Chunxing Used Lead Acid Battery (ULAB) recycling facility

Works Approval Application

Prepared for:
Chunxing Corporation Pty Ltd

Prepared by:
Ascend Waste and Environment

Date: November 2019
Geoff Latimer

Project Number:
 # 15041CH

Chunxing Corporation Pty Ltd

ASCEND
WASTE AND ENVIRONMENT

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VERSION CONTROL RECORD

Document File Name	Date Issued	Version	Author	Reviewer
15041CH Chunxing ULAB WAA - draft RevE	5 July 2019	Draft revE	G Latimer	L Jayaweera
15041CH Chunxing ULAB WAA - draft RevH	25 July 2019	Draft revH	G Latimer	L Jayaweera
15041CH Chunxing ULAB WAA - draft Rev0	26 July 2019	Draft submission to EPA	G Latimer	L Jayaweera
15041CH Chunxing ULAB WAA - final Rev0	15 November	Final submission to EPA	G Latimer	L Jayaweera

Contents

SECTION 1 – GENERAL INFORMATION

1 Primary information

1.1 Company legal entity

Applicant type (select ☒ relevant box below)					
Company	x	State government		Owners corporation	
Partnership		Local government			

Corporation	
Full name of company^	Chunxing Corporation Pty Ltd
Trading name	Chunxing
ABN	50 632 456 538
ACN	632 456 538
Registered address	Level 1, Unit 7 11 Lord Street
Suburb/Town	Botany
State	NSW
Post Code	2019

Attach – ASIC company search, not more than 14 days old

^ In the case of a partnership, the application must specify the full names of the individual partners under company name, in addition to referring to the trading name and supplying a business name certificate. Please see page 2.

A current ASIC company search is provided in ***Appendix A***.

1.2 CEO contact details

Name	Dr. Lakshman Jayaweera
Phone	+ 61 418 239441
Email	lakshman.jayaweera@jschunxing.com

1.3 Premises

Premises address	Crown Allotment (CA) 2047, Fourth Rd, Hazelwood North, Victoria

1.4 Supporting information

EPA VICTORIA
State Government Victoria

SUPPORTING INFORMATION

1. Status of application

Please ☒ to indicate if this form is submitted as a Draft Application or Formal Application:

Draft ☐ Formal X

2. Scheduled premises

Please specify scheduled premises:

I02 Metal Melting Works and A02 (Other waste treatment)

3. Pathway process

Please ☒ to indicate which pathway EPA has advised you to apply for:

Fast Track ☐ Standard X

Briefly summarise the basis for the decision:

N/A – this was EPA's decision.

4. Auditor-approved application

Please ☒ if the application has been approved by an EPA-appointed auditor:

Yes ☐ *Please attach the auditor's report/statement.*

5. Application fee

Application Fee ($)	Payment status	Please ☒ relevant box	Payment date
$66,645	By EFT	x	14 November 2019
	By credit card		
	Have not paid		

6. Proposal summary

Provide a simple, one-line project description:

To establish a Used Lead Acid Battery (ULAB) recycling plant (secondary lead smelter) at Crown Allotment (CA) 2047, Fourth Rd, Hazelwood North, near Morwell, Victoria, to process 50,000 tonnes per year of spent lead acid batteries and recycle them into 28,000 tonnes of refined lead per year.

Proposed dates:

Start construction (month/year):	August 2020	Start operation (month/year):	Dec 2021

6. Proposal summary *continued*

Is there a plan for future expansion within the next two years?

Yes ☐ No ☒

If yes, briefly explain why the planned expansion is not included in this application:

N/A

7. Checklist

Please ☒ to indicate you have attached the completed checklist after this page:

Yes ☒

Applicant statement

I declare that to the best of my knowledge the information in this application is true and correct, that I have made all the necessary enquiries and that no matters of significance have been withheld from EPA

Signed by CEO or delegate:

Signature	See separately provided signature page
Full name	Lakshman Dissanayake Jayaweera
Date	12.11.2019

1.5 Completed Works Approval Application checklist responses

2 Land use

2.1 Planning and other approvals

A planning permit is required from Latrobe City Council and an application is being prepared by Chunxing in parallel with the EPA Works Approval process.

Joint advertising can sometimes occur with EPA works approvals and Council planning permits. However, this is only the case if both processes require public notification. Current advice is that advertisements or public notifications will not be required by Council as part of the planning permit application process. Therefore, a joint process is not possible, and the planning permit application is planned for submission to Council after the EPA process has concluded, or subject to EPA's advice.

2.2 Choice of location for new premises

This proposal by Chunxing Corporation Pty Ltd is to establish a state-of-the-art technology Used Lead Acid Battery (ULAB) recycling plant at Crown Allotment (CA) 2047 Fourth Rd, Hazelwood North, near Morwell, Victoria.

