires and fires at other waste and recycling facilities, eg scrap metal industry, a similar provision may be appropriate and would facilitate the earlier release of fire service resources.

There appears to be no similar provision within the *Metropolitan Fire Brigades Act 1958*, however there are many landfill sites located within the Metropolitan Fire District

where fires with the same resource and time implications for the MFB do occur. Consideration should be given to a similar provision in MFB legislation to permit the MFB to direct an owner/occupier to extinguish a fire.

Transfer of Risk

Imposing responsibility for extinguishment of a landfill fire onto the operator once containment has been achieved (as detailed above) would 'encourage' operators to be better prepared and to provide improved water supplies and firefighting equipment.

This will enable fire services resource commitments to be minimised. It also recognises that fire is of minimal threat to the broader community but a real threat to the operators business and license renewal.

Such an approach would need to be supported by inclusion of additional guidance in the **BPEM** guidelines or the involvement of fire services in the approval process for licensing of sites.

Site and Waste Management Practices.

If the guidelines for waste disposal require daily compaction and coverage of deposited material then allowing accumulation of waste over weekends and public holidays would seem to be done in contravention of good practice. This was a contributory factor to the severity and duration of the fires at the transfer stations.

On site staff should receive 'first response' training so they can take appropriate action when a fire is discovered. This presupposes that appropriate water supplies and equipment are available. The **BPEM** guidelines suggest that management of fire should be part of the operators Contingency Planning

When operators are considering new ways to reduce the volume of waste to be conveyed to the landfill their proposals should be tested against a comprehensive risk assessment process that may include consultation with fire services.

At the Knox transfer station a large hopper mulcher was used to shred mattresses. A hot piece of spring steel wire that had been repeatedly flexed during the mulching/shredding process ignited the freshly shredded foam rubber and fibre. Staff operating the machine reported that they knew the process produced hot metal fragments but apparently did not consider that depositing hot metal with the shredded foam rubber was likely to result in a fire.

The machine was designed to break down a broad range of solid materials, generally building rubble, into smaller pieces. A powerful magnet designed to remove metal from the shredded material as it passed along the discharge conveyor belt had been removed from the machine because it had caused blockages.

Fire Fighting Practices and Procedures

Fires at landfill facilities are invariably resource intensive, long duration jobs with the potential to create significant interference and detriment to normal community activity, including public health issues. The commitment of fire service resources to a landfill fire means they are not then available to service the broader community need.

Consequently, landfill facilities should be considered as premises that require the preparation of a Pre-plan, as do other major hazard facilities even though the landfills may present limited threat to life or property.

Early intervention is essential to preventing any fire from developing into a large and difficult to extinguish event. Once a fire is well established there seems no substitute for copious quantities of water to contain the spread and enable access by machines to physically disturb and remove the burning material and application of more water until it is certain that all burning material has been extinguished.

Unfortunately, the absence of reticulated water at most landfills precludes any early intervention to limit the spread of a fire by on site personnel.

If the on site personnel are not able to contain the fire quickly then it is essential that the first response by fire services be by sufficient and appropriate resources to establish and maintain immediate large volume water streams. The content of a Pre-plan should address this. Response tables should be structured/varied accordingly for these premises.

A pro-active, even interventionist, approach by fire services at the planning and design phases of the development of a landfill would emphasise the importance of meeting the **BPEM** guidelines 'required outcome'⁸ of being able to deliver water to all parts of the landfill.

A more pro-active approach by fire services would also be likely to result in more effective fire management by landfill operators. The active involvement of fire service personnel throughout the development of fire management plans should improve the content and quality of those plans. It would also provide an opportunity to prompt the need for training of facility staff so they know how to take appropriate and safe actions to limit the spread and development of any fire.

Fires in landfills involve a range of complicating factors that are not always immediately apparent to responders. The use of Checklists to guide and prompt decision making is an established method of dealing with such situations. Development of a Checklist for use at landfill fires is considered desirable. A draft version is attached as **Appendix 6**.

⁸ refer **Table 2**

Other Equipment required

Thermal Imaging Camera (TIC)

The use of thermal imaging cameras was not mentioned in relation to any of the fires considered in this review, however they are a very useful tool for locating any deep seated hot spots and aiding crews to target both containment and extinguishment efforts more effectively.

Decontamination facilities

Personnel attending landfill fires will be exposed to a range of substances and combustion products. They might also be contaminated by leachates depending on the source of water used to extinguish the fire. Since it is not always possible to identify what specific exposures may have occurred it would be prudent to undertake some form of cleaning with water to remove any obvious residue from the wheels of vehicles and the boots of personnel prior to leaving the site.

The need for comprehensive decontamination must always be considered as a possible requirement.

Plume Monitoring Equipment

Smoke plume monitoring both in terms of content and trajectory should be considered a standard activity at any significant landfill fire. The default position should be to treat the plume as hazardous until proven otherwise by actual monitoring with instruments.

