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Cleanaway Operations Pty Ltd

Melbourne Energy and Resource Centre

Waste Management Technical Report

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Contents

Abbreviations and glossary

Abbreviations	Definition
ANZECC	Australian and New Zealand Environment and Conservation Council
APCr	Air Pollution Control Residue
ASLP	Australian Standard Leaving Procedure
BAT	Best Available Techniques
BREF-WI	Best Available Techniques Reference Document – Waste Incineration
COPC	Chemicals of Potential Concern
C&I	Commercial and Industrial
CWMP	Construction Waste Management Plan
DLA	Development License Application
EPA	Environmental Protection Authority
EC	European Commission
EU	European Union
GED	General Environmental Duty
GPT	Gross Pollutant Trap
HP	Hazardous Property
IBA	Incinerator Bottom Ash
IBAA	Incinerator Bottom Ash Aggregate
IED	Industrial Emissions Directive
MERC	Melbourne Energy and Resource Centre
MSW	Municipal Solid Waste
OWMP	Operational Waste Management Plan
TC	Total Contaminant
WFD	Waste Framework Directive
WtE	Waste to Energy

1. Waste and Resource Management

1.1 Executive Summary

This report's scope encompasses waste and process residues generated by the Proposal during construction, commissioning and operation. It presents an initial classification of the major waste streams to be produced, a summary of the management pathways proposed for each waste stream and identifies risks (and associated controls) related to waste management.

The Proposal will generate a range of waste streams and residues across construction, commissioning and operation which will need to be managed in accordance with the EP Act and EP Regulations. The focus of this chapter is thermal treatment residues (IBA and APCr), however other streams (including construction earthworks spoil, operational waste (such as from the admin building) and unacceptable feedstock) are also discussed.

Waste classification:

Wastes that will be generated through construction, commissioning and operation have been identified and classified according to Schedule 5 of the EP Regulations. In addition, data for IBA, IBA Aggregate (IBAA) and APCr from international reference facilities has been obtained, assessed and compared to the Victorian waste disposal categories to inform estimates of likely management pathways for each stream.

- Matured and processed IBA (IBAA) requiring disposal is likely to be classified as Industrial waste
- Stabilised APCr requiring disposal is likely to be classified as Reportable Priority Waste Category B.

Management pathways:

Wastes generated through construction, commissioning and operation of the facility will be managed in accordance with the waste hierarchy. For thermal treatment residues:

- IBA will undergo maturation and metals recovery on-site, producing IBAA
- IBAA will preferentially be re-used as a construction aggregate (noting approval will need to be obtained to confirm the end-of-waste re-use status for the IBAA, and market development will need to be undertaken to enable this reuse pathway). As a contingency and/or in the short term (e.g. during commissioning), if removed from site, it will be disposed of to landfill.
- APCr will be stabilised on-site using solidification with cement and water, before disposal to landfill, if an alternative commercially proven treatment process is not available.

Key risks:

An environmental risk assessment has been undertaken for the Proposal which identified the following as key risks related to waste management. Additional risks and associated controls are identified within this report.

- Escape of waste (including thermal treatment residues) or runoff from waste (leachate), causing pollution of land or waterways, including groundwater, or risk to human health through exposure to potentially hazardous substances
- Uncertainty surrounding the quantities and composition of thermal treatment residues produced by the process
- Risk of explosion from hydrogen build up or suspended dust related to IBA processing

A range of design and administrative measures have been proposed and incorporated within the design to mitigate the risks identified. The control measures identified at this stage represent reasonable steps to avoid and minimise impacts to human health and the environment.

1.2 Introduction

The Proposal involves the construction and operation of a Waste to Energy (WtE) facility which will divert residual Municipal Solid Waste (MSW) and residual Commercial and Industrial (C&I) waste from landfill, to recover energy and metals, and produce an aggregate suitable for construction applications. This chapter's scope encompasses waste and process residues generated by the facility during construction, commissioning and operation. The state of knowledge surrounding design, construction and operation of Waste to Energy facilities in Victoria is discussed in Chapter 5 State of Knowledge.

This chapter does not address waste inputs (feedstock). Feedstock required for the operation of the facility (characterisation, quantity modelling, transport, handling and processing) is discussed in the Development License Application Chapter 2 The Proposal, and related appendices.

The operations of the facility will generate various waste streams from construction activities and operational use, including key streams such as:

- Residues from the WtE process
- Construction waste (such as spoil from earthworks and site clearing)
- Operational waste from staff amenity spaces.

This chapter describes the type and classification of waste generated during normal operations and waste management approaches during construction and operation of the Proposal. This chapter also outlines Cleanaway's commitments to support resource recovery by planning for on-site separation of recoverable materials for high-value recycling off-site.

During the operational phase, source separation systems will be arranged for all relevant waste streams generated by onsite activities, including paper and card, comingled recyclables, organic waste and e-waste. This will enable residual waste from the site offices and visitor and education centre to be directed to the energy recovery process (subject to the standard waste acceptance protocols and criteria).

At this stage, detailed design of the facility has not been carried out. High-level estimates of waste generation rates have been developed for main waste streams during construction and operation. Estimating the waste generation and classification assists to identify risks related to waste management and supports the identification of potential impacts and development of design and administrative risk mitigation measures. More refined waste estimation and management provisions will be detailed in a Construction Waste Management Plan (CWMP) as the Proposal progresses. Detailed waste management provisions for site operation will be documented in an Operational Waste Management Plan (OWMP).

1.3 Proposal overview

Cleanaway Operations Pty Ltd (Cleanaway) is an Australian waste management, recycling, and industrial services company. Cleanaway is developing a waste-to-energy (WtE) facility in Victoria known as the Melbourne Energy and Resource Centre (MERC) (the Proposal).

The MERC has been designed to thermally treat a design capacity of 380,000 tonnes per annum (tpa) of waste feedstock, consisting of residual Municipal Solid Waste (MSW) and residual commercial waste, which is waste that would otherwise be sent to landfill. Waste feedstock processed by the MERC will be subject to a Waste Acceptance Protocol to determine eligibility and suitability for processing both prior to arrival and upon arrival on-site. The Proposal will also incorporate maturation and processing of bottom ash to recover recyclable metals, with the intent to utilise the remaining ash as an aggregate in construction.

Residual waste is waste that is left over from recycling and resource recovery operations and waste from source separated collections. Source separation involves separating waste into common material streams or categories for separate collection. Waste processed at the site will be subject to a Waste Acceptance Protocol to ensure only appropriate waste is used as feedstock.

The WtE process would generate approximately 46.3MW gross of electricity, 4.7MW of which would be used to power the facility itself and the associated on-site by-product and residue handling processes, with 41.6MW (328,700 MWh/year) exported to the grid as base load electricity. In addition to supplying electricity to the grid, there is also potential to supply energy in the form of heat and/or process steam to local industrial users.

Some residual materials are produced because of the WtE process, including Incinerator Bottom Ash (IBA), boiler ash and flue gas treatment residue. The boiler ash and flue gas treatment residue are typically combined and together are referred to as Air Pollution Control residue (APCr). Overall, the WtE process typically leads to about 90% reduction in the volume, or 80% reduction in mass (tonnes), of waste that would otherwise go to landfill. If IBA is reused as an alternative construction product to virgin materials, this percentage increases further to approximately 95% reduction in volume and mass of waste that would otherwise go to landfill. The final volume of waste diverted from landfill is dependent on the classification and market for the residues and by-products generated by the WtE facility.

The Proposal includes the construction and operation of an IBA maturation and processing facility on site. The purpose of this facility is to store the IBA to mature (stabilise) it, before mechanically processing IBA from the WtE facility into an aggregate for reuse. As part of this process, both ferrous and non-ferrous metals will be recovered from the IBA for recycling and sale to market.

The Proposal also includes a stabilisation facility for APCr, a necessary treatment step to immobilise leachable components of the APCr prior to removal from site by vehicle and disposal at an appropriately licenced landfill.

The Proposal will use best available techniques and technologies in the engineering design, operation, maintenance and monitoring activities associated with the MERC. Moving grate technology has been chosen as the means to thermally treat incoming waste to recover energy and other resources. Current international best-practice techniques, including automated combustion controls and advanced flue gas treatment technology will be applied so that air emissions meet stringent emission standards. The moving grate combustion system is a common form of thermal WtE technology in which the waste is fed through the combustion chamber on a travelling grate. This enables efficient and complete combustion of the waste, with primary combustion air introduced from below the grate and secondary combustion air introduced directly into the combustion zone above the grate. Moving grate technology has been used globally for over 100 years, and in that time the technology has been subject to continual improvement responding to regulatory, industry and public demands. There are approximately 500 similar operational examples across Europe alone, the majority of which use the moving grate-type technology being proposed for the MERC.

The Proposal involves the building of all onsite infrastructure required to support the WtE facility, including site utilities, internal roads, weighbridges, parking and hardstand areas, stormwater infrastructure, fencing and landscaping. The Proposal will also include a visitor and education centre to help educate and inform the community on the circular economy, recycling, resource recovery, the benefits of landfill diversion and the WtE process. The intent behind this education is to drive a shift in community thinking and actions around waste management.

The Victorian Waste to Energy Framework (2021) recognises the role of WtE to divert waste from landfills, helping Victoria transition to a circular economy. *Recycling Victoria* recognises a role for WtE investment and supports WtE facilities where they meet best-practice environment protection requirements. This includes reducing waste to landfill, supporting waste avoidance, reusing and recycling, and demonstrating social license with affected communities. The Victorian Environment Protection Authority (EPA) Energy from Waste Guideline (Publication 1559, 1 July 2017) also notes that efficient recovery of energy from the thermal processing of waste is considered a resource recovery as opposed to a waste disposal option.

The EPA VIC Guideline: Energy from Waste stipulates that *'Proponents of EfW proposals…will be expected to demonstrate that the siting, design, construction and operation of EfW facilities will incorporate best practice measures for the protection of the land, water and air environments as well as for energy efficiency and greenhouse gas emissions management. Facilities should be able to provide evidence of how they minimise and manage emissions (including pollutants, odour, dust, litter, noise and residual waste) in accordance with relevant statutory requirements.*'

The WtE facility has been designed to meet the European Industrial Emissions Directive (IED) (2010) and the associated Best Available Techniques Reference (BREF) Document for Waste Incineration published December 2019, which sets the European Union environmental standards for waste incineration. The facility will also comply with the technical criteria set out in the EPA Victoria Guideline: Energy from Waste publication 1559.1.

The purpose of this specialist assessment is to demonstrate compliance with the various authority requirements, develop community support and social license.

1.4 Regulatory Context and State of Knowledge

This section sets out the waste and residue management legislation, policy and guidelines applicable to MERC. Together, these documents form the current 'state of knowledge' for waste and residue management as it pertains to the MERC facility.

1.4.1 Commonwealth Legislation

Relevant Commonwealth legislation is discussed in Chapters 4 and 5 of the DLA.

1.4.2 State Legislation

Relevant State legislation is discussed in detail in Chapters 4 and 5 of the DLA.

Specific legislation that has been considered in relation to waste management includes:

- Environment Protection Regulations 2021 (particularly with respect to Schedule 5 waste classifications)

1.4.3 Policy, Standards and Guidelines

Specific policies and guidance documents that have been considered in relation to waste management include:

- Recycling Victoria: a new economy (2020).
- EPA Publication 1756.2: Summary of Waste Framework
- EPA Publication 1827.2: Waste Classification Assessment Protocol
- EPA Publication 1828.2: Waste disposal categories – characteristics and thresholds

1.4.4 Waste Framework

Changes to the EP Act and EP Regulations in 2021 have resulted in a significant update to the regulatory framework for waste management and introduced the General Environmental Duty (GED). In relation to waste, the EP Act requires duty holders to:

- Manage risks to human health and the environment from waste; and
- Support and encourage waste resource recovery and reuse.