A number of potential sites were evaluated for this project, including Shepparton, Vic, Gladstone, Qld and the far north of NSW. Gladstone and Shepparton have excellent transport links and industry support but the supply and transport of ULABs would be a challenge while suitable industrial land (with correct zoning) in Shepparton and the far north of NSW was an issue.

The Hazelwood North site was preferred due to its 33 acre size with correct zoning and a good buffer zone of greater than 1 km from the closest residential address/ sensitive receptor, and over 2km to the south eastern outskirts of the town of Morwell, the closest residential area.

CA 2047 Fourth Rd, Hazelwood North is within industrial 2-zoned land, surrounded by related recycling activities and heavy industries also surrounded by related recycling activities and heavy industries also in Industrial 2 zoning. The next layer of land radiating outwards from Fourth Road is zoned as Industrial 1.

A locality plan and land zoning report are provided in ***Appendix B***.

The proposed project will occupy only 50% of the land area allowing sufficient room for landscaping and buffer. An artist's depiction of what the plant will look like is provided in Figure 1, which depicts the aspect from the east (Tramway Road).

2.3 Sensitive receptors

The area immediately surrounding the site is largely agricultural and industrial. The nearest residence is approximately 1.1km away (from the nearest site boundary) and there is a primary school (Hazelwood North Primary) located approximately 1.7 km south east from the nearest point on the proposed site boundary. The nearest suburban residential area is Morwell South, its southernmost edge approximately 2.1km to the north of the proposed site.

The locations included in the air quality model (see Section 8.3) are shown in Figure 2 and Table 1. The distances indicated in the sensitive receptor labels (SR# in Figure 2) are indicative of the distance to the nearest point on the proposed site boundary.