Regardless of the content of the plume the path of the smoke plume across roadways may also create traffic safety issues due to reduced visibility.

Water Additives

Use of additives, such as 'A' Class foam, may help to reduce the impact of landfill fires. To understand whether this will be of advantage and actually produce any measurable benefit when used to extinguish landfill fires needs to be verified. If it can be demonstrated that control and extinguishment times are shorter, water volumes required are reduced and resource commitment needs are lower then the use of additives should become a standard practice. Environmental and health issues must be part of the verification process.

Conclusion

This review was conducted principally to identify common features / issues arising from three significant landfill fires that occurred over a short period in January 2012. There were a number of improvement opportunities identified and they are summarised below.

There are changes that can be made to improve responses by fire services, however the changes that will result in the greatest and measurable improvements to outcomes are those that require the collective input and actions by each of the principal stakeholders.

Fire services can improve outcomes by:-

- using a pre-planned response to provide appropriate resources,
- developing a checklist for use by incident controllers,
- implementing standard procedures that ensure the welfare and safety of crews and the public are not compromised,
- establishing a suite of standard warning messages for advice to the community,
- working with **EPA** as the regulator and licensing authority to achieve improved compliance with the required outcomes specified in the **BPEM** guidelines,
- seeking input to decisions about siting, design and fire water systems as part of the planning and licensing processes,
- initiating discussions with landfill operators about fire management planning and emphasising the critical importance of water supplies and early intervention.

Regulators can help to achieve improved outcomes by:-

- considering the issues identified by this review,
- acknowledging that changes to legislation and the **BPEM** guidelines may be required to help address the identified issues,
- auditing compliance with the **BPEM** guidelines on a regular basis,
- involving fire services in the planning and licensing processes.

Landfill Operators must:-

- be encouraged to achieve greater compliance with the required outcomes relating to fire that are set out in the **BPEM** guidelines, particularly with regard to water supplies.

Indicators of improvement to outcomes can be measured by:-

- reduction in the number of landfill fires,
- reduced duration and severity of fires that do occur,
- reduction in commitment of resources required to control and extinguish those fires.

Achieving material and measurable improvement will depend on the decisions made and actions taken by stakeholders after consideration of the findings of this review and the identified opportunities for improvement.

Appendix 1 - LEGISLATION CODES, STANDARDS AND GUIDELINES REFERENCED IN THE EPA PUBLICATION: SITING, DESIGN, OPERATION AND REHABILITATION OF LANDFILLS

9.2 Legislation

Environment Protection Act 1970.

Environment Protection (Scheduled Premises and Exemptions) Regulations 2007.

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State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1.

Industrial Waste Management Policy (Waste Acid Sulfate Soils).

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Australian Standard AS 1940-2004. *The Storage and Handling of Flammable and Combustible Liquids.*

Australian Standard AS 3798-2007. *Guidelines on earthworks for commercial and residential developments.*

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Appendix 2 - EXTRACT FROM SITING, DESIGN, OPERATION AND REHABILITATION OF LANDFILLS

which fences and surrounding areas are cleaned of any litter. It will also have contingency plans for which resources are engaged to deal with extreme events that cause gross litter problems.

In areas where litter is especially problematic, this may involve a dedicated litter crew, more frequent covering and enhanced litter screens. Such landfills may also have dedicated areas for waste deposition that are more sheltered from winds from particular directions, and therefore minimise litter from the landfill.

7.9 Fires

Landfill fires can cause significant impacts on local air quality through odour and smoke. They can also spread outside the landfill, triggering a grass or bushfire. Subterranean landfill fires may burn for many years before they are detected. The smell of smoke or the presence of carbon monoxide in the landfill gas may be the first sign that a landfill is burning and, in some cases, the surface of the landfill may collapse as a result of the fire creating a subsurface cavity. If this collapse is triggered by the passage of a vehicle over the cavity, it could be fatal for the vehicle's occupants.

Once started, landfill fires are difficult to extinguish, so the primary objective should be to prevent a fire from starting. This is done, as far as is practical, by removing potential ignition sources, such as hot coals, from the tipping area. Other measures include not burning waste and not lighting fires on or near areas where wastes have or are being deposited.

Finally, wastes should be covered with non-combustible material.

The level of carbon monoxide within landfill gas provides some indication as to whether there is or has been a subsurface landfill fire. Carbon monoxide is produced when there is insufficient oxygen present, such as within a landfill, to fully burn the fuel.

Carbon monoxide levels in excess of 1,000 ppm strongly indicate that there is a fire burning within the landfill. Levels above 100 ppm are not as conclusive but should be investigated as part of the fire investigation plan with further gas and temperature measurements to determine if and where there is or was a fire.