The three steps for a duty holder to manage industrial waste under the EP Act and Regulations are:

1. **Waste Classification**: Properly identify and classify wastes so that it is clear what duties apply to managing the waste. This involves:
    a. Finding the relevant waste codes
    b. Determining if it is industrial waste, priority waste or reportable priority waste and which waste duties apply
    c. For priority waste going to landfill or for soil that is priority waste, determining which priority waste category applies.

The EPA can also issue a ‘Designation’ if a waste cannot be readily classified. A Designation will apply to a specific waste producer for the specified waste only.

2. **Waste Transportation**: provide sufficient information to waste transporters and undertake waste tracking and reporting to the EPA for reportable priority waste
3. **Lawful Place**: ensure that industrial waste only goes to a destination with lawful authority to receive it.

An overview of the EP Act waste framework is provided in Figure 1.

Figure 1: Overview of the waste framework (EPA 1756.2)

Waste is divided into three categories (refer to Figure 2):

- Industrial waste - waste arising from commercial, industrial, trade activities or from laboratories, or waste that has been prescribed as industrial waste. Includes municipal waste once it is received at a premises for any waste and resource recovery activity.
- Priority waste – any waste that is prescribed to be priority waste for the purposes of:
  - Eliminating or reducing risks of harm to human health or the environment
  - Ensuring waste is managed in accordance with the duties
  - Facilitating waste reduction, resource recovery and resource efficiency.
- Reportable priority waste – a subset of priority waste with the highest controls.

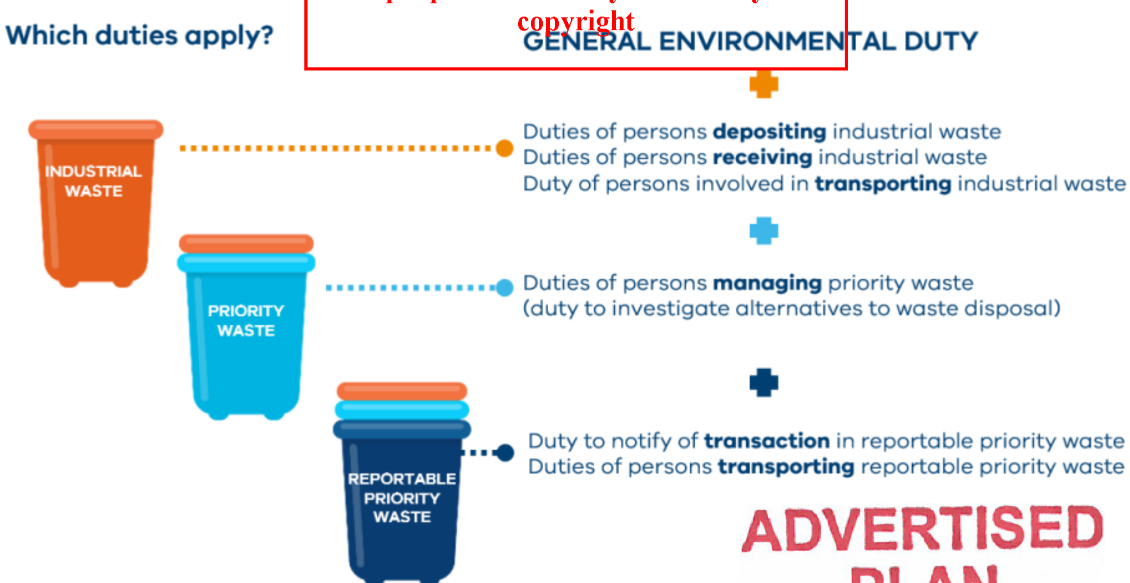

Figure 2: Waste types and their duties (note: duties are accumulative) (EPA 1756.2)

The classification of waste involves determining the relevant waste code(s), as set out in Schedule 5 of the EP Regulations. Wastes in this schedule have been pre-classified so that relevant obligations for waste generators and waste transporters can be readily identified. For wastes not in this schedule, EPA Publication

1827.2 Waste classification assessment protocol and EPA Publication 1968.1 Guide to classifying industrial waste, may be used.

Priority wastes consigned for disposal to landfill require categorisation. The priority waste category indicates the lawful place (which landfills can receive the waste) and the waste levy to be paid for disposal at a landfill. The priority waste category depends on how hazardous the waste is. Priority waste categories are determined based on contaminant concentrations and leachability, and are identified in Schedule 6 of the Regulations. Table 1 summarises the categories. EPA Publication 1828.2: Waste disposal categories – characteristics and thresholds, sets out the total and leachable concentrations of a range of chemicals used to determine the categorisation and acceptable handling and disposal pathways for soils and industrial wastes or waste mixtures containing potentially hazardous chemicals. Additionally, some substances not included in 1828.2 (such as dioxins & furans) have been addressed within this report.

Table 1: Management options for each hazard category

Category	Management Option
A	Category A is for the most hazardous wastes which cannot be disposed of to landfill without treatment. Treated waste may be reclassified as less hazardous Category B, C or D waste. It can then be managed under that category. Category A is industrial waste that can be classified as a Dangerous Good, generates gases that can be classified as a Dangerous Good, or with contaminant concentration or leachable concentration greater than the upper limits for Category B.
B	For Category B waste, the waste code and type determine how it must be managed before it goes to landfill. The priority waste category only tells you which landfill it can be disposed of at. Category B waste is industrial waste with contaminant concentration or leachable concentration greater than the upper limits for Category C.
C	For Category C waste, the waste code and type determine how it must be managed before it goes to landfill. The priority waste category only tells you which landfill it can be disposed of at (a landfill which can accept Category B or C). Category C waste is industrial waste with contaminant concentration or leachable concentration greater than the upper limits for Category C.
D	Category D waste is for soils only, with contaminant concentration exceeding the upper limits for fill materials, but not exceeding the Category D contaminant or leachable concentrations.
Industrial Waste	Industrial wastes are not regulated as Priority wastes, but when disposed of to landfill, continue to be controlled by EPA. These wastes can be accepted at solid inert landfills (non-putrescible) or municipal solid waste landfills (putrescible) licenced by EPA to accept this type of waste.

The Victorian waste categorisation guidelines use two tests:

- The total contaminant (TC) concentration of any chemical contaminant in the waste, expressed as milligrams per kilogram (mg/kg). This is to be assessed against the relevant TC threshold for each waste category.
- The leachable contaminant concentration of any chemical contaminant using the Australian Standard Leaching Procedure (ASLP), determined in accordance with AS 4439.2 and 4439.3, expressed as milligrams per litre (mg/L). This is to be assessed against the relevant ASLP threshold for each waste category.

Assessment must be for all chemical substances known and reasonably expected to be present in the waste.

In addition to the chemical analysis testing, a hazard characteristics assessment is used to determine whether waste displays any of the specific hazard characteristics listed in Table 1 of EPA 1828 2. Any solid industrial waste which displays one or more of the hazard characteristics listed is classified as Category A. The list of hazard characteristics is as follows:

- Explosive Wastes
- Flammable Solid Wastes
- Wastes liable to spontaneous combustion
- Wastes which, in contact with water, emit flammable gases
- Oxidising wastes

- Organic peroxide wastes
- Infectious wastes
- Corrosive wastes
- Wastes that liberate toxic gases in contact with air or water
- Wastes capable of yielding another material which possesses any of the characteristics above
- Non-corrosive acids and alkaline wastes
- Soil containing asbestos only
- Packaged waste asbestos.

Table 2 summarises the environmental duties relating to the management of wastes generated and handled at MERC.

Table 2: Summary of environmental duties relating to waste and resource management (EP Act, 2017)

Duty	Requirements
General Environmental Duty	A person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable.
Industrial Waste (Depositing)	A person must not deposit or abandon industrial waste at a place or premises, unless the place or premises is authorised to receive industrial waste.
	A person must not deposit industrial waste at a place or premises that is authorised to receive industrial waste without obtaining the consent of— (a) the holder of the permission authorising the place or premises to receive industrial waste; or (b) the occupier or person in management or control of the place or premises.
Industrial waste (Receiving)	A person in management or control of a place or premises must not receive industrial waste at the place or premises, unless the place or premises is authorised to receive industrial waste.
Industrial waste (Transporting)	Before relinquishing management or control of the industrial waste, the person must take all reasonable steps to ensure that the industrial waste is or will be— (a) transported to a place or premises that is authorised to receive industrial waste; and (b) received at a place or premises that is authorised to receive industrial waste. taking reasonable steps includes (but is not limited to) the following— (a) identifying and classifying the industrial waste (b) providing to a person who is collecting, consigning, transferring or transporting the industrial waste sufficient information regarding

Duty	Requirements
	the industrial waste to enable transportation to a place or premises that is authorised to receive industrial waste; (c) verifying that a place or premises that is proposed to receive industrial waste is authorised to receive industrial waste. A place or premises in another State or Territory of the Commonwealth is authorised to receive industrial waste if the industrial waste may be transported to, and received at, the place or premises under the law of the State or Territory in which the place or premises is located.
Priority waste (managing)	A person who has the management or control of priority waste must classify the priority waste in accordance with the EP Act and the regulations.
	A person who has the management or control of priority waste must take all reasonable steps to ensure that— (a) the priority waste is contained in a manner that prevents its escape; and (b) the priority waste is isolated in a manner that ensures resource recovery remains practicable; and (c) a person who collects, consigns, transfers or transports the priority waste is provided the following, where reasonably available— (i) information regarding the nature and type of the priority waste; (ii) information regarding any risks of harm to human health or the environment that exist in relation to the priority waste; (iii) any other information that can reasonably be expected to be necessary for the person to comply with a duty in relation to the priority waste under the EP Act.
Investigation of alternatives to waste disposal	A person who has the management or control of priority waste must— (a) take all reasonable steps to identify and assess alternatives to waste disposal for the priority waste, including— (i) reuse and recycling of the priority waste; and (ii) if the person produced or generated the priority waste, avoiding producing or generating similar priority waste in the future; and (b) have regard to the following in making a decision relating to management of the priority waste— (i) alternatives to waste disposal identified and assessed under paragraph (a); (ii) any guidelines issued by the Authority relating to alternatives to waste disposal for that type of priority waste; (iii) the objects of this Chapter. Taking reasonable steps includes (but is not limited to) the following—

Duty	Requirements
	(a) considering any guidelines issued by the Authority relating to alternatives to waste disposal for that type of priority waste; (b) considering any other relevant guidelines or publications; (c) considering the availability of any relevant technology used in resource recovery; (d) consulting a person or body with relevant expertise relating to alternatives to waste disposal for that type of priority waste
Reportable priority waste (transaction)	A person undertaking a prescribed transaction in connection with reportable priority waste must— (a) record the prescribed transaction details in the prescribed manner and form; and (b) provide the prescribed transaction details to a prescribed person in the prescribed manner and form.
Reportable priority waste (transportation)	A person must not— (a) transport reportable priority waste other than in accordance with a permission; or (b) cause or permit the transport of reportable priority waste other than where the reportable priority waste is transported in accordance with a permission

1.4.5 Waste Hierarchy

The waste hierarchy is one of the principles of environment protection outlined in the EP Act. The principle states:

Waste should be managed in accordance with the following order of preference, so far as reasonably practicable –

(a) *Avoidance;*

(b) *Reuse;*

(c) *Recycling;*

(d) *Recovery of energy;*

(e) *Containment;*

(f) *Waste disposal.*

The primary objective of MERC is to support best practice waste management by upholding the waste hierarchy, which recognises recycling and recovery as higher order actions than disposal. MERC will divert waste from landfill, in order to minimise disposal, supporting the Victorian Government targets for recycling and landfill diversion, responsible waste management and reducing the burden of landfills on the environment and communities. In doing so, MERC will recover energy and recyclable materials from the feedstock that would otherwise have been destined for disposal.