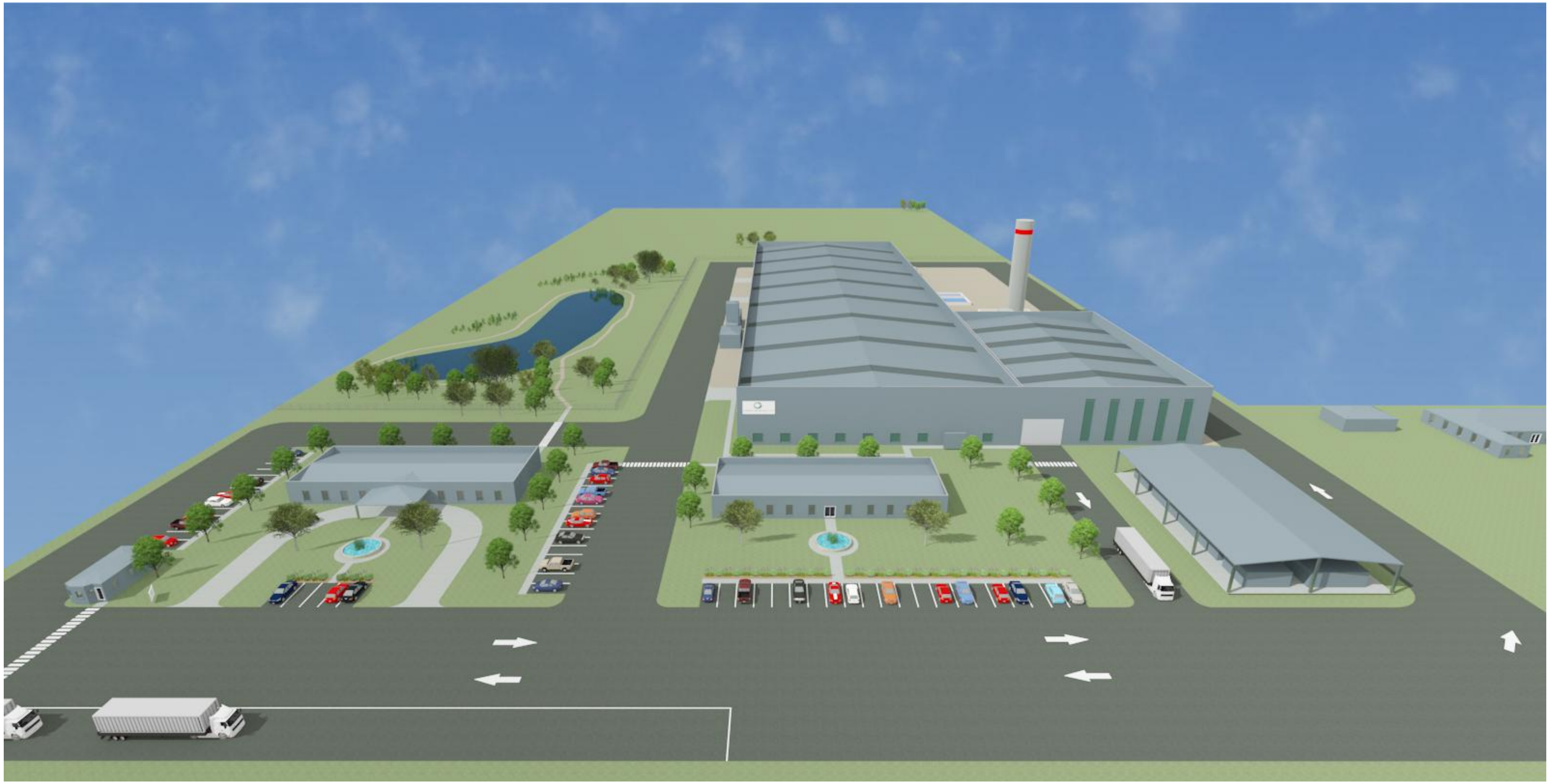

Figure 1: **Artist's impression of the Hazelwood North facility (viewed from the east)**

Figure 2: Buffer distances to the nearest sensitive receptors in all directions from the proposed site

Table 1: Location of nearest sensitive receptors

Label	Description	Coordinates	
		mE	mS
SR1	Residential address	450774.34	5764208.27
SR2	Residential address	451162.33	5764328.29
SR3	Residential address	451594.08	5764407.02
SR4	Hazelwood North Primary School	451674.43	5764241.46
SR5	Residential address	451350.53	5764077.37
SR6	Residential address	451906.15	5764816.55
SR7	Residential address	451920.37	5766261.66
SR8	Residential address	448424.49	5766536.52
SR9	Residential address	448898	5767265

A minimum buffer distance for 'non-ferrous metal production greater than 2,000 tonnes per year' is specified in EPA Publication 1518[1] as 500 metres. All residences are more than double this minimum buffer distance away.

This facility is well located from the perspectives of land use, existing air emissions profile, buffer distance (from sensitive receptors) and community impacts.

This separation distance to the nearest residence is a significant feature of the Hazelwood North site. Recent approval of a similar but much larger site in NSW (more than double the size of the Hazelwood North proposal) provides useful context. In its assessment report in February 2019, when the NSW government approved an expansion of the secondary lead smelter facility in Wagga Wagga NSW, from 70,000 tonnes of ULAB to 120,000 tonnes, the NSW Department of Planning and Environment noted with respect to the facility's buffer:

> *"No public submissions were received during the exhibition of the EIS, likely due to the isolated nature of the facility which is located 1.2km from the nearest residence."* *(emphasis added).*

3 Community engagement

A community engagement plan was prepared to guide the nature and scope of consultation with the local community. Its elements are shown in Table 2.

[1] EPA 2013, Publication 1518, *Recommended separation distances for industrial residual air emissions*, available at: https://www.epa.vic.gov.au/business-and-industry/guidelines/~/media/Publications/1518.pdf

Table 2: Identified key stakeholders

Category	Type	Potential stakeholders	Considerations	Engagement type
Neighbours	Community	Nearby residents, including nearest sensitive receptors such as: - Those residences on Church Road & surrounds - Hazelwood North Primary School - Residence on Firmins Lane - Surrounding Hazelwood North streets' residents	A minimum buffer distance for 'non-ferrous metal production' greater than 2,000 tonnes per year is specified in EPA Publication 1518 as 500 metres	Open community meetings Door-knock/ letterbox drop Project summary/ presentation copies distributed
	Business	- Other nearby zone IN2 businesses such as: - The Dasma Group - Omnia Specialties Australia - Other Hazelwood North businesses		
Government	Regulators	- EPA Victoria - Latrobe City Council - VicRoads (Regional Roads Vic) - Gippsland Water	Regulatory compliance such as environment, planning permit, dangerous goods management, worker health and safety and trade waste agreements.	Direct meeting convened at DELWP Traralgon Project summary/ presentation copies distributed EPA – various additional face to face meetings at progress points
	Other government agencies/ related entities	- Dept of Environment, Land, Water and Planning - Department of Jobs, Precincts and Regions (Regional Development Victoria- Gippsland) - Gippsland Waste and Resource Recovery Group - Latrobe Valley Authority - Latrobe Health Advocate	Regional planning and other information provision to assist the project	Direct meeting convened at DELWP Traralgon Project summary/ presentation copies distributed Individual meetings as required
Community groups	Local organised	- Latrobe Valley Sustainability Group - Voices of the Valley - Environmental Justice Association - Other community groups	Clearly articulate the purpose, benefits and potential environmental impacts of the project, how the latter will be managed and seek input, views, concerns	Introductory letters, project summary document sent Open community meetings Individual meetings as required
Business	Peak bodies	Victorian Farmers Federation Traralgon Chamber of Commerce Rotary/ Lions Clubs		
	Engineering, apprentice training & services companies	Local companies		
Local unions and related bodies	WHS reps	Gippsland Trade Council		
Local representatives	MPs Local Councillors	Ms Harriet Shing, State MP Mr Russell Northe, State MP Mr Dale Harriman, Councillor, and other Councillors, Latrobe City Council		