Some field meters can provide false results for carbon monoxide due to other constituents of landfill gas such as hydrogen and hydrogen sulfide. Fitting appropriate filters or laboratory analysis of the collected landfill gas provides more accurate results.

If a fire should start, every effort must be made to extinguish it before it gets established. Equipment to extinguish a fire must be readily available at any time to enable a prompt response to any part of the premises. A water supply, either reticulated water or from dams or tanks, combined with a means of delivery (pump and hoses or a tanker truck) allows the

prompt extinguishment of a fire on the site. Groundwater and stormwater stored in dams might be suitable for combating a fire. Leachate should not be used unless all parties are aware of the possible risks and adequate measures are taken to reduce human exposure. Where reticulated water is not provided, at least 50,000 litres should be stored onsite for the purpose of combating small fires. In the event of a significant fire, this volume will need to be supplemented by another source of water.

It is not usually possible to extinguish deep-seated fires using water except where the operator has sufficient plant and water to excavate and extinguish all burning waste. Where extinguishment is not possible, adding water to the landfill exacerbates the fire because the water adds oxygen to the fire. Attempts to dig out deep seated fires with inappropriate plant may exacerbate the situation by admitting air. To combat deep-seated fires, key elements are to minimise oxygen ingress to the fire by capping off the area and surcharging the area with claylike material. Landfill gas vents and extraction systems in the vicinity of the fire should be plugged.

In some areas, the local fire authority might require a firebreak to prevent the spread of fire into or out of the site. This, in conjunction with developing a fire management plan with the local fire authority, is best practice in areas where grass or bushfires might be a concern.

BPEM requirements to comply with clause 15 (3) and (4) of the Landfill WMP

Fires

Relevant BPEM objectives

To prevent landfill fires and efficiently extinguish any that should occur.

Required outcomes of the BPEM

- Maintenance of a water supply capable of being delivered to any point on the landfill.
- No fires must be lit at the landfill or near areas where wastes have been or are being deposited.
- That all practical steps have been taken to prevent landfill fires.

Suggested measures of the BPEM

- Develop a fire-management plan in conjunction with the relevant fire authority.
- Remove ignition sources such as hot coals and car and marine batteries from the waste at the tipping area.
- Cover combustible wastes with inert material.
- Construct a firebreak around the perimeter of the landfill to the satisfaction of the relevant fire authority.
- Where the reticulated water supply is not adequate for fire fighting purposes or not available, maintain at least 50,000 litres of water onsite.

Appendix 3 - EXTRACT FROM SITING, DESIGN, OPERATION AND REHABILITATION OF LANDFILLS

Appendix C - SUMMARY OF OBJECTIVES AND REQUIRED OUTCOMES

<p>7.6 Waste placement</p>	<p>Relevant BPEM objectives <i>To place waste in a manner that is mechanically stable, controls litter and birds and that maximises the degree of compaction.</i></p> <p>Required outcomes of the BPEM</p> <ul style="list-style-type: none"> • Maintenance of an active tipping area that is as small as possible. • Compaction of all waste deposited in the landfill. • Assurance that waste is placed so that all unconfined faces are mechanically stable and capable of retaining cover material.
<p>7.7 Waste cover</p>	<p>Relevant BPEM objective <i>To ensure that wastes are covered appropriately, to mitigate against any environmental or health impacts.</i></p> <p>Required outcomes of the BPEM</p> <ul style="list-style-type: none"> • Covering of the waste, at least daily, with soil or another approved cover material for all sites that accept putrescible waste and maintain the cover. • Close cracks in old, exposed cover layers to contain landfill gas and odour. • No use of acid sulfate soil as daily cover.
<p>7.9 Fires</p>	<p>Relevant BPEM objectives <i>To prevent landfill fires and efficiently extinguish any that should occur.</i></p> <p>Required outcomes of the BPEM</p> <ul style="list-style-type: none"> • Maintenance of a water supply capable of being delivered to any point on the landfill. • No fires must be lit at the landfill or near areas where wastes have been or are being deposited. • That all practical steps have been taken to prevent landfill fires.
<p>7.10 Contingency planning</p>	<p>Relevant BPEM objectives <i>To ensure that all potential incidents are considered and that appropriate measures are planned to deal with them.</i></p> <p>Required outcomes of the BPEM</p> <ul style="list-style-type: none"> • A contingency plan is in place • All likely impacts are covered in the preparation of the contingency plan. • All staff are trained in the implementation of the contingency plan.