Opportunities for the facility to manage process waste in line with the waste hierarchy include:

- Recovery of construction spoil – to be re-used on-site as a fill material
- From the Incinerator Bottom Ash (IBA) stream, prior to re-use or disposal, the facility intends to recover metals (ferrous and non-ferrous) for recycling

- Source separation of recyclable materials generated in construction and operations (in offices/visitor centre)
- Recovery of energy from residual wastes generated in operations (in offices/visitor centre)
- Treatment of Air Pollution Control residue (APCr) prior to disposal
- Containment, classification and correct identification of non-recyclable wastes, including reportable priority wastes, to ensure that these can be correctly treated and disposed by waste contractors.

1.4.6 Precedent for waste management at WtE facilities

The major waste streams generated by MERC during operation will be IBA and Air Pollution Control Residues (APCr). These are solid waste streams which contain the incombustible fraction of the process feedstock and residues from the flue gas treatment process (spent chemicals and dust) in combination with boiler ash.

There are currently no WtE facilities operating in Australia. Consequently, direct sampling and testing of IBA and APCr arising from Australian waste streams is not possible. The expected classification of thermal treatment residues is based on the residue composition information for the Covanta Dublin WtE reference facility (Reference facilities are introduced in Chapter 5) and leachability data for matured IBA from a Danish WtE facility. The Victorian Waste Classification Thresholds have been applied to this data in Section 2 to determine expected classifications.

International test procedures prescribed for waste testing differ from standard procedures prescribed in Victoria. In some cases, this creates uncertainty in the interpretation of results against the Victoria Waste Classification Guidelines. Potential sources of uncertainty are identified and discussed.

Direct testing of MERC residues will be possible during the commissioning phase. The Victoria Waste Classification Guidelines prescribed standard testing procedures will be used to confirm the waste classifications for those residues requiring disposal. Whilst the preference is for the re-use of IBAA where possible, and the expectation is that IBAA will not require disposal, classification will still be required for IBA/IBAA to allow for contingency disposal and will be required for the disposal of APCr.

During the commissioning phase it is also recommended that precedent end-of-waste characterisation and quality testing procedures, which are expected to be implemented in Western Australia (for the Kwinana and East Rockingham WtE projects currently under construction) and/or the Maryvale WtE facility in Victoria (due to commence construction in 2024), be used to confirm the quality of the IBA and its suitability for reuse as an alternative civil construction product. Characterisation of thermal treatment residues during commissioning will be noted in the Commissioning Plan.

In international jurisdictions it is common to re-use IBA as a construction aggregate. The Maryvale facility has been granted approval for a bottom ash processing facility and both Kwinana WtE (now known as Avertas Energy) project partner Blue Phoenix and the East Rockingham WtE facilities have constructed dedicated IBA processing facilities, however the re-use pathway is yet to be established in Victoria. For more details on the management pathways for IBA and APCr, refer to Section 2.

1.5 Waste Management Assessment

Construction waste has been determined based on on-site inspections and typical construction activities of this scale, to determine the likely material types that will be generated and the appropriate management requirements for these materials.

Operational waste has been outlined based on typical waste generation in commercial and industrial activities, similar to the site office and visitor and education centre.

Waste substances arising during commissioning and operation from the thermal processing of waste to recover energy (thermal treatment residues) are discussed separately in Section 2.

1.5.1 Existing conditions

The site currently contains a residential building which generates municipal waste and is serviced by a four-bin kerbside system (residual waste, comingled recycling and glass, opt-in FOGO) as part of the City of Whittlesea's regular waste collection services.

The residence on site will be demolished as part of the construction of the WtE facility. The City of Whittlesea will cease to service the site.

1.5.2 Construction waste generation and management

Waste will be generated at the site during the construction phase of the proposal. Construction waste will be managed in line with best practice guidance (as per EPA Publication 1834: Civil Construction, Building and Demolition Guide 2020) to prevent environmental damage and, where possible, recover materials for reuse and recycling. Construction waste generation and management will be documented in a CWMP before starting onsite works. The CWMP will outline:

- Types and volumes of waste likely to be generated
- The procedure for assessing, classifying and storing waste in line with the EP Regulations
- Storage and treatment of waste on site including stockpiles
- Methods of transport and disposal of wastes, including priority and reportable priority wastes, so that any waste leaving the site is transported and disposed of lawfully and does not pose a risk to human health or the environment
- All opportunities for reducing waste, reusing materials and increasing recycling
- Requirements for compliance with the EP Act
- Any exemptions required for construction phase waste management

The CWMP will reflect the core principles of the waste hierarchy and waste framework:

- Waste is to be minimised wherever practicable
- Waste should be separated where practicable to maximise resource recovery
- Waste should be contained to avoid generation of odour, leachate, windblown litter and vermin attraction
- Industrial wastes, priority wastes and reportable priority wastes will be identified and classified in order to identify and comply with relevant waste duties (Step 1 – classification)
- Waste removal by appropriately licenced waste transporters, complying with waste duties (Step 2 – transportation)
- Consignment of waste streams for recovery or disposal at an appropriately licenced facility (Step 3 – lawful place).
- Waste transactions will be recorded and shared with the EPA Waste Tracker System where necessary.

The largest waste stream arising from the construction phase of MERC will be spoil (soil and rock) from the excavation and site enabling works. Ground investigations at the site identified a low risk of contamination and the material type is likely to be suitable for re-use. Preliminary earthworks design indicates no net export of material from the site will be required, with surplus from cut/fill balance to be re-used onsite for landscape design purposes.

Other minor construction waste materials include excess masonry and concrete, offcuts and packaging materials. These items are not priority wastes under Schedule 5 of the EP Regulations (Refer items 115-128) and do not have associated reporting or tracking duties. However, the GED and associated environmental duties for depositing, receiving and transporting the waste still apply. C&D waste typically lends itself to source separation (i.e. different receptacles for various waste materials generated) and Cleanaway will implement systems to achieve source separation for reuse/recycling as part of the construction of the MERC, in order to maximise resource recovery and achieve the highest order outcomes possible.

The existing farmhouse, along with some agricultural infrastructure (such as fences and troughs) will need to be demolished/removed as part of the project and will fall under the same classifications as construction waste.

Biodiversity assessments are being undertaken which will identify high-threat weeds present on the site. If high-threat weeds are present, a Weed Management Plan will be developed, specifying appropriate control and disposal measures to minimise impacts associated with the spread of weeds and plant pathogens. Weed management will need to be considered in the CWMP.

1.5.3 Commissioning waste generation and management

All waste generated at the MERC during commissioning will be contained in appropriately labelled containers while on site and removed by appropriately licenced waste transporters for management at a lawful place.

Commissioning related wastes are expected to include pre-commissioning wastes associated with lubricating oil flushing of hydraulic units and wastewater from boiler chemical cleaning as well as operational residues such as IBA and APCr, though in more varying compositions and quantities relative to normal steady state operation as the extent of operation will vary whilst the Commissioning Plan is executed. Commissioning waste streams are identified in Table 3.

The MERC Commissioning Plan will identify procedures for testing residues to confirm process operating performance (e.g., IBA unburnt carbon content to meet environmental and combustion performance guarantee requirements), residue treatment requirements (e.g. establishing APCr blending requirements for stabilisation) and testing requirements for residues requiring disposal offsite (e.g. blended and cured APCr).

During commissioning, management procedures (for IBA and APCr) may be refined based on the results of the testing undertaken. Sufficient space is provided on site such that no waste will require transportation off site prior to undergoing an appropriate stabilisation process.

1.5.4 Operational waste generation and management

Operational waste can be described in several sub- categories. These include:

- WtE process residues
- Municipal-type waste (from offices, visitor centre)
- Commercial-type wastes from facility operation

Cleanaway is committed to demonstrating best practice in waste management and resource recovery by ensuring that source separation systems are in place for all relevant operational waste streams. This includes paper and card, comingled recyclables, organic waste and e-waste. Operational waste streams are identified in Table 3.

All waste generated at the MERC during operation will be contained in correctly labelled containers while on site and removed by appropriately licenced waste transporters for management at a lawful place.

An OWMP will be developed during detailed design and will include:

- Types and quantities of waste expected to be generated
- Waste storage area details, including:
    - Location of storage area
    - Bin sizes and quantities (aligned with expected generation and collection frequency)
    - Facilitating equipment (such as scales, sinks, bin wash and compactors) as determined relevant

- Collection frequencies and access for the collection vehicle
- Requirements for compliance with relevant legislation (including waste classification).

Preliminary waste generation rates have been estimated by applying the typical waste generation rates for offices, published in the City of Melbourne Guidelines for Waste Management Plans (2021). The facility layout includes approximately 3200m^2 of floor area between the visitor centre and administration buildings, which will generate operational waste similar to a commercial office. As a conservative estimate for this DLA it is assumed that the entire area operates as an office. Waste generation estimates will be refined during the detailed design stage as the OWMP is developed.

Wastes will be segregated into appropriately labelled and colour-coded receptacles. Waste segregation enables recovery of recyclable materials and appropriate containment and management of higher risk materials. Waste and recyclable materials will be removed from the site by appropriately licensed contractors and reused, recycled or disposed of at appropriately licensed facilities (lawful place). Cleanaway offers collection services for commercial and industrial waste as part of its core business and is likely to service the site during operation. Various other private service providers may be used at the facility and the site operator will provide contractors with all necessary waste classification information to enable them to comply with any relevant waste tracking and reporting duties.

Given that source separation systems will be in place to support high-value recovery of all relevant waste streams, the residual waste generated by the facility will be eligible for energy recovery under the Victorian Energy from Waste Framework (refer Chapter 5 State of Knowledge for details).. Residual waste from onsite operations will be subject to the same waste acceptance criteria as waste from external sources.

Domestic-type waste, generated by the operators of the facility typically within the kitchen, meeting rooms and workshops and from packaging for delivered parts and equipment, will be managed separately to priority wastes. Domestic-type wastes will be source-separated for recycling, where practicable, and collected regularly by waste collection contractors or Cleanaway's own service staff as required.

Sewage will be generated through routine operations in minor quantities (~2000L/day) via the use of staff amenities, lunch rooms, etc. At this stage of design it is proposed that a septic holding tank be installed on-site and the wastewater treated and re-used on site, for landscape irrigation purposes (after treatment to an appropriate standard).

1.5.5 Waste classifications

Table 3 identifies materials which may arise as waste streams during commissioning and operation of the facility and classifies them in accordance with Schedule 5 of the EP Regulations. Several streams (thermal treatment residues) are expected to be generated as part of normal operations, and their classification and management pathways are discussed further in Section 2.

Other streams are expected to be generated in minor quantities (some regularly, some irregularly as part of maintenance operations, as identified in Table 3). If waste streams are generated during construction and operation that are not identified in Table 3, they will be classified and managed on a case-by-case basis in accordance with the EP Act (using Schedule 5 of the EP Regulations 2021 and EPA Publications 1828.2 and 1968.1, as required).