The approval process for this application will be via standard Works Approval, which includes statutory advertising and potentially a 'Section 20B' conference' to formally hear stakeholder views. However, to better gauge the positions of different stakeholders, Chunxing has conducted a wide range of engagements in parallel with the development of this application document:

1. Two open-to-the-public community meetings, advertised via the Latrobe Valley Express, venue Kernot Hall Morwell, on the evenings of 19 and 25 June. Distributed project summary document and presentation printout. The sessions involved a presentation followed by a lengthy audience participation Q&A.
2. All of the stakeholders listed in Table 2 were contacted in writing and/or face to face (nearby residents and businesses were door-knocked), advising of the proposal, the public sessions and provided with a project summary document.
3. All stakeholders were invited to their choice of one of these meeting options.
4. Additional one-on-one meetings were held with particular groups such as:
    a. Voices of the Valley, face to face meeting at Moe library
    b. Latrobe Valley Sustainability Group, face to face meeting at Kernot Hall
    c. Advance Morwell
    d. Government agencies meetings including: DELWP, EPA, Regional Development Victoria- Gippsland, Latrobe Valley Authority, Latrobe City Council, the Latrobe Valley Health Advocate, the Gippsland Waste and Resource Recovery Group, VicRoads (Regional Roads Victoria) and Gippsland Water
    e. Hazelwood North Action Group (once formed), face to face meetings with members on several occasions
    f. Latrobe City Council (all councilors), face to face meeting at Council offices
5. Local Councilors and Members of Parliament were also contacted by letter and met with face to face where such a meeting could be arranged
6. Multiple follow-up one on one meetings
7. A third open-to-the-public community meeting, advertised via the Latrobe Valley Express and letterbox drop, venue Hazelwood North Community Hall, on the evening of 29 October 2019. Distributed proposal fact sheet and responses to Action Group claims documents. The session involved a presentation followed by a lengthy audience participation Q&A.
8. Follow-up enquiries continue fielded by phone and in person, as required.

The first community session, held from 5-8pm on Wednesday 19th June, attracted approximately 25 attendees, while 23 attended the second. These included a good representation of people living locally (within 2 km of the site), those from nearby businesses, other interested community members and representatives from non-government organisations (NGOs) with an interest in environment and community health.

The third community meeting was held on Tuesday 29 October at the Hazelwood North Hall from 7.30pm, attracting an exceptionally large audience of approximately 160 attendees and local media. These included a good representation of people living locally (within 2 km of the site), Hazelwood North Community Action Group members, those from nearby businesses and other interested community members.

The third open session was held following two community meetings arranged by the Hazelwood North Community Action Group, on Tuesdays 15th and 22nd of October. Chunxing (and Ascend) requested to attend but this request was declined.

Outcomes from these consultations are summarised in Table 3.

Responses to the key concerns expressed at the community meetings and recorded in Table 3 are detailed in ***Appendix C***. In addition, Appendix C contains direct responses to a number of claims made by the Hazelwood North Community Action Group, which was formed after the first two public meetings were held, in meetings, media releases and related materials.

A detailed list of all engagement activities is provided in ***Appendix D***.