Appendix 4 - Extracts from Country Fire Authority Act No 6228 (1958)

48 Power to police, Chief Officer etc. to direct extinguishment of fire

- (1) In this section *authorized officer* means—
- (a) a member of the police force; or
 - (b) the Chief Officer; or
 - (c) any officer exercising the powers of the Chief Officer; or
 - (d) the captain of any brigade; or
 - (e) any officer of a brigade appointed generally or specially in respect of any district for the purpose of this section.
- (1A) An authorized officer may direct—
- (a) the occupier or owner of any land; or
 - (b) any person residing upon or in control of any land; or
 - (c) any person having lit or maintained a fire on any land within the country area of Victoria—
to extinguish the fire on that land or to take the steps directed by the authorized officer to extinguish the fire or to prevent the fire from spreading or causing injury.
- (1B) A direction of an authorized officer must be complied with even if the fire was lit or maintained in accordance with this Act and the regulations under this Act.
- (2) An owner, occupier or person to whom a direction has been given under subsection (1A) must, without delay, take all reasonable steps to comply with the direction.

Penalty: 120 penalty units or imprisonment for 12 months or both.

50 Required safety features of motor vehicles driven during fire danger period near crops

- (1) In the country area of Victoria a person shall not drive or operate a vehicle propelled by internal combustion (other than a vehicle referred to in subsection (2)) so that the vehicle is in contact with any crop, grass, stubble, weeds, undergrowth or other vegetation unless the vehicle is fitted with an efficient silencing device so constructed that all the exhaust from the engine of the vehicle passes through the silencing device.
Penalty: 10 penalty units.
- (2) In the country area of Victoria a person must not drive or operate a tractor or a self-propelled farm machine or a traction engine or an earth-moving, excavating or road-making machine propelled by or incorporating a heat engine within nine metres of or in contact with any crop, grass, stubble, weeds, undergrowth or vegetation unless the tractor, traction engine or machine—

- (a) is free from faults and mechanical defects which would tend to cause an outbreak of fire; and
- (b) is fitted with a spark arrester; and
- (c) carries the prescribed fire suppression equipment during a fire danger period.

Appendix 5 - Extract from Country Fire Authority Regulations 2004

109 Vehicular heat engines

- (1) For the purpose of section 50(2)(c) of the Act, the prescribed fire suppression equipment is—
 - (a) at least one knapsack spray pump that—
 - (i) is in proper working order; and
 - (ii) is fully charged with water; and
 - (iii) has a tank capacity of not less than 9 litres; and
 - (iv) complies with Australian Standard AS1687–1991 approved by Standards Australia in 1990 and published in February 1991 as amended and in force on 31 January 2004; or
 - (b) at least one water (stored pressure) fire extinguisher that—
 - (i) is in proper working order; and
 - (ii) is fully charged with water and maintained at the correct pressure; and
 - (iii) has a tank capacity of not less than 9 litres; and
 - (iv) complies with Australian/New Zealand Standard AS/NZS 1841.2:1997 approved by Standards Australia in 1997 as amended and in force on 31 January 2004.
- (2) For the purpose of section 50(5) of the Act, a spark arrester must comply with Australian Standard AS1019–2000 approved by Standards Australia in 2000 as amended and in force on 31 January 2004.

110 Non vehicular heat engines

- (1) In this regulation, *fire danger period* includes a prohibited period declared under section 3 of the **Forests Act 1958**.
- (2) This regulation does not apply to—
 - (a) a heat engine propelling or incorporated in a vehicle or machine to which section 50 of the Act applies; or
 - (b) a chainsaw, plant or grass trimmer or lawn mower used in green vegetation.
- (3) A person must not use a heat engine in the open air unless—
 - (a) the heat engine is fitted with an efficient spark arrester; and
 - (b) if a fire danger period is in force in the area of use—
 - (i) the area around the heat engine is cleared of flammable material for a radius of not less than 3 metres; or
 - (ii) subject to sub regulation (4), a person is in attendance at all times the heat engine is in operation together with fire suppression equipment referred to in regulation 109(1) or other fire suppression equipment of the type and number approved by the Chief Officer.

Penalty: 10 penalty units.

- (4) The Chief Officer may exempt a person from compliance with sub regulation (3)(b)(ii) where, in the opinion of the Chief Officer, the circumstances surrounding the operation of the heat engine warrant it.

Appendix 6 - DRAFT CHECKLIST

Landfills, transfer stations, other waste handling facilities

- Secure the area involved in fire
- Only essential appliances and personnel in immediate area
 - locate upwind and in position where exit can be made if necessary
- Establish Incident Management Team with Site Manager
 - Will Command Module / Vehicle be required
- Is site a general waste facility or a specialist prescribed waste facility?
- Ascertain whether a surface fire only or deep seated ground fire
- Treat smoke plume as toxic (fuels, contaminants unknown)
 - Is monitoring of the smoke plume required?
 - Weather forecast / wind changes
- Community Information and/or Warnings
 - Media management
 - OSOM
- Establish large volume streams to contain further spread
 - Ground/Vehicle monitors preferred
 - Movement of hose lines risks damage on sharp objects
- Arrange necessary support to maintain adequate water supplies
- Get site management to have heavy machinery:-
 - consolidate containment lines
 - pull burning material apart
 - cover area with non flammable cover material
- Establish a containment area for any runoff water
 - Is recycling water a possibility?
- Crew welfare needs
 - hygiene
 - feeding
 - hydration
- Is or will lighting equipment be required?
- What specialist equipment is required?
 - Thermal Imaging
 - Smoke Plume Monitoring
 - Gas Analyser