Table 3: Identification and expected classification of likely construction, commissioning and operational solid waste streams

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
Waste streams primarily generated during construction						
Excavated soil and rock	Construction	Significant generation during site establishment works. Note: Site investigations identified risk of contamination as low and material should be suitable for re-use.	Excavated material or engineered fill including fill material	N122	N/A – GED applies	On-site reuse as part of landscape design.
General construction and demolition waste	Construction	Moderate generation during construction activities	Untreated timber, including sawdust Concrete Rubble Steel	K310-NH Y100 Y120 Z300	N/A – GED applies	Material transported off-site for recycling/recovery opportunities at various facilities depending on stream (timber, metals etc)
Liquid effluent from construction amenities	Construction	Routine generation in minor quantities	Septic tank waste	K410	Priority waste	Collected in portable toilets on site and transported off-site for disposal at appropriately licensed facility.
Wash-water from concrete wash-out plant (if required)	Construction	Routine generation in minor quantities	Industrial wastewaters (excluding sewage) not otherwise specified in this schedule	L200-H	Reportable priority waste (transactions and transport)	Collected on-site and transported off-site for disposal at appropriately licensed facility.
Waste streams primarily generated during commissioning						
Boiler and pressure piping hydrostatic pressure test water	Construction /Commissioning	Likely once off for each boiler and associated pressure piping as part of hydrotest procedure	Industrial wastewaters (excluding sewage) which meets conditions relating to wastewater reuse in a permission	L200-NH	Priority waste	Wastewater transported offsite for treatment and re-use as appropriate.
Waste streams primarily generated during operation						

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
Operational waste – WtE process residues						
Incinerator Bottom Ash (IBA) **Note: IBA Contains boiler ash from the radiative section of the boiler**	Commissioning (hot) and Operation	Thermal treatment residue ~95,000tpa (dry weight, before metals recovery)	Residues from industrial waste treatment/ disposal operations, including digestate, bottom ash and char	N205 (prior to maturation and treatment)	Reportable priority waste (transactions and transport) (prior to maturation and treatment)	Metals recovery on-site IBA reuse off-site (after treatment, pending approval). Alternatively, as a contingency only, disposal at appropriate facility (expected to be Industrial waste after maturation and recovery of recyclable metals).
Air Pollution Control Residues (APCr) **Note: APCr contains boiler ash from the convective section of the boiler, and fly ash (captured in the baghouse)**	Commissioning (hot) and Operation	Thermal treatment residue ~16,000tpa (dry weight, before stabilisation)	Residue from pollution control operations, including baghouse dust and activated carbon	N210	Reportable priority waste (transactions and transport)	On-site treatment to reduce leachability of contaminants. Disposal at appropriately licensed facility (expected to be Category B priority waste after treatment)
			Fly ash	N150		
			Encapsulated, chemically-fixed, solidified or polymerised hazardous wastes	N160		
			Filter cake contaminated with residues of hazardous substances	N190		
			Alkaline solids or alkaline solutions with pH value of 10 or more, including caustic soda, alkaline cleaners and waste lime	C100		

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
Oversize waste rejected from IBA	Operation	Oversized materials that are unsuitable to convey to the IBA treatment area	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected	Combustible waste may be returned to the waste bunker (after shredding), while oversized metal objects may be recycled as scrap metal, with recovered scrap metals. Waste that is unsuitable for reprocessing or recycling to be assessed on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected
Operational waste – municipal-type waste						
Recyclable streams arising from office, lunch rooms, visitor centre etc	Operation	Routine generation in minor quantities ~17,500L/y organic waste ~5,000L/y comingled recycling ~110,000L/y paper/card (volume estimates are conservative and will be revised during development of OWMP)	Solid commercial food wastes Glass Metals Cardboard Plastics	K210 Z100 Z300/310/320 Z400/Z420/Z430 Z500	N/A GED applies	Materials source separated and transported off-site for recycling/recovery opportunities at various facilities depending on stream (organics, plastics, paper/card etc)
Residual waste arising from office, lunch rooms, visitor centre etc **Note: To contain only items which cannot be practicably source-separated for higher order recovery.**	Operation	Routine generation in minor quantities ~100,000L/y Mixed industrial waste residues that are not suitable or practicable to source separate for recycling	Compounds containing glass, metals and plastics Contaminated cardboard Textiles	Z100 Z300/310/320 Z400/Z420/Z430 Z500 X100	N/A GED applies	Energy recovery on-site

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
		(Volume estimates are conservative and will be revised during development of OWMP)				
Operational waste – commercial-type waste						
Unacceptable waste feedstock	Operation	Waste received but unacceptable for processing Intermittent generation during operation, minor quantities	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected	To be determined on a case-by-case basis as per Schedule 5 of the Regulation (or publication 1828.2 as required) for the specific material type rejected
Pallets (from deliveries)	Construction and Operation	Routine generation in minor quantities	Untreated timber, including sawdust	K310 – NH	N/A – GED applies	Reused or returned to suppliers in most cases.
Green waste	Construction and Operation	Moderate quantities generated during site clearing works and maintenance of landscaped areas during operation.	Commercial garden & landscaping organics that does not contain any physical or chemical contamination	K300	N/A – GED applies	On-site or off-site re-use as mulch
Packaging	Construction and Operation	Routine generation in minor quantities. Items likely to include: Plastic bags Boxes Plastic wrap (pallets)	Plastics Cardboard	Z500 Z400	N/A – GED applies	Material transported off-site as discrete streams for recycling/recovery opportunities at various facilities depending on stream (plastics, cardboard etc)
Operator and operational consumables **(Note: Chemical consumables are included in APCr.)**	Construction and Operation	Routine generation in minor quantities. (PPE, disposable plastic equipment, disposable/damaged glass equipment)	Plastics Glass	Z500 Z100	N/A – GED applies	Off-site recycling or disposal at appropriately licensed facility.

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
Workshop and maintenance consumables (such as paints, oils, solvents, greases)	Construction and Operation	Routine generation in minor quantities. Various items are possible	Aqueous-based wastes from the production, formulation and use of paints, lacquers, varnish, inks, dyes and pigments Solvent-based wastes from the production, formulation and use of paints, lacquers, varnish, inks, dyes and pigments Waste oils, hydrocarbons, emulsions and transformer fluids excluding poly-chlorinated biphenyls Wastes from the production, formulation and use of organic solvents	F100 F120 J100 G160	Reportable priority waste (transactions and transport).	Transported off-site for disposal at appropriately licensed facility
Empty paint, oil, chemical, solvent, grease containers	Construction and Operation	Routine generation in minor quantities	Rigid steel or plastic containers with an original volume less than 200L contaminated with reportable priority waste (transport)	N100	Reportable priority waste (transactions and transport)	Transported off-site for disposal at appropriately licensed facility
Worn or broken baghouse filter bags	Operation	Routine though infrequent generation in minor quantities	Residue from pollution control operations, including baghouse dust and activated carbon	N210	Reportable priority waste (transactions and transport)	Disposal at appropriately licensed facility
Firewater run-off	Construction, Commissioning and/or Operation	No routine generation (emergency measure only)	Industrial wastewaters (excluding sewage)	L200-H or L200-NH depending on contamination	Reportable priority waste (transactions and transport) if L200-H	Firewater to be retained on-site to prevent off-site contamination of waterways and groundwater. Testing may be required to determine re-use

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
						opportunities, treatment required or lawful place of disposal.
Lubricating oil flush for hydraulic units (e.g. steam turbine and grate hydraulics)	Commissioning and Operation	Infrequent generation arising from commissioning and maintenance works.	Waste oils, hydrocarbons, emulsions and transformer fluids excluding poly-chlorinated biphenyls	J100	Reportable priority waste (transactions and transport).	Transported off-site for disposal at appropriately licensed facility
Boiler initial chemical clean and excess boiler drain down wastewater	Commissioning and Operation	Infrequent generation arising from commissioning and maintenance works.	Industrial wastewaters (excluding sewage) not otherwise specified in this schedule	L200-H (for commissioning wastewater)	Reportable priority waste (transactions and transport) (for commissioning wastewater)	Collected on-site and transported off-site for disposal at appropriately licensed facility. Test boiler drain down water quality (demineralised water quality) to confirm suitability for reuse or disposal.
Chemical clean up/spill kits	Operation	No routine generation (contingency measure only)	Absorbents contaminated with residues of priority wastes	N250	Reportable priority waste (transactions and transport)	Off-site disposal at appropriately licensed facility.
Waste activated carbon from secondary odour control	Operation	No routine generation (contingency measure only) Classification to be confirmed (separate from baghouse system).	Residue from pollution control operations, including baghouse dust and activated carbon	N210	Reportable priority waste (transactions and transport)	Off-site disposal at appropriately licensed facility.
Laboratory testing chemicals	Operation	Routine generation in minor quantities.	Waste chemical substances arising from laboratories, research and development, or teaching activities	T100	Reportable priority waste (transactions and transport)	Off-site disposal at appropriately licensed facility

Waste material	Generated in	Expected generation, description and quantity	Description (Schedule 5 EP Regulations) (Expected)	Waste code (Schedule 5) (Expected)	Waste classification and duties (Schedule 5) (Expected)	Management pathway
Liquid effluent from site amenities	Operation	Routine generation in minor quantities (~2,000L/day)	Septic tank waste	K410	Priority waste	Collected in on-site septic tank and re-used on-site as irrigation water after treatment to appropriate standard.
Leachate from IBA generated under emergency provisions **(Note: to be reused within on-site process in normal operations)**	Operation	No routine generation (emergency measure only)	Leachate from waste treatment/ disposal operations	T330	Reportable priority waste (transactions and transport).	Disposed of at an off-site appropriately licensed facility
Stormwater interceptor and Gross Pollutant Trap (GPT) wastes	Operation	Routine generation in minor quantities. GPTs installed in stormwater network. Oil/water separators installed in stormwater network in sensitive areas.	Triple interceptor waste and stormwater contaminated with oil or hydrocarbon	J130	Reportable priority waste (transactions and transport).	Transported off-site for disposal at appropriately licensed facility
Replacement equipment (process)	Operation	Infrequent generation arising from maintenance works.	Metals or plastics	Z300, Z310, Z320, Z500 (depending on material)	Industrial waste	Recycling (various opportunities depending on material)
Replacement equipment (electronic)	Operation	Infrequent generation arising from maintenance works.	E-waste	T300	Priority waste	Recycling

1.6 Risk Management

This section summarises the waste management risk assessment in relation to both construction and operational impacts. A complete register of risks to human health and the environment, and controls for each risk for the project, is provided in Table 4. The key risks related to waste management in construction and operation are identified and discussed below.

Risk controls have been developed as far as appropriate at this stage of the design. Further risk assessments will be undertaken during the detailed design process to identify additional risks and mitigation pathways, so far as reasonably practicable, to meet the GED.

1.6.1 Assessment and mitigation of risks

Table 4 outlines the risks identified that are associated with waste management, and the proposed management measures that have been developed to mitigate the risks of the proposal during construction and operation.