Table 3: Issues and concern raised by stakeholders

Category	Type	Views raised
Neighbours	Community	Those opposing the proposal raised the following views: - Cautious concern about emissions to the air from the project - Serious concern about lead emissions and their impact on health - Disbelief in the modelling data/ metereological data - Impacts on students of the Hazelwood North Primary School (located 1.6km away) - Concern that no additional 'factories' were welcome in the area, regardless of their impacts - Why does this sort of activity have to be built here – can't it be done overseas? - Concern about the cumulative impact of lead pollution: collecting on rooves, drinking water, land contamination - Impacts to property prices - Visual impacts - Concerns about fire risk and plant malfunction risks, such as explosion - Concerns about worker health at the facility - Can local landfills manage the wastes that will come out of this facility? - Seeking assurance that community monitoring will be carried out (of operating plant) and that it will be made available online - Traffic impacts to Tramway Road: current road condition, fog, impacts on a currently busy road. Those in favour of the the proposal raised the following views: - We need more recycling and forward-looking technology businesses to help regrow the area - We need to encourage high value operations like this – it has potential to bring with it other industries - More jobs are critical to rebuilding the local economy - This project could be a source of low-cost 'battery bank' power (those batteries still in useable condition) to lower power costs in local buildings/ schools and related infrastructure - We are immediately-local residents and we see this as good for the local economy and are comfortable from what we have seen that the emissions will not impact us - The emissions from this plant will be low – there is no comparison between 2020's technology versus 1950s technology - We are interested in direct business opportunities that will come out of this project - As long as the environmental concerns can be assured we are keen for businesses like this to set up in the Valley
	Business	- Neighbouring businesses were very supportive. No concerns about environmental impacts were raised at all - Local business groups were keen to get a form of recycling into the area that could draw on some of the industrial skill base left behind from coal fired power industry closures. - There was a shared view from businesses and their groups that the area was economically depressed and that this project is one of many that need to occur to turn around the local economy.
Government	Regulators	Regulators were keen to ensure strong levels of community participation in the proposal and were interested in gaining updates as the EPA Works Approval Application was developed.
	Other government agencies/ related entities	- Community is wanting us to take responsibility for our own waste, and this would be a positive for the proposal - There will be employment and skill base opportunities - Suitable heavy industry site given its Industrial 2 Zone.
Local representatives	MPs Local Councillors	- Very supportive – the community needs new businesses with new jobs - Good opportunity for skill development and technology partnerships, such as with Fed Uni - Impressed by the level of the technology and emissions control compared to 'old' existing industries in the region

4 Process and integrated environmental assessment

Section 4.1 provides background on the nature of lead acid batteries, while sections 4.3 and 4.4 describe the Hazelwood North proposal, the process it will employ and the specific proprietary technology used. This technology is provided directly by New Chunxing Resource Recycling Group, using their Jiangsu Province, China facility as a reference plant. The reference plant is described in 4.2, and has been used extensively throughout this Works Approval Application to estimate the Hazelwood plant's likely operational and emissions performance.

Section 4.5 outlines alternative technology considerations and section 4.6 details an integrated environmental assessment of the proposed plant.

4.1 Background: lead acid batteries

Lead acid batteries are relatively simple electrochemical devices able to store electrical energy and deliver it to motors and other appliances when needed. Unlike common dry cell or alkaline batteries used in touches and other household appliances, lead acid batteries may be recharged after the stored energy has been used. This is why they are widely used in motor vehicle starting energies and running appliances (e.g. air conditioning, headlights). Although the starter motor and headlights use much of the battery's stored energy, the battery is continuously recharged by the alternator during normal running of the engine.

Lead acid batteries are made up of sheets of lead immersed in a 'bath' of sulfuric acid. Usually the whole assembly is contained in a robust plastic case made of polypropylene or polyethylene.

Although lead acid batteries may be charged and re-charged many times, each cycle places small stresses on the lead plates, which eventually distort. This causes short circuits within the battery so that the battery is unable to hold stored energy for a prolonged period. Depending on operating conditions and other factors, a number of other processes may take place in the battery which coat the plates with scale or other non-reactive material, making them difficult or impossible to re-charge.

As a result of these degradation processes batteries become unusable and are then known as used lead acid batteries (ULABs) and are waste. In Australia the lifetime for motorcar batteries is typically three to four years, while for trucks and tractors the typical lifetime is two to three years.

4.2 The Chunxing China reference plant

New Chunxing Resource Recycling Group (http://www.jschunxing.com/e/) are the major shareholder of Chunxing Corporation Pty Ltd, and the design of the Hazelwood plant is based directly on their Jiangsu Province, China plant, a modern 800,000 tonne ULAB per year capacity facility, which is the largest ULAB (secondary smelting) recycler in China. The plant began operating in 2017 with one of its lines operating, at a total capacity of 300,000 tonnes ULAB per year. Then was increased to 800,000 tonnes per year in late 2017.

This plant and key monitoring data received from it has been used in this application as the reference plant for estimation of impacts on key environmental segments as follows:

- In estimating emissions to air, based on an approximate scaling rate of Hazelwood being 1/16th the capacity (size) of the China plant (for data collected in 2018 and 2019).
- In estimating emissions to air, based on an approximate scaling rate of Hazelwood being 1/6th the capacity (size) of the China plant (for data collected in 2017).
- In describing the technology and estimating the energy (electricity and fuel), raw materials and water resources it will use.
- Estimating the volumes of products and by-products the Hazelwood plant will produce.
- The composition and volume of slag and other key wastes the Hazelwood plant is likely to produce.