- Is decontamination required?
 - personnel
 - equipment, hoses, etc
- Who needs to be advised?
 - EPA
 - Worksafe
 - Municipality
 - Vic Roads / Police –smoke hazard / traffic control
 - Health Dept

Safety Note

- High potential for injury by sharp objects
- Hydration and feeding station requires provision of suitable hygiene facilities because of the nature of the site

Environmental Note

- Avoid pollution of nearby waterways due to run off
- Avoid carrying potential contaminants off site by washing down appliances, wheels in particular, prior to leaving the site

References

- *Siting, Design, Operation and Rehabilitation of Landfills*, Best Practice Environmental Management; © EPA Victoria 2010; Publication 788.1* September 2010
- *Landfill Fires – Their Magnitude, Characteristics and Mitigation*, prepared by TriData Corporation for FEMA, United States Fire Administration, National Fire Data Centre, May 2002
- *Fighting Fires in refuse*, Generic Risk Assessment 3.7; August 2011, Dept of Communities and Local Government UK.
- *Review and Investigation of deep seated fires in landfill sites; Using Science to create a better place – Science Report SCO10066*; Environment Agency (UK) March 2007
- *Natural Gas Incidents*, Fire Service Manual Vol 2, Fire Service Operations –HMSO (UK) 2003
- *Landfill Fires*; US Fire Administration Topical Fire Research Series – Vol 1, Issue 18, March 2001 (revised Dec 2001)
- Country Fire Authority Act No 6228 (1958)

ANNEXURES:

- A. Brief Report on Knox Transfer Station fire
- B. Brief Report on Werribee Landfill fire
- C. Brief Report on Brooklyn Landfill fire
- D. Detailed Resources Commitment Tables for each fire

Annexure A - Knox Transfer Station Fire

The Site.

A large area for the dumping of waste for preliminary processing and recovery of recyclable materials prior to transfer to the actual landfill site at Lilydale. Hard waste collections from the surrounding suburbs were also delivered to this site for processing, sorting and compaction prior to transfer.

Reduction in volume of waste was achieved by a mechanical grab loader that dropped waste into a large track mounted shredder / grinder equipped with a hopper. The output from the shredder / grinder was delivered by conveyor to a large heap located on a concrete slab. The heap extended right to the exterior wall of a large storage building and workshop.

Installed fire safety equipment consisted of two large water tanks that captured runoff from roofed areas at the premises. These are located remote from the area where the fire occurred. There was no fire main / fire service on site and no mobile tanker type vehicle able to transport and deliver water to any fire that might occur at the premises.

The Fire.

At about 1.13pm on 26th January a small fire began in the immediate vicinity of the large hopper grinder/shredder machine which was being used to shred old mattresses. The fire developed quickly due to the type and distribution of fine fuels (heaped, shredded foam rubber and fibre from mattresses) and because the initial ignition point was being fanned by the airflow from the machines engine cooling system.

Staff immediately moved the grab loader away from the area and then attempted to do same for the shredder but were driven back by the heat from the rapidly developing fire. The machine became involved and was totally destroyed. It was valued at \$800,000.

The fire extended through the length of the continuous stack of waste and caused damage to the corner of a large shed and to an attached workshop fashioned out of old shipping containers. The building and workshop damage was considered to be valued at \$50,000.

There was no water supply or extinguishers immediately available for use by staff.

Fire fighting was also hampered by the lack of an adequate installed water supply. The response data in Annexure D illustrates the large number of tanker resources that were called to maintain a water supply.

The Cause.

Ignition was attributed to hot pieces of spring steel dropping from the machines conveyor with the other material. The transfer station manager told me that a powerful magnet designed to extract the metal had been removed from the machine because it regularly caused blockages.