Table 4: Risk assessment and mitigation measures for waste management

Risk	Mitigation measure
Handling or contact with contaminated soil (such as with agricultural chemicals), causing risk to human health	Soil removed during earthworks to be assessed and remediated as necessary (noting site investigations did not identify a likelihood of contamination).
Waste of recyclable resources through unnecessary disposal to landfill	Waste to be managed in line with the waste hierarchy. Construction Waste Management Plan to include provisions for segregation and separate collection of recoverable materials, including green waste.
Escape of waste or runoff from waste, causing pollution of land or waterways including groundwater	Construction Waste Management Plan to include measures for the containment of waste during storage and transport, such as covering, fencing, bunding. Septic waste to be managed in purpose-built portable toilets, serviced by an appropriately licensed contractor/provider. Construction assessment to include consideration of large rainfall events and collection/containment/disposal of wastewater during construction (such as for fire suppression). Commissioning Plan to include consideration of containment and disposal of boiler chemical cleaning wastewater and waste lubricants used for flushing of hydraulic units.
Spread of weeds, pests or pathogens within recovered waste materials	If noxious weeds are identified through the ecology assessment, a Weed Management Plan will be developed, outlining appropriate control and disposal options.
Disposal of construction waste to an unlawful place	Construction Waste Management Plan to classify wastes in accordance with the EP Act and include a requirement that all wastes will be delivered to an appropriately licensed facility for recovery or disposal. Transport documentation to be provided as required. Commissioning Plan to include testing of solid residues IBA and stabilised APCr for waste classification purposes, for those residues requiring disposal to a lawful place.

Risk	Mitigation measure
Storage of hazardous/dangerous waste materials in an inappropriate way	Site construction plan to include hazardous waste storage areas and transport considerations.
Concrete laden water infiltrating into soil and waterways	Site construction plan to include methods for capture, storage and transport of concrete washout water (if required). Appropriate plant and equipment to be used.
Waste of recyclable resources through unnecessary disposal to landfill	Waste to be managed in line with the waste hierarchy. Operational Waste Management Plan to include provisions for segregation and separate collection of recoverable materials, including paper and card, organics and green waste. No recyclable operational waste to be disposed into waste bunker. Infrastructure and processing procedures developed for metals recovery from IBA.
Spillage of thermal treatment residues during on-site handling	IBA: Conveyor to be enclosed to contain IBA and dust. Handling and storage is undertaken on hardstand area where spillage can be contained. Dust is controlled by spraying water on the IBA storage piles. APCr: 'big-bags' for filling with stabilised APCr (cured on-site) are to be waterproof and closed before transport.
Uncontained leachate from storage of thermal treatment residues	IBA "Leachate" consists of excess rainwater run-off from the IBA treatment area and stockpiles which may contain dust (solids) and salts absorbed in water run-off from stockpiles, road washing and other dust suppression activities. IBA leachate is collected on the hardstand area and contained within a dedicated attenuation basin. IBA leachate will be used on the IBA storage piles to maintain moisture levels. APCr curing is to occur in an undercover space within waterproof bags.
Overflow of attenuation basin for leachate storage caused by a large rainfall event.	Attenuation basins have been appropriately sized to contain large rainfall events (refer civil design for details). In an emergency scenario, basins may be emptied with wastewater transported off-site to reduce risk of overflow.
Increased volume of IBA, or longer maturation period required, leading to spillage/overflow of IBA outside designated storage area.	Storage area provided is significantly larger than calculations indicate will be required. Spatial provision allowed for expansion to the IBA area if necessary / as part of future development. Ongoing monitoring of IBA generation and storage.
Increased volume of APCr, or longer curing period required leading to outside storage of APCr.	Storage area provided is significantly larger than calculations indicate will be required. Spatial provision allowed for expansion to the APCr area if necessary / as part of future development. Ongoing monitoring of APCr generation and storage.

Risk	Mitigation measure
Change in chemical composition of IBA leading to unlawful disposal pathway	Treated IBA that is found to be unsuitable for reuse will be tested in accordance with Vic EPA waste classification protocols.
Dust explosion caused by ignition in the presence of suspended dust in processing areas for IBA, cement and/or APCr	Where appropriate, conveyors are to be enclosed to contain dust (some conveyors e.g. for wet IBA do not need to be enclosed, and in fact, some ventilation is beneficial to prevent potential build-up of any evolved hydrogen gas, as discussed below). Implementation of sanitation and cleaning schedules to prevent any pervasive dust accumulation, this may include washdown procedures. Adequate ventilation to remove suspended dust. Buildings and conveyors designed with fire suppression systems, including sprinklers. Management and removal of ignition sources. This should include inherently safe design of moving mechanical equipment to prevent spark or static ignition. Permit to work orders must consider the introduction of ignition sources to the process area.
Exposure of operators and environment to hazardous dust caused by breakage or crushing of APCr concrete	APCr concrete is contained within 'big-bags' which will contain dust in the event of a concrete breakage.
Odour or vermin associated with operational waste, resulting in loss of amenity for workers, visitors, and neighbours	Waste Management Plan to be developed during detailed design for the adequate provision of storage and collection of waste, which is to consider ventilation and vermin-proofing. General housekeeping of all areas to prevent odour and vermin.
Escape of litter causing harm to wildlife, loss of amenity	Waste Management Plan to be developed during detailed design for the adequate provision of storage and collection of waste.
Harm to wildlife resulting from exposure to hazardous waste material inside the property boundary	Waste with the potential to cause harm to be appropriately contained at all times on site. Site infrastructure (fences, buildings etc) will discourage wildlife from interaction with site operations.
Disposal of waste to an unlawful place	Operational Waste Management Plan to classify wastes and include requirement that all wastes will be delivered to an appropriately licensed facility for recovery or disposal. Transport documentation to be provided as required.
Escape of firewater, causing pollution of land or waterways including groundwater	Operational Waste Management Plan to include measures for collection/containment/disposal of wastewater from fire suppression. Firewater associated with extinguishing a fire in the waste bunker will be retained within the waste bunker and processed with the waste.

Risk	Mitigation measure
Hydrogen can be generated in fresh IBA depending on the content of metallic aluminium, pH and residence time.	Fresh IBA will not be stored indoors for extended periods. Design of IBA materials handling system to ensure good ventilation and to eliminate confined spaces where hydrogen gas (lighter than air) could accumulate. Bottom ash vapour extraction fans are connected to the Emergency Diesel Generator.
IBA and/or APCr containing levels of emerging contaminants of concern such as dioxins and furans that may be re-formed as the combustion gases/products cool.	The MERC will undertake testing of the IBA and APCr for dioxins, furans and dioxin-like PCBs: - Monthly for the first year of operation - Quarterly thereafter. The flue gas treatment system (reagent use) will be optimised to control acid gases, metals and dioxins.

2. Residues from thermal treatment

Combustion of waste creates solid residues (ash) that must be managed appropriately. MERC will produce two types of thermal treatment residues from the energy recovery process:

1. *Incinerator Bottom Ash* – IBA is the primarily inert, non-combustible component of the waste that is left on the grate at the end of the combustion process. It is collected at the bottom of the grate and contains non-ferrous and ferrous metals that can be recovered.

   Some of the lighter particles of ash from the combustion process becomes entrained in the flue gases and is carried into the heat transfer section of the boiler, and is called radiant boiler ash, convective boiler ash, or fly ash depending on where it is collected.

   Boiler ash is the name given to the ash that is then deposited in the boiler hoppers located at low points and below each heat exchanger tube bank, before any flue gas treatment reagents are injected into the process. With reference to Figure 4, radiant boiler ash, which is the portion of boiler ash collected from the radiant section passes of the boiler (extracted via a screw conveyer at the bottom of the boiler's vertical 2nd and 3rd pass, i.e., in the high temperature section of the boiler) is suitable for recovery in construction applications and will be mixed with the IBA. This resource recovery practice is noted in the BREF WI (2019) and is known to occur in EU Member States such as Norway and Denmark, which have strict local regulations to minimise landfill disposal and maximise resource recovery.

   The expected generation for this stream is approximately 95,000 tpa dry weight, or 25% of the waste feedstock content.

2. *Air Pollution Control residues* – APCr is the mixture of convective boiler ash (boiler ash from the convective section of the boiler), fly ash (which is residual particulate matter remaining in the flue gas when it reaches the bag house), neutralisation reaction salts formed from the reaction between acid gases in the flue gas and lime reagent, excess lime reagent and spent powdered activated carbon. With reference to Figure 4, boiler ash captured downstream of the vertical 3rd pass (the cooler convective section of the boiler) is expected to contain higher concentrations of heavy metals and will be diverted to the APCr stream for treatment and disposal. Fly ash, neutralisation reaction salts, powdered activated carbon and solid lime reagent are separated from the flue gas by the baghouse filter section of the Flue Gas Treatment system. Since the baghouse filter cake contains unspent reagents, the majority is recirculated to the reactor section of the Flue Gas Treatment system, to minimise fresh reagent consumption. A small purge stream of baghouse filter cake is removed to prevent the build-up of fly ash, neutralisation reaction salts and spent powdered activated carbon within the Flue Gas Treatment system.

   This purge stream and the convective boiler ash are combined and are together referred to as APCr. APCr is temporarily stored in silos prior to treatment to stabilise the material prior to landfill disposal. The APCr represents a small proportion of the total residues collected and is typically equivalent to 3-4.5% of the total weight of the waste feedstock processed. The expected generation rate for this stream prior to stabilisation is approximately 14,600tpa (dry weight).

Figure 3 below shows the various WtE process residue streams and how these process residues flow into the two managed thermal treatment residues.

The key objectives of the residue management systems are to maximise resource recovery where feasible and to stabilise residues that are not suitable for recovery, prior to landfill disposal.

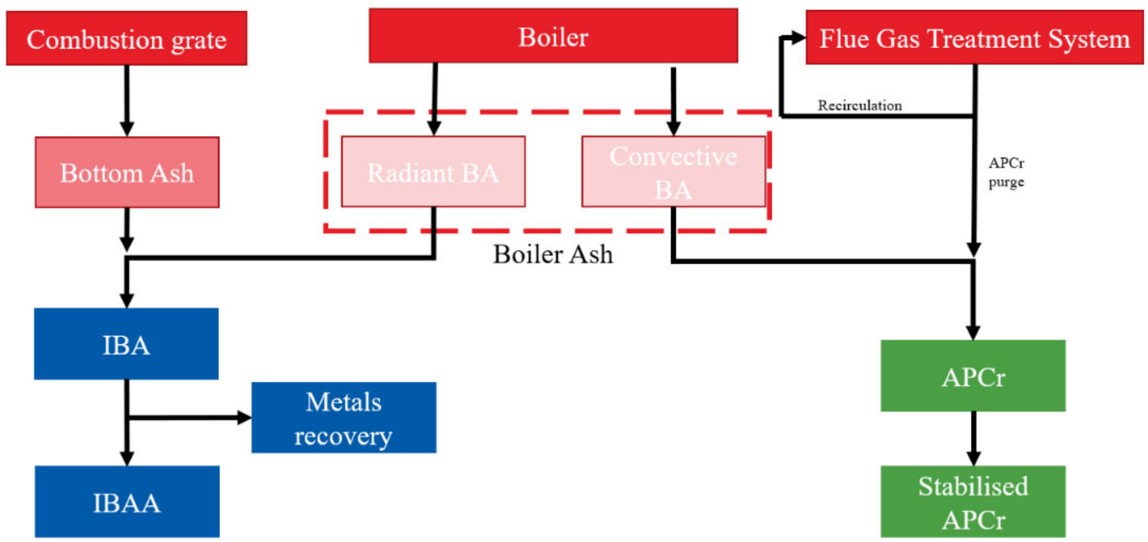

Figure 3 Process residues from thermal treatment

The boiler ash is distributed between the IBA (for radiant boiler ash) and APCr (for convective boiler ash) streams for relevant handling and management. The expected generation from this stream is approximately 2,320tpa (dry weight) in total or less than 1% of the feedstock by weight. The radiant boiler ash is expected to be less than 1% of the IBA by weight.