Data obtained from the reference plant that has been used in these assessments includes:

- stack air quality monitoring data, conducted quarterly since from 2017 inclusive, for heavy metals, particulates, SO_x, NO_x and sulfuric acid mist
- stack air quality monitoring data, conducted on an annual basis, for dioxins and furans
- one upwind and three downwind within-site ground-level monitoring points (four samples) tested quarterly for the same pollutants
- four nearby residential ground-level monitoring points (four samples) tested quarterly for lead and sulfuric acid mist
- test data on total lead concentration in slag, as well as slag TCLP test data on a full range of heavy metals.

Other than in terms of scale, detailed descriptions of the Chunxing China plant’s processes, technologies and environmental impacts are described in this application in terms of the Hazelwood proposal, which uses a smaller scale but virtually identical design.

4.3 Description of the Hazelwood proposal

Chunxing wishes to build, own and operate a ULAB recycling facility, at Crown Allotment (CA) 2047 Fourth Rd, Hazelwood North, using patented secondary lead smelting technology supplied by New Chunxing Resource Recycling Group, the second largest recycler of lead acid batteries in the world. The lead, plastic and electrolyte (sulfuric acid) in ULABs will be recycled, as is commonplace in secondary smelting. Around 98% of the material in each battery will be recycled.

Currently, Australia generates about 150,000 tonnes of ULAB, most of which is sent to four existing facilities (RMT in Wagga Wagga NSW, Hydromet in Unanderra NSW (and Laverton, Vic) and V Resource in Loganholme Qld). However, only RMT conducts secondary lead smelting to produce lead product – the other two are simply ‘battery breakers’, which then send lead-containing waste overseas, where the smelting of lead occurs (and therefore real value is realised). We believe such incomplete ‘recycling’ is unsustainable, and vulnerable to overseas demand and policy changes, similar to the export of kerbside recycling, which collapsed after China introduced its China National Sword Policy. We also see this low penetration of ‘full recycling’ in the market as an opportunity.

Even worse, some ULABs are exported as whole ‘wet batteries’: ABRI 2014 estimated that 16% of total ULAB volumes were either exported in this way, illegally landfilled or retained in stockpile. Almost 70% of the ULAB market comes from NSW and Vic, but there is no recycling capacity in Vic at present. We believe that our location will be strategic for the south-east markets, which will reduce the number of batteries managed illegally, outside recycling infrastructure.

Chunxing’s Hazelwood North plant will therefore be a full lead recycling facility, which will produce lead ingot, a highly valuable commodity that is returned back to battery manufacturers, ensuring maximum value recycling. They plan to secure significant market volumes of ULABs that are currently partially processed and sent for export, and believe the extra market capacity our plant will provide will lead to the federal Department of the Environment an Energy rejecting some export permits in favour of in-country full recycling options. Approximately 77% of the national ULABs market is provided by Vic, NSW and SA. The Chunxing facility would be strategically positioned geographically to service this market and compete well with its major competitor, the Wagga Wagga plant.

The facility will process 50,000 tonnes per year of ULABs and recycle them into 28,000 tonnes of refined lead per year. The main waste will be approximately 4,000 tonnes per year of lead-containing smelting slag.

At a high level, the proposed project can be described as three conceptual processing stages:

- First stage - physical breakdown of the batteries into its components i.e. metallic lead grid, lead oxide paste, plastics and spent acids.
- Second stage - further processing of the plastics and spent acids to convert them into value added products, such as chipped plastic for further recycling and fertiliser grade zinc sulfate.
- Third stage - melting and smelting of lead components recovered into refined lead products.

The proposed project will operate 24 hours 7 days per week with allowance for 30-40 days of maintenance per year.

A site plan/ plant layout is provided in ***Appendix E***.

4.4 Process and technology

At the plant operating level, the three-stage process can be further broken down into six main steps of processing:

1) ULAB breaking (physical separation)
2) Waste acid processing for value added fertilizer (zinc sulfate solution)
3) Melting of lead grid fraction in melting furnace and alloy production
4) Pre desulfurisation of lead paste fraction
5) Smelting and desulfurisation of lead paste
6) Refining of smelted lead to produce high quality lead metal.

These processing steps are presented as a process flow block diagram in Figure 3. Orange boxes denote products and by-products of the process, while green boxes denote environmental management points, such as waste to landfill or emission to air. The Chunxing technology results in a very high utilisation of materials: plastic is chipped and uses for new battery casing; zinc sulfate is used a foliage spray, ammonium sulfate is used as a soil fertiliser, lead alloy is specified with alloy-metals to be suitable as new battery alloy plates; pure lead ingot is of a purity that can be used to make lead dioxide (another new battery material) and, finally, output gypsum (calcium sulfate) from the addition of lime (calcium oxide/ hydroxide) in wet scrubbing treatment of sulfur dioxide can be also be used agriculturally, as well as in cement kilns.