Assessment of Knox Site against BPEM Requirements

Objective: <i>To prevent landfill fires and efficiently extinguish any that should occur.</i>	
Required outcomes of the BPEM	Observations on Compliance
Maintenance of a water supply capable of being delivered to any point on the landfill.	There were no systems or arrangements for delivering water “to any point on the landfill” to facilitate fire fighting.
No fires must be lit at the landfill or near areas where wastes have been or are being deposited	Compliant General prohibition of fires in force.
That all practical steps have been taken to prevent landfill fires	Generally Compliant
Suggested measures of the BPEM	Observations on Compliance
Develop a fire management plan in conjunction with the relevant fire authority.	Non Compliant No evidence of any plans having been developed. No request made to fire authority.
Remove ignition sources such as hot coals and car and marine batteries from the waste at the tipping area	Mostly Compliant Staff were aware that during mattress shredding operations hot pieces of metal were part of the machines output but apparently did not consider them to be ‘sources of ignition’
Cover combustible wastes with inert material	Non Compliant As a transfer station coverage is not required, however removal of deposited waste to the landfill ought to be happening as a continuous process whilst the facility is operating. This was not happening due to the Public Holiday
Construct a firebreak around the perimeter of the landfill to the satisfaction of the relevant fire authority	Compliant No evidence that fire authorities have been consulted by management
Where reticulated water supply is not adequate for firefighting purposes or available, maintain at least 50,000 litres of water on site.	Compliant Water tanks were located on site but remote from where the fire occurred.

Knox Transfer Station – Area where fire occurred. (image dated 15.02.12)



Knox Transfer Station – General overview of Site (image dated 15.02.12)



Annexure B - Werribee Landfill

The Site.

Is a large landfill located in a disused section of a quarry. It is located some 7km from the fire station at Werribee. Reticulated water is available approx. 700m from the entry gate but flow rates are low.

The site incorporates a transfer station where the public deposit their rubbish. Commercial operators deliver their waste direct to the tipping area.

A working quarry is adjacent to the landfill site and large dump trucks use a road at the bottom of the batter face. During fire fighting operations this road must be used to gain access to the static water supply and to the lower section of the battered face. The quarry must therefore cease or limit its operations whenever a fire occurs. This is a hidden cost of fires at this facility.

Quarry resources are made available to assist with fire fighting. In particular a large (30,000 litre) water tanker equipped with a monitor.

The Fire

An area of around 20m x 50m of the sloping batter face was involved when the first appliance arrived. This was contained and then extinguished with copious quantities of water drawn from a pond located near the base of the tip face.

Heavy machinery was used to move waste at and near the top of the face but the batter face is considered too unstable for work by the machines. Consequently, ground monitors were used to progressively extinguish the face. The extinguished area was then covered with soil.

'A' Class foam was used. It was considered to improve the penetration of the water into the compacted waste however it is difficult to measure whether this is in fact the case. Experience with other compacted fuels, (paper, hay, mulch) indicates that it does reduce time on scene and prevent re-ignitions.

Health and Safety Issue

The dam from which water was used probably includes leachate as it is located on the floor of the old quarry area and the waste is being deposited above that. Any water draining through the landfill ultimately finds its way to the dam. There have been no apparent hygiene issues arising from this however the potential does exist because of spray from hose streams.

Assessment of Werribee Site against BPEM Requirements

Objective: <i>To prevent landfill fires and efficiently extinguish any that should occur.</i>	
Required outcomes of the BPEM	Observations on Compliance
Maintenance of a water supply capable of being delivered to any point on the landfill.	Non Compliant No distribution system available to get water to any point.
No fires must be lit at the landfill or near areas where wastes have been or are being deposited	Compliant
That all practical steps have been taken to prevent landfill fires	Generally Compliant
Suggested measures of the BPEM	Observations on Compliance
Develop a fire management plan in conjunction with the relevant fire authority.	Non Compliant No evidence of any plans having been developed however since the fire arrangements have been made to commence a consultation process.
Remove ignition sources such as hot coals and car and marine batteries from the waste at the tipping area	Mostly Compliant Largely achieved through use of transfer station approach and segregation of recoverable and recyclable wastes
Cover combustible wastes with inert material	Mostly Compliant The exposed area involved in this fire was larger than would normally be expected based on a study of aerial imagery of the site. The reason for this is not known.
Construct a firebreak around the perimeter of the landfill to the satisfaction of the relevant fire authority	Generally Compliant No evidence that fire authorities have been consulted about this.
Where reticulated water supply is not adequate for firefighting purposes or available, maintain at least 50,000 litres of water on site.	Compliant A static water supply was available near the transfer station. There was no system for delivering water "to any point on the landfill." The pondage in the old quarry is a useful source of water but there are no pumps installed.

Werribee Landfill – Showing transfer station and current landfill area

The area involved in the fire has been circled. The substantial area of uncovered waste when this image was taken indicates that daily coverage of deposited waste is not always achieved.



Annexure C - Brooklyn Landfill

The Site

This transfer station is within a large site in an old quarry that has been used as a landfill for a number of years. The landfill is apparently nearing the end of its life. The installation of a gas collection system and vapour barrier over the whole facility is currently underway. (refer photos)

Waste is delivered to the transfer station near the main gate. Commercial operators deliver direct to the tipping area. Recyclables are separated and the remainder is then transferred to the actual landfill.

The Fire

This fire was reported at 00.28hrs on a Sunday night and was located in the transfer station pit where there had been an accumulation of waste (est. to be approx 6000 cu.m.) during the two previous days. The normal transfer process had not been occurring because of the weekend.