Incinerator Bottom Ash Aggregate (IBAA) is the name given to the matured and stabilised product that is suitable for reuse markets.

Figure 4 illustrates the collection points for the radiant and convective boiler ash streams.

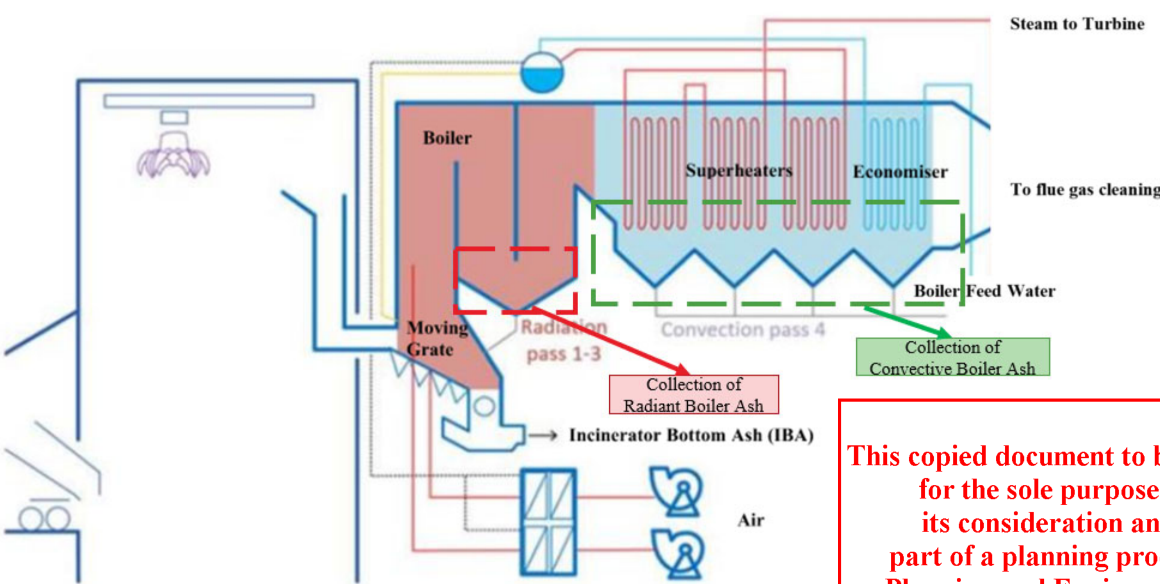

Figure 4 Radiant and Convective Boiler Ash residues

2.1 Residue classification

All WtE residues and by-products must be characterised and managed according to the EP Regulations.

The characteristics and classification of the thermal treatment residue streams informs appropriate onsite handling and pathways for recovery or disposal. The MERC preferred approach is to establish recycling pathways where possible, while also identifying appropriate disposal options, so that environmental protection is maintained while recycling outlets are unavailable for any reason.

There are currently no WtE facilities operating in Australia. Consequently, direct sampling and testing of IBA arising from Australian waste streams is not possible. The expected classification of thermal treatment residues is based on the residue composition information for the Dublin reference facility and data from Denmark (provided by Ramboll).

The test procedures prescribed for waste testing in Ireland differ from standard procedures prescribed in Victoria. In some cases, this creates uncertainty in the interpretation of results against the Victoria Waste Classification Guidelines. Potential sources of uncertainty are identified and discussed in the following sections.

Direct testing of MERC residues will be possible during the commissioning phase. The Victoria Waste Classification Guidelines prescribed standard testing procedures will be used to confirm the waste classifications for those residues requiring disposal. Whilst the preference is for the re-use of IBAA where possible, and the expectation is that IBAA will not require disposal, classification will still be required for IBA/IBAA to allow for contingency disposal and will be required for the disposal of APCr. It is important to note that IBA disposal is a contingency only (during the commissioning period or in the event that IBA quality deteriorates due to a process fault). In addition to the standard testing procedures the MERC intends to test IBA and APCr at regular intervals to monitor the concentration of dioxins, furans and dioxin-like PCBs. The EPA may also require that alternative test methods (such as multiple extraction procedure) are used.

During the commissioning phase it is also recommended that precedent end-of-waste characterisation and quality testing procedures, which are expected to be implemented in Western Australia (for the Kwinana and East Rockingham WtE projects currently under construction) and/or the Maryvale WtE facility in Victoria (due to commence construction in 2023), be used to confirm the quality of the IBA and its suitability for reuse as an alternative civil construction product.

Characterisation of thermal treatment residues during commissioning will be included in the Commissioning Plan.

2.1.1 Incinerator Bottom Ash

The composition of IBA residues from the Dublin reference facility was obtained through the EPA Ireland. A detailed report on Characterisation and Classification of IBA was submitted to the regulator on 20 November 2019 in support of IBA classification as non-hazardous waste and is publicly available for download.[1]

The IBA characterisation and classification report is based on a full suite of 'hazardous property testing' for waste classification, performed by WRc laboratories on 11 samples of IBA collected from the Dublin reference facility in 2018. The ash was representative of material as it is transported off the Dublin site and prior to any maturation processes, which are undertaken at an overseas IBA recycling facility.

Of these 11 samples:

- 1 sample was tested against all 15 HP (Hazardous Property) characteristics
- 7 samples were tested against the 4 HP characteristics which are most relevant to IBA (HP 4/8 - irritancy/corrosivity, HP7 – carcinogenicity, HP 14 – ecotoxicity)
- 4 samples were submitted to detailed minerology testing, which informed the assessment of ecotoxic fractions of some metals for which the total metal content exceeded the basic HP14 threshold

[1] Available from: http://www.epa.ie/licences/lic_eDMS/090151b280733e4b.pdf

- Further testing was performed involving chemical speciation and thermodynamic modelling, to allow the assessment of HP14 ecotoxicity to be refined.

Leachability testing was conducted, however is not presented here as the testing reflects the leachability of raw IBA, which is not a waste product from MERC. MERC's raw IBA will be matured on site (described further in section 2.2.1), a process which involves chemical changes that contribute to the immobilisation of contaminants to reduce the leachability of compounds (total concentration is largely unaffected by the maturation process). The IBA will then undergo metals recovery at a dedicated on-site ash sorting facility. IBAA is the final by-product to be re-used or disposed, if not in specification, and is therefore the relevant waste stream to categorise under the Victorian framework (noting that the characterisation is only applicable for disposal purposes, not for re-use). IBAA leachability data has been provided by Ramboll from an example Danish EfW plant (which processes MSW and C&I waste streams using the same technology on a similar scale to the MERC). Leachability was assessed using the European standard EN 12457-1 methodology.

The Victoria Waste Classification Guidelines prescribe leachability testing in accordance with Australian Standards AS 4439.2-1997 and AS 4439.3—1997 and are expressed as an ASLP value in the Australian Standard Leaching Procedure. It is noted that the AS standard test procedures are likely to be different to the European Standards test procedures. Aspects that may vary include the liquid: solid ratio and implementation of pH correction. As such, results cannot be directly compared with a high degree of accuracy. However, where the reference facility test results are well below the Victoria waste classification thresholds, the expected classification can still be determined. It is recognised that the EPA may require further procedures (such as the multiple extraction procedure) to confirm long-term leachability performance.

There are also differences in the suite of compounds required to be tested in each jurisdiction. Table 5 compares the total contaminant concentration for all compounds which were tested at the Dublin reference facility and for which a threshold is specified in the Victoria Waste Classification Guidelines. Leachability data was more limited and is provided for the compounds where it was available.

Table 5: IBA and IBAA characterisation based on reference data (comparison to waste classifications only relevant for disposal, not recovery)

Category *Note 1*	IBAA Leachability (Ramboll data – average of 8 samples)	Dublin IBA 1st phase testing	Dublin IBA 2nd phase testing	VIC Industrial waste / Category D – upper limits *Note 2*		VIC Category C upper limits		VIC Category B upper limits		Preliminary Categorisation
Component	mg/L L/S 2, EN12457-1 Test procedure.	Maximum 'as received' mg/kg	Maximum 'as received' mg/kg	ASLP mg/L *Note 3*	TC mg/kg *Note 4*	ASLP mg/L	TC mg/kg	ASLP mg/L	TC mg/kg	Industrial Waste/ Priority waste C/B/A
Antimony	Not available	46.7	71.3	0.15	75	0.3	75	1.2	300	Industrial Waste
Arsenic (As)	0.002	8.65	15.5	0.5	500	1	500	4	2000	Industrial Waste
Barium	Not available	396	899	100	6250	200	6250	800	25000	Industrial Waste
Beryllium (Be)	Not available	0.87	0.92	3	100	N/A	100	N/A	400	Industrial Waste
Boron	Not available	136	161	200	15000	400	15000	1600	60000	Industrial Waste
Cadmium (Cd)	0.0003	14.8	21.3	0.1	100	0.2	100	0.8	400	Industrial Waste
Chromium VI (Cr)	0.04	<0.09	nd	2.5	500	5	500	20	2000	Industrial Waste
Copper	1.21	2105	2927	100	5000	200	5000	800	20000	Industrial Waste
Cyanide (free)	Not available	<0.82	nd	1.75	300	3.5	300	14	1200	Industrial Waste
Cyanide (total)	Not available	<0.82	nd	4	2500	8	2500	32	10000	Industrial Waste
Lead	0.01	1,254	1,316	0.5	1500	1	1500	4	6000	Industrial Waste
Mercury (Hg)	Not available	0.42	0.46	0.05	75	0.1	75	0.4	300	Industrial Waste
Molybdenum (Mo)	Not available	14.7	13.8	2.5	1000	5	1000	20	4000	Industrial Waste
Nickel (Ni)	0.005	94.9	107	1	3000	2	3000	8	12000	Industrial Waste
Polycyclic aromatic hydrocarbons PAH (total)	Not available	6.98 (one sample. All others nd)	nd	N/A	50	N/A	100	N/A	400	Industrial Waste
PCBs *Note 5*	Not available	0.000008	nd	N/A	2	N/A	50	N/A	*Note 6*	Industrial Waste
Phenol (total)	Not available	1.07	nd	7	560	14	560	56	2200	Industrial Waste
Silver (Ag)	Not available	5.05	7.25	5	180	N/A	180	N/A	720	Industrial Waste
Selenium (Se)	Not available	0.45	0.46	0.5	10000	1	10000	4	40000	Industrial Waste
Zinc	0.04	1901	2841	150	35000	300	35000	1200	140000	Industrial Waste

All values are below the threshold for the designated classification	
More than one value exceeds the threshold for the designated classification	**Bold values indicate the determining figures**
One value exceeds the threshold for the designated classification. All other values value are below the threshold for the designated classification	**Bold values indicate the determining figure**

Note 1: In this table, N/A means there is no applicable compliance value for this contaminant and the category will be determined by the available values for the contaminant. Not available means the test was not undertaken for this substance. nd means the substance was not detected in the sample.

Note 2: Category D upper limits are only applicable to contaminated soils. Waste other than contaminated soils which have contaminant leachable concentration and TC concentrations less than the 'Category D / industrial waste upper limit' are industrial waste.

Note 3: Unless otherwise specified, leachable concentration values are derived from the National Health and Medical Research Council (2011) Australian Drinking Water Guidelines (Version 3.5 updated August 2018).

Note 4: Unless otherwise specified, TC for inorganic species and anions are derived from National Environment Protection Measure on the Assessment of Site Contamination 1999, Health Investigation Level for Commercial/Industrial land.