Figure 4 shows all of the key areas of the plant as a detailed process flow chart.

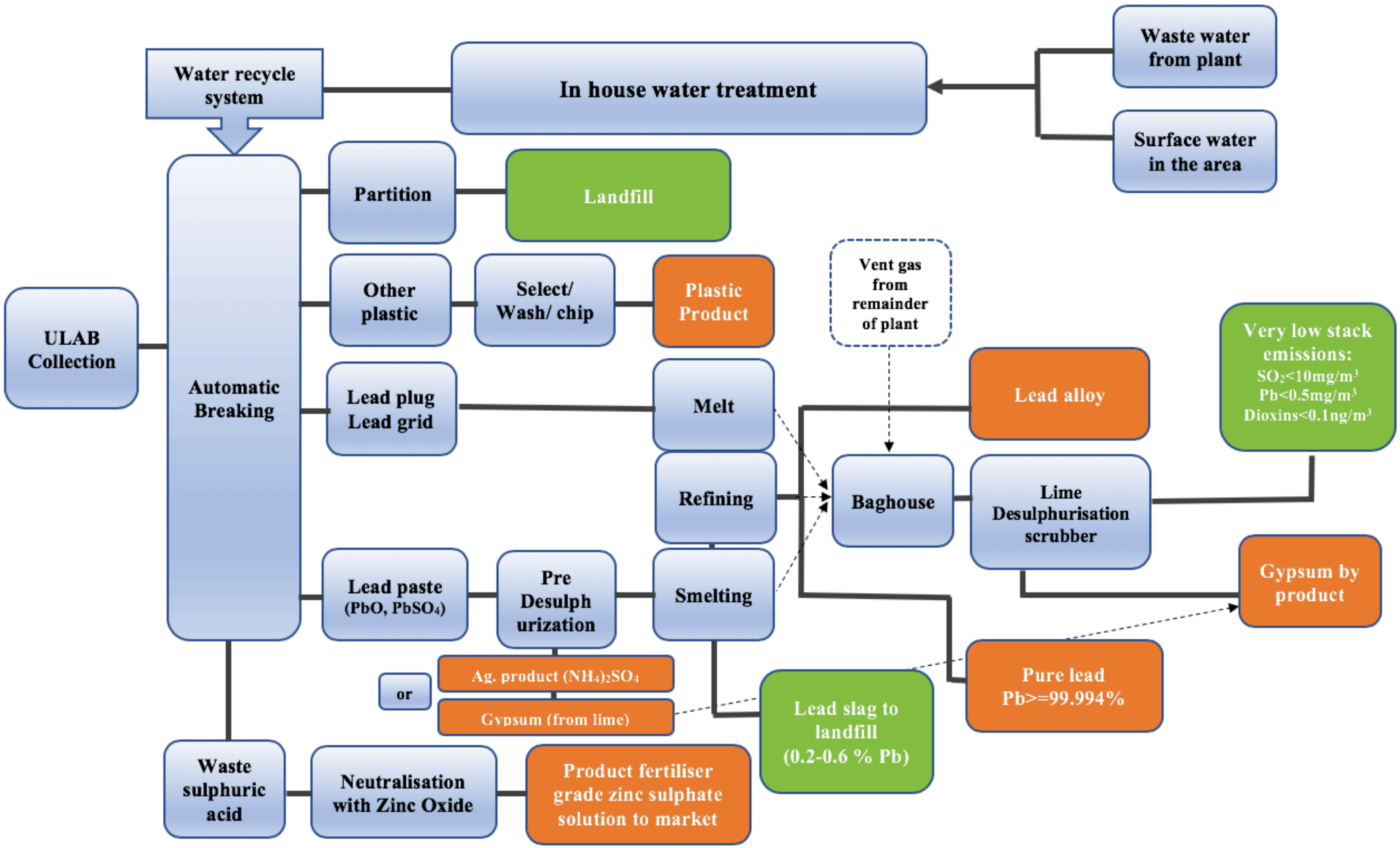

Figure 3 **Chunxing's ULAB recycling process block diagram**

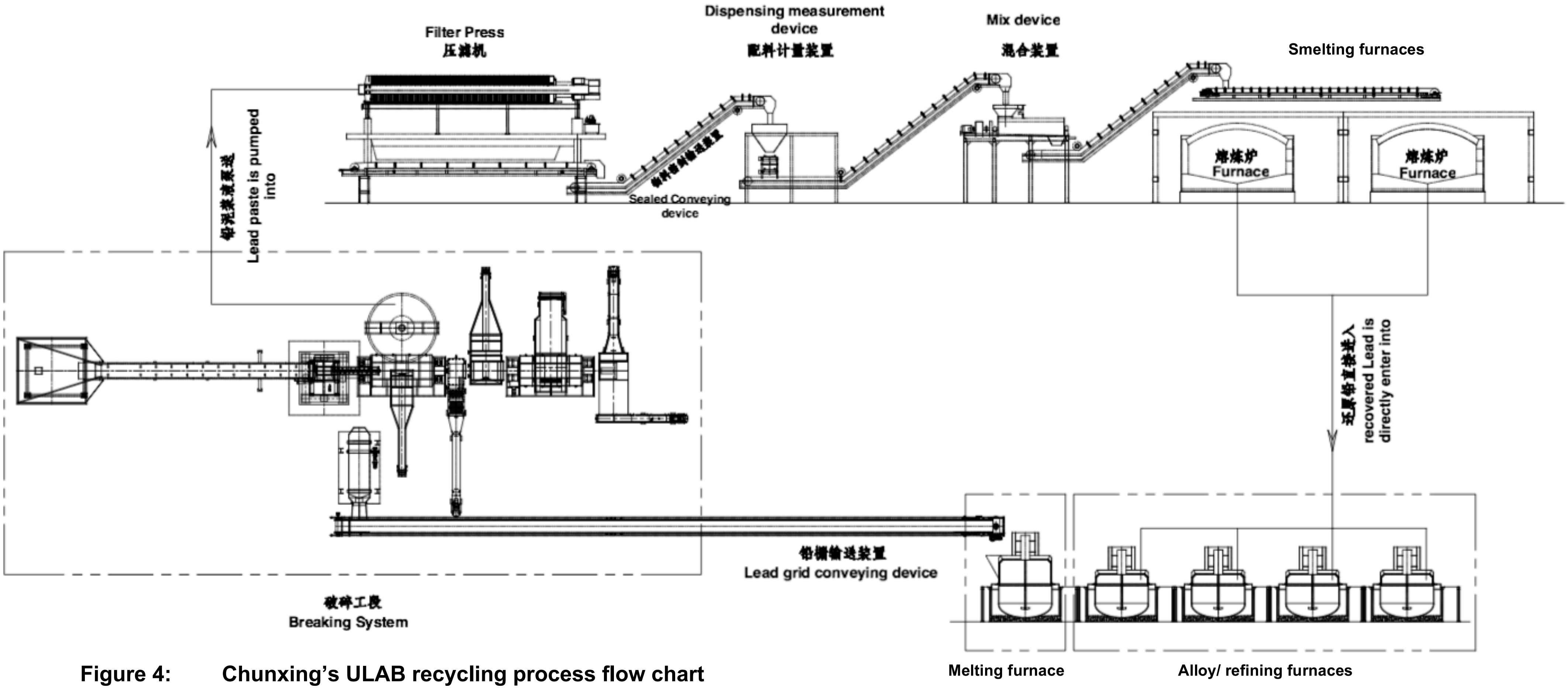

Figure 4: Chunxing's ULAB recycling process flow chart

Each of the six steps are described below.

4.4.1 ULAB breaking

This first stage of this process is the collection and transport of ULAB from the collection network in EPA licensed (permitted) trucks, which are then unloaded at the site. Both unloading and processing are carried out in an undercover enclosed area, marked as the 'loading zone' in the plant layout. Trucks unload the batteries to a segregated bay area and the trucks after unloading are washed within the same area before leaving the site.

Batteries are then collected from a crane and loaded into the hopper of the battery breaker (marked as 'breaking section' in plant layout) in one tonne lots. Batteries then pass into the enclosed hammer mill via a conveyor belt where they are broken into the various fractions in a wet system. From the hammer mill then, dilute acid is continuously drained into one compartment, while all of the solid fractions (in slurry form) are separated. These are processed through various tanks, where the different densities of the materials cause some to sink (lead) and some to float (rubber and plastics). From here the materials are separated and treated individually.

Apart from the drained sulfuric acid, the main separated components from breaking are:

- lead paste (mostly lead sulfate, which is poorly soluble)
- lead grid (mostly metallic lead)
- Plastics, including separators, shown as 'partition' in Figure 3 (mostly high density polypropylene (HDPP) with some rubber) and high density polyethylene (HDPE).

The lead sulfate paste fraction is filtered and taken to the pre-desulfurisation reactor. The fraction containing lead grids, HDPE and HDPP are separated in to these 3 separate fractions in a wet separating system based on density. The lead grid portion is further washed and sent to the melting furnace for production of lead alloys. Any plastic within this is further washed and segregated into finished bags based on colour for sale.

Plastic partitions are thin separator sheets that separate the battery plates. Due