The actual cause is not known but was thought to be the deposit of hot materials earlier in the day that caused smouldering ignition within the heap and flared once it reached the surface of the rubbish pile.

The fire fight was hampered by poor water supply. Extinguishment was eventually achieved by pulling the heap apart with heavy machinery once operators arrived on site. Water supply was augmented by use of water tenders.

Smoke plume travel caused a number of further calls from residents downwind who could smell the smoke. The premises was within an industrial area and warnings were issued to the public prior to the expected increase in traffic through the area as workers arrived for work at surrounding premises.

Assessment of Brooklyn Site against BPEM Requirements

Objective: <i>To prevent landfill fires and efficiently extinguish any that should occur.</i>	
Required outcomes of the BPEM	
Maintenance of a water supply capable of being delivered to any point on the landfill.	Non Compliant
No fires must be lit at the landfill or near areas where wastes have been or are being deposited	Compliant
That all practical steps have been taken to prevent landfill fires	Generally Compliant
Suggested measures of the BPEM	Observations on Compliance
Develop a fire management plan in conjunction with the relevant fire authority.	Non Compliant No evidence of any plans having been developed however management were co-operative and likely to be motivated to develop a plan because of this experience.
Remove ignition sources such as hot coals and car and marine batteries from the waste at the tipping area	Compliant Largely achieved through use of transfer station approach and segregation of recoverable and recyclable wastes
Cover combustible wastes with inert material	Compliant Very little exposed tipping area visible. This site is being capped and membranes put in place to collect gas.
Construct a firebreak around the perimeter of the landfill to the satisfaction of the relevant fire authority	Generally Compliant No evidence that fire authorities have been consulted.
Where reticulated water supply is not adequate for firefighting purposes or available, maintain at least 50,000 litres of water on site.	Non Compliant A limited capacity water supply was available near the transfer station but it was inadequate for the needs on this occasion. There is no distribution system to deliver water "to any point on the landfill."

Brooklyn Landfill Fire – (image taken 22.02.2012)

Fire Area can be seen in the image and units are still in attendance.



Annexure D - Detailed Resources Commitment Tables

KNOX TRANSFER STATION

RESOURCE	TURN OUT	IN STATION	TOTAL	CREW	Respond to station	Person hours
PT28	13:13:36	15:22:00	2:08:24	3		6:25:12
Scoresby P1	13:14:56	20:02:36	6:47:40	4		3:10:40
P31	13:16:26	17:14:43	3:58:17	4		15:53:08
WT31	13:21:22	17:14:43	3:53:21	2		7:46:42
Scoresby Hose Layer	13:22:31	19:58:50	6:36:19	2		13:12:38
Bayswater T1	13:24:23	18:31:55	5:07:32	5		1:37:40
Rowville T1	13:25:02	19:13:09	5:48:07	5	3	5:00:35
CMAT	13:25:18	17:14:43	3:49:25	1		3:49:25
Boronia PT	13:26:20	18:22:36	4:56:16	4		19:45:04
Ferntree Gully T1	13:26:53	18:12:14	4:45:21	5	2	23:46:45
Scoresby FCV	13:28:53	19:47:59	6:19:06	1	6	6:19:06
Scoresby T1	13:40:33	20:54:21	7:13:48	5		12:09:00
Upwey T1	13:51:17	21:45:22	7:54:05	5	7	15:30:25
Upper FTG T1	13:52:16	17:34:31	3:42:15	4	4	14:49:00
The Basin T1	13:52:26	18:25:18	4:32:52	5	2	22:44:20
Dandenong T1	13:58:37	18:26:00	4:27:23	5		22:16:55
Dandenong Supp	14:01:42	18:32:04	4:30:22	4		18:01:28
BS38	14:09:02	15:52:54	1:43:52	1		1:43:52
Patterson Rvr MCV	14:15:44	20:54:09	6:38:25	3		19:55:15
Ferntree Gully BF	14:17:56	15:31:15	1:13:19	2		2:26:38
Rowville SlipOn	14:22:32	18:57:18	4:34:46	4		18:19:04
Bayswater BA	15:02:08	17:59:10	2:57:02	4	6	11:48:08
Boronia Supp	15:09:49	15:13:22	0:03:33	1	1	0:03:33
Boronia P2	15:12:50	15:49:09	0:36:19	4		2:25:16
Sassafras T1	15:39:00	19:42:09	4:03:09	5	5	20:15:45