Note 5: Management of PCBs is based on the Polychlorinated Biphenyls Management Plan (2003, Australian and New Zealand Environment and Conservation Council (ANZECC).

Note 6: Leachable Concentration based on NSW - Waste Classification Guidelines Part 1: Classifying waste,

2014. Maximum values for leachable concentration when used together with specific contaminant concentration.

Based on the IBA testing results for the Dublin reference facility, and the accompanying IBAA testing results for leachability, Lead and Antimony content govern the classification of this reference facility IBAA stream. Whilst the results presented fall into the industrial waste category, at least one of these measurements was nearing the upper threshold. It is possible that IBAA samples at MERC will exceed these thresholds.

The data indicates with a high degree of confidence that the concentration of all other compounds fall within the 'Industrial waste' classification based on the TC contaminant concentration threshold and the ASLP threshold from leachability testing. In addition, all samples from the other reference facilities (Gloucestershire and Greatmoor) were categorised as 'non-hazardous' in 2020 and 2021, indicating Industrial waste to be an appropriate classification (noting that test procedures and criteria in the UK will be different to Victoria).

Furthermore, in some jurisdictions, including the UK, convective boiler ash is allowed to be mixed with IBA. This would result in IBA containing higher concentrations of some hazardous compounds, including heavy metals. It is unknown if the Dublin facility mixes convective boiler ash with IBA. If this is the case, the Dublin data represents a conservative initial estimate of the likely concentrations of hazardous compounds in MERC's IBA.

It is therefore expected that IBAA from the MERC facility will be classified as Industrial Waste and managed accordingly (refer section 2.2.1). However, given there remains some uncertainty about the Lead and Antimony levels, direct laboratory testing of matured IBA should be conducted during the commissioning phase.

It is possible that an alternative classification may be indicated. Alternative residue handling and management pathways will be prepared for this possibility during detailed design / operational readiness and would be enacted based on testing results.

The proposed management method for IBA is discussed in Section 2.2.1.

2.1.2 Air Pollution Control residues

Data has been obtained through a Freedom of Information Request on the analysis of APCr for the Dublin reference facility. The dataset analyses the key elements of the waste that could be classified as hazardous. The reference facility dataset does not include typical major constituents such as calcium or silicon as these are inherent in any ash stream and thus did not need to be analysed. A typical compositional make up of APCr is provided in Table 6.

Table 6: Typical composition of APCr

Element	Average Composition (mg/kg)
Ca	230,000
Cl	18,000
Si	69,000
Mg	9,400
Fe	12,000
Al	26,000
K	23,000
Na	17,000
Zn	15,000
S	15,000
Pb	5,400
Ti	3,300
Mn	480
Ba	540
Sn	890
Cu	710

Table 7 **c**ompares the maximum concentration of compounds which were tested at the Dublin reference facility with the corresponding contaminant threshold stated in the Victoria Waste Classification Guidelines. The maximum values were chosen from the data set to be as conservative as possible in the analysis.

The Dublin reference facility tested for twenty contaminants; only 13 of the contaminants correlate with the thresholds stated in the Victoria Waste Classification Guidelines.

Table 7: Comparison of Victoria Waste Classification thresholds to Dublin APCr testing data for maximum contaminant concentration

Category	Dublin APCr testing	VIC industrial waste – upper limits	VIC Category C upper limits	VIC Category B upper limits	Category
Component	Maximum mg/kg (dry basis)	TC (mg/kg)	TC (mg/kg)	TC (mg/kg)	Industrial Waste/ Priority Waste C / B / A
Antimony	690	75	75	300	Priority Waste A
Arsenic (As)	67	500	500	2000	Industrial Waste
Barium	1200	6250	6250	25000	Industrial Waste
Cadmium (Cd)	180	100	100	400	Priority Waste B
Chromium	180	500	500	2000	Industrial Waste
Copper	750	5000	5000	20000	Industrial Waste
Fluoride	170	10000	10000	40000	Industrial Waste
Lead	2200	1500	1500	6000	Priority Waste B
Mercury (Hg)	8	75	75	300	Industrial Waste
Molybdenum (Mo)	33	1000	1000	4000	Industrial Waste
Nickel (Ni)	150	3000	3000	12000	Industrial Waste
Selenium (Se)	8	10000	10000	40000	Industrial Waste
Zinc	11000	35000	35000	140000	Industrial Waste

Based on the APCr results from the Dublin reference facility, it can be seen that several components exceed the threshold for industrial waste. In this sample, the Antimony content would govern the classification of the APCr stream. This compound exceeds the TC upper limit value for Category B Priority waste.

Leachability test results for Dublin were not available, so could not be compared. However, because Antimony levels are classified as Category A, the APCr will already be classified as a Category A priority waste and will require treatment prior to disposal. Direct testing of raw and stabilised APCr from the MERC facility using the Victorian Waste Classification Guidelines will be essential during the commissioning phase to confirm the waste classification and level of treatment required.

The proposed management method for APCr is discussed in Section 2.2.2.

2.2 Proposed management pathways for process residues

2.2.1 Incinerator Bottom Ash (and Aggregate)

Waste codes provided in the EP Regulations that may apply to IBA are:

- Residues from industrial waste treatment/ disposal operations, including digestate, bottom ash and char – Waste code N205.

This waste code is ‘pre-classified’ as a priority waste and a reportable priority waste for transactions and transport.

IBA Stabilisation and Maturation Process and IBA Aggregate Production

IBA will be the largest solid residue stream generated by the MERC energy recovery operations.
The proposed IBA treatment process after its extraction from the WtE process will enable recovery of valuable metals for recycling, ensure efficient and safe handling and will achieve a residual product which can be reused, as has been successfully and safely demonstrated globally. A key objective is to optimise resource recovery outcomes for all residues produced by the MERC.

Boiler ash collected from the boiler radiant section (vertical passes 2 and 3) will be combined with the IBA stream. This approach is recognised by the BREF-WI as a typical procedure for EU Member States. The stabilisation and treatment process for IBA will be a multi-stage process which is consistent with BAT 36 for increasing the resource efficiency for the treatment of IBA. The MERC IBA/IBAA treatment process will be confirmed during detailed design as end-user requirements become clear, however will include maturation and metals recovery, and is likely to include various mechanical processing techniques, such as:

- Screening and sieving
- Crushing
- Air separation for lighter materials
- Recovery of ferrous and non-ferrous metals

In summary:

- IBA will be quenched at the bottom of the grate with water to cool the IBA, which the IBA will then be conveyed to the IBA treatment area. At the IBA treatment area, the IBA will be matured in temporary stockpiles. IBA maturation consists of storage for a period of approximately 2-12 weeks (testing during commissioning phase and from time to time throughout operation is required to confirm this duration). This maturation process will occur in the open air and is a widespread treatment method in Europe. It will result in a reduction of the leaching of metals through both oxidation and a natural carbonation process in which carbon dioxide absorbed from the atmosphere binds the metals to the mineral parts of the moist IBA. The aging process will also lower the pH, remove or transform organic ligands and reduces the reactivity of the IBA. These are all important for making the IBA suitable for construction applications. This maturation process is recognised as best practice in BAT 36 (e). During maturation, the IBA stockpiles will be wetted to facilitate the chemical reactions and control fugitive dust emissions and may also be turned to ensure homogeneity of the processes that occur during the maturation process (uptake of CO_2 from air due to the moisture, drainage of excess water, oxidation, etc.). According to the BREF-WI (2019), this also helps to reduce the necessary residence time for maturation of each batch of IBA.

- The IBA stream will contain metals, which can be recovered for recycling. Ferrous and non-ferrous metals will be recovered on-site within the IBA treatment area. This process may involve the use of various techniques including sieving, magnetic separation, eddy current separation, sensor technology and crushing/milling to separate metals from the IBA. All mechanical separation and processing of IBA will occur within the 'IBA Hall' building to control noise, water and dust emissions. Dust management techniques include a combination of managing the IBA moisture content and the use of enclosed conveyors.

- Further processing such as product size grading may be undertaken as required by offtake customer re-use application specifications. After maturation and sorting to recover metals, the remaining inert aggregate product is referred to as Incinerator Bottom Ash Aggregate (IBAA). The IBA stockpile storage area is sized such that it is suitable to store the IBA for up to three months during the maturation process and a further three to four months of IBAA product storage, prior to dispatch to an offtake customer. Cleanaway intend to select a reputable, experienced provider for IBA/IBAA processing equipment that can supply best available technology. Specific equipment has not been identified at this stage of design due to the developing IBAA re-use market.

IBAA Reuse

In Europe, it is common to reuse IBAA as an aggregate for construction purposes, such as for road-base or 'in-fill' materials. Regulations for IBA utilisation are set by each country.

A precedent for the re-use of IBAA in Victoria is anticipated in the coming years, with the Maryvale Energy from Waste facility proposed by Opal ANZ/ Masdar Tribe/Veolia/Paper Australia (Maryvale facility) having recently been granted approval to construct an IBA recycling facility, to produce an aggregate for use in road construction. It is expected that the aggregate may be used as a sub-base, fill or aggregate input to asphalt or concrete production and the aggregate will be aligned with VicRoads Class 3 and Class 4 aggregate performance standards[2].

Most of the IBAA generated at the MERC is expected to be reused for purposes similar to that described above, with the expectation that acceptable environmental and geotechnical properties would be established for re-use in construction applications. The market and associated product quality specifications for IBAA will be developed in consultation with potential offtake customers seeking a recycled material as an alternative to traditional quarried materials. While alternatives to IBAA such as quarried gravel are reasonably cheap within Australia, major construction projects are proactively seeking or requiring the use of recycled materials as an alternative to natural quarried materials. To ensure sufficient volumes of IBAA are available to facilitate export on a campaign basis, additional on-site storage is provided. Alternative options for IBAA reuse could include its use as daily cover material at landfill sites instead of traditional materials such as soil. Cleanaway will continue to engage with the local market prior to the MERC's operational date.

The preferred pathway for the IBAA at MERC is to recycle and reuse the material in a similar fashion to the Maryvale facility. As the Maryvale facility will process residual MSW and C&I waste (a similar feedstock stream to the MERC), it is expected that an aggregate of similar standard can be produced. However, approval will need to be obtained to confirm the end-of-waste re-use status for the IBAA, and market development will need to be undertaken to enable this reuse pathway. It is intended that analysis and testing for the processing of the IBA residue into IBAA and recyclable metals would be undertaken during the commissioning phase.

Given the immaturity of this industry, in the short term a disposal pathway may be required. IBAA that requires disposal is expected to be classified as Industrial waste, based on the analysis in section 2.1.1, and will be disposed of to a suitably licensed landfill (such as Cleanaway's Melbourne Regional Landfill - License No. 12160). Testing will be required to finalise classification prior to disposal to determine the appropriately licensed disposal facility.

The management pathway for IBA/IBAA is shown schematically in Figure 5.

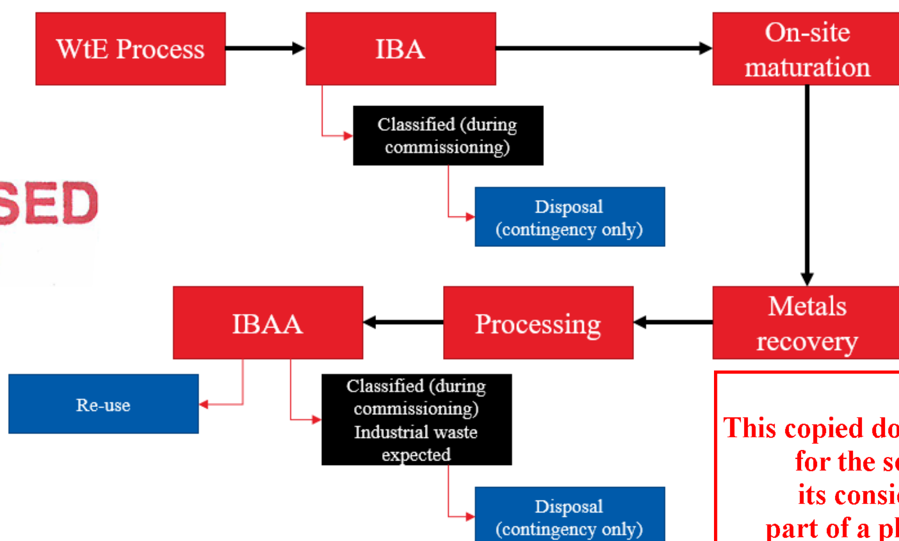

Figure 5 IBA/IBAA Management pathway

Environmental Safeguards (IBA)

Key environmental safeguards related to IBA have been considered in the development of the MERC design and are included in section 1.6 and the Environmental Risk Assessment, including:

[2] https://opalanz.com/app/uploads/2022/09/220907-Media-release-Maryvale-Bottom-Ash-Recycling-facility-approval-FINAL.pdf

- Bunding of IBA maturation area to contain leachate
- Wetting of IBA piles, screening and/or bunding to control fugitive dust emissions
- Indoor processing of IBA (to produce IBAA) to control noise and dust
- Enclosed IBA conveyor to avoid spillage and dust.

2.2.2 Air Pollution Control residue (APCr)

Waste codes provided in the EP Regulations that may apply to APCr include:

- Fly ash - Waste Code N150
- Encapsulated, chemically-fixed, solidified or polymerised hazardous wastes – Waste code N160
- Filter cake contaminated with residues of hazardous substances – Waste code N190
- Residue from pollution control operations, including baghouse dust and activated carbon – Waste Code N210
- Alkaline solids or alkaline solutions with pH value of 10 or more, including caustic soda, alkaline cleaners and waste lime – Waste Code C100.

All of these waste codes are 'pre-classified' as a priority waste and a reportable priority waste for transactions and transport.

APCr Treatment and Stabilisation

APCr, combined with the convective boiler ash recovered downstream of vertical boiler pass 3 is likely to contain hazardous levels of heavy metals and treatment will be required to immobilise contaminants.

APCr generated at MERC will need to undergo chemical composition and leachability testing in order to be accurately classified. It is expected that raw APCr would be classified as a Category A Priority Waste (as discussed in Section 2.1.2). This category of waste requires a high level of control and ongoing management to protect human health and the environment. Wastes in this category cannot be accepted at a disposal facility without prior treatment to reduce or control the hazard.

If testing during the commissioning phase demonstrates that APCr from MERC is classified as Category A priority waste, it will require treatment to reduce its classification category and allow for disposal. After treatment it will be disposed of at an appropriately classified landfill. The objective of treating the APCr prior to landfilling is to reduce the concentration and leachability of Chemicals of Potential Concern (COPC) (heavy metals and some salts), which enables compliance with the relevant landfill acceptance criteria. An on-site APCr stabilisation process area has been provided inside the WtE building for the preparation of stabilised APCr, while an area has been set aside for on-site curing and storage of the stabilised APCr prior to off-site transport to landfill disposal. Whilst the standard ASLP leachability test is expected to be a worst case test for stabilised APCr, it is recognised that the EPA may require further procedures (such as the multiple extraction procedure) to confirm long-term leachability performance.

The treatment method selected for APCr at MERC is solidification. According to the EU Best Available Techniques (BAT) Reference Document for Waste Treatment 2018 (WT BREF), this is the most widespread technology for reducing the leachability of organic and inorganic COPC in APCr in both Europe and Japan. Solidification involves mixing APCr with cement, water and other binding agents such as pozzolans (alumino-silicious material that reacts with lime and water) to increase the strength of the treated materials. This process creates a physical change and decreases the exposed surface area to leaching by immobilising the contaminants in a bound cementitious matrix. The WT BREF (2018) notes that the waste input (APCr) will react with water and the cement to form metal hydroxides or carbonates which are usually less soluble than the original metal compounds in the waste matrix. COPC can also be subject to chemical stabilisation and immobilisation reactions with components in the binding material, to be confirmed during commissioning.

Stabilisation of the APCr will be integrated with the APCr collection systems through the use of fully enclosed conveyors and APCr storage silos. The APCr storage silos prevent exposure to the external environment and provide buffer storage capacity to allow the on-site APCr stabilisation plant to operate on shift-based campaigns. The on-site stabilisation plant will allow for adjustments to the solidification process with ongoing testing for compliance with landfill waste classification criteria. Curing of the cementitious APCr mixture will reduce the permeability of the APCr and subsequent potential for leaching.

During the treatment process, the APCr is mixed into a slurry with cement and potentially other additives/binders such as pozzolans (depending on the type of cement used and desired stabilised material characteristics) as well as recycled process water (which may include harvested rainwater). The slurry is then poured directly into closable big-bags. These bags are transferred to a dedicated APCr stabilisation area for curing in an undercover area, with the encapsulation of the curing APCr mixture within the bags limiting the opportunity for dust, leachate, air emissions or chemical spills. The treated material is stored in the APCr stabilisation area for approximately 7 days whilst the curing process occurs (curing time within bags to be finalised at commissioning stage).

The basis of design for the APCr treatment on-site at MERC is provided in Table 8. Adjustments to the mixture may be required to ensure compliance with both pollutant concentration and leachability criteria associated with landfill acceptance. The mixture should be confirmed during the commissioning phase with lab-scale testing.

Table 8: APCr stabilisation design parameters

Parameter	Adopted criteria
APCr composition	Approximately 52% hydrated lime and neutralisation reaction products, 1-3% activated carbon, 45% flue gas particles (semi-dry flue gas treatment system)
APCr production	~14,600tpa
Silo size	2x 250m^3 (providing redundancy)
Cement required for treatment (as a percentage of APCr weight)	~20%
Density of immobilised APCr	1.7t/m3
Moisture content of immobilised APCr	25-35%
Immobilised APCr production	~25,000tpa
Curing time	~7 days

APCr Disposal

After treatment it is expected that the waste will be classified as Priority Waste Category B. In this event, it and will be disposed of to a suitably licensed landfill, for the long-term controlled storage and management of the stabilised APCr. Currently, suitably licensed landfills include:

- Veolia Taylors Road Landfill (VIC) (License No. 70542).
- Inkerman Landfill (SA) (License No. 14463)

Stabilisation by solidification has also been selected by Veolia as the preferred technique for implementation at its proposed Advanced Energy Recovery Centre, to be located at Woodlawn in NSW. Appendix E (Ash Management Study, 2022) from the Environmental Impact Statement (EIS) for the proposal considered a range of techniques and technology before selecting Portland cement stabilisation as the most suitable treatment option for APCr. There is limited actual performance information in the public domain regarding

APCr stabilisation using cement solidification techniques in the European context, however the Durham York Energy Centre in Canada published their commissioning test report[3] on the use of pozzolan and Portland cement solidification to render the APCr from its lime scrubbing system non-hazardous for local landfilling purposes.

Whilst the initially proposed management pathway is treatment and disposal, MERC will manage APCr in line with the waste hierarchy and therefore the preference is to recover materials from the APCr if possible (without compromising the environment or human health). Technologies are currently emerging in international markets which may make the recovery of valuable resources from APCr possible in the future. Cleanaway will continue to investigate methods for increased resource recovery from the APCr stream throughout design and operation.

The management pathway for APCr is shown schematically in Figure 6

Environmental Safeguards (APCr)

Key environmental safeguards related to APCr have been considered in the development of the MERC design and are included in section 1.6 and the Environmental Risk Assessment, including:

- Controlled handling of untreated APCr in enclosed conveyor systems into dedicated temporary buffer storage silos
- Preparation of stabilised APCr to occur inside a building to control dust, noise and spills
- Controlled handling of APCr into slurry form and bagging of stabilised APCr (using big-bags) to control spillage, emissions and leachate and to facilitate transportation
- Undercover area to facilitate curing while protecting from inclement weather

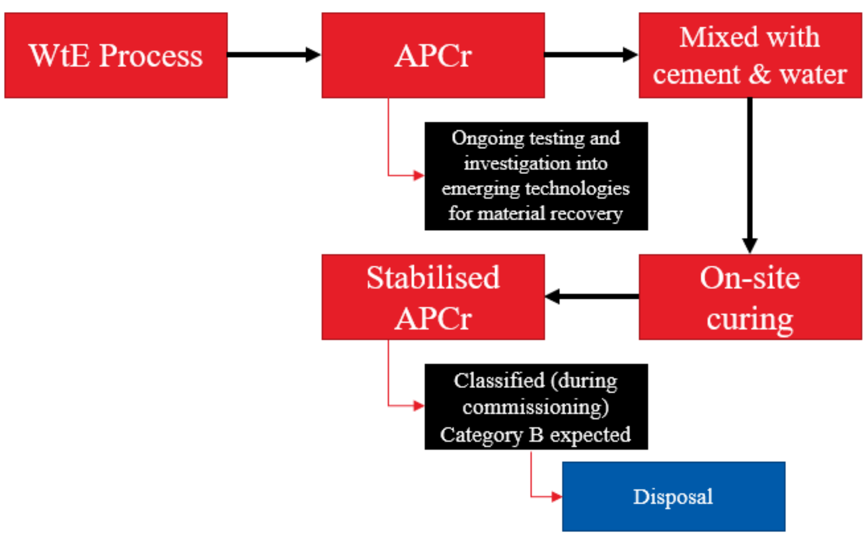

Figure 6 APCr Management pathway

[3] https://www.durhamyorkwaste.ca/en/environmental-monitoring/environmental-monitoring.aspx

3. Conclusion

This report has identified the relevant waste streams generated during construction and operation of the MERC. Waste streams have been classified according to Victorian Regulations and guidelines where possible, with the exceptions of IBAA and APCr. The classification of these residues will need to be determined during the commissioning phase of the facility via chemical testing.

In this report, potential risks associated with waste management, including environmental pollution, human health and outcomes under the waste hierarchy have been identified for the Proposal. The control measures identified at this stage represent reasonable steps to avoid and minimise impacts to human health and the environment, whilst noting uncertainty around the exact composition of some streams.

The largest stream arising from the construction phase of the MERC will be spoil from the excavation of the facility. Ground investigations at the site identified a low risk of contaminated land and concluded that spoil from site excavations is likely to be classified as fill material, making it suitable for re-use.

The majority of waste produced during operation of the MERC will be residues from the thermal treatment of residual MSW and C&I waste to recover energy. These have been indicatively classified and appropriate management pathways have been considered. Other waste streams, including waste arising from commissioning, operation, maintenance and general administrative activities, have been indicatively classified so that it is clear what waste duties apply.

Some aspects of the design related to waste management will be reviewed and refined during the detailed design and commissioning phases, which will need to review the latest guidance and undertake further risk assessments, including safety in design and environmental risk assessments, in order to appropriately manage the remaining risks. During the detailed design stage, further plans will need to be developed relating to waste management, including:

- Construction Waste Management Plan
- Operational Waste Management Plan
- Commissioning Plan
- Further development of management pathways for thermal treatment residues, including IBAA re-use.

Management of all wastes will be in accordance with the EP Act 2017 and EP Regulations.