Towards Improved Fire Management in Landfill Sites

RESOURCE	TURN OUT	IN STATION	TOTAL	CREW	Respond to station	Person hours
Olinda T1	15:40:33	19:36:29	3:55:56	4	9	15:43:44
Belgrave T1	15:40:46	17:59:31	2:18:45	3	6	6:56:15
Clematis T1	15:41:03	19:40:19	3:59:16	5	6	19:56:20
Kallista-The Patch T1	15:41:40	19:42:17	4:00:37	5	3	20:03:05
Narre Warren East BF	15:42:04	18:09:55	2:27:51	3	3	7:23:33
Frankston BA	16:05:33	17:31:13	1:25:40	2		2:51:20
Dandenong LP	16:22:08	16:54:37	0:32:29	2		1:04:58
The Basin FCV	16:46:43	17:22:30	0:35:47	1		0:35:47
Dandenong FCV	17:07:11	18:22:34	1:15:23	4		5:01:32
			3:47:26			
Resource totals						
27 appliances			3.79	117	63	443.43
7 other vehicles						
						<i>Person days</i>
						18.48
S/T turned back						
Yarra Glen T1	16:21:27	17:35	1:13:33	5	4	
coldstream T1	16:35	17:22	0:47:00	4	3	
Healesville T1	16:22:23	17:35	1:12:37	5	3	
Sth Warrandyte FCV	16:21	17:41	1:20:00	2	9	
Badger Creek T1	16:16:58	17:42	1:25:02	5		
Mooroolbark	16:08				10	Did not respond due to need to maintain cover in own area
Dixons Creek	16:07				6	
Monbulk	14:01				8	

Towards Improved Fire Management in Landfill Sites

RESOURCE	TURN OUT	IN STATION	TOTAL	CREW	Respond to station		Person hours	
Resource totals								
4 appliances				21	43			
1 other vehicle								

WERRIBEE LANDFILL

RESOURCE	DISPATCH	RETURN	TOTAL	CREW	Respond to station		Person hours
Werribee T1	17:04:41	21:09:50	4:05:09	3	18		12:15:27
Werribee Ute	17:04:41	20:00:09	2:55:28	4			11:41:52
Werribee FCV	17:04:41	21:17:39	4:12:58	3			12:38:54
Hoppers Crossing T1	17:11:03	20:18:36	3:07:33	3			9:22:39
Truganina FCV	17:11:03	21:10:20	3:59:17	2			7:58:34
Truganina T1	17:11:03	21:14:30	4:03:27	5	4		20:17:15
Wyndham Vale PT	17:11:03	19:22:38	2:11:35	4			8:46:20
Wyndham Vale T1	17:11:03	21:18:08	4:07:05	4	1		16:28:20
Little River T1	17:14:14	20:30:07	3:15:53	2	1		6:31:46
Caroline Springs T1	17:55:45	20:06:09	2:10:24	5	*		10:52:00
Caroline Springs Car	17:55:45	19:59:02	2:03:17	4	*		8:13:08
Lara T1	17:55:45	20:15:11	2:19:26	5	4		11:37:10
Point Cook P1	17:55:45	21:18:14	3:22:29	3	2		10:07:27
Point Cook T1	17:55:45	21:43:16	3:47:31	5			18:57:35
Rockbank T1	17:55:45	20:05:08	2:09:23	2			4:18:46
PT49	17:58:15	21:00:00	3:01:45	4			12:07:00
P40	17:58:48	21:00:00	3:01:12	4			12:04:48
WWEI	18:02:36	20:21:37	2:19:01	1			2:19:01
Melton T1	18:03:47	21:42:41	3:38:54	3			10:56:42
ZC44							
			3:19:33		30		
Resource totals							Person hours
14 appliances			3.32	66			219.12
6 other vehicles							
							Person days
							9.13

BROOKLYN LANDFILL

RESOURCE	DISPATCH	IN STATION	TOTAL	CREW	Person hours
P45	0:30:55	12:26:29	11:55:34	3	11:46:42
PT49	0:30:55	9:11:44	8:40:49	4	10:43:16
P47B	0:39:28	11:30:17	10:50:49	3	8:32:27
PT40	0:39:28	11:57:25	11:17:57	3	9:53:51
WWEI	0:39:28	9:05:10	8:25:42	1	8:25:42
WT43	1:25:45	2:36:23	1:10:38	3	3:31:54
T44	1:26:33	2:25:58	0:59:25	2	1:58:50
ZC44	2:11:03	3:20:57	1:09:54	1	1:09:54
T44	2:53:42	3:47:15	0:53:33	2	1:47:06
BESA	8:03:54	12:27:15	4:23:21	1	4:23:21
T44	11:30:43	12:20:23	0:49:40	2	1:39:20
move ups					
P42 to FS45	1:05:30	n/a			
P44 to FS40	1:09:22	n/a			
WT43 to FS49	1:09:22	1:25:45	0:16:23		
WT51 to FS49	1:27:49	n/a			
			5:03:07	25	
Resource totals					Person hours
9 appliances			5.2		130
3 other vehicles					
					Person days
					5.42

Intentionally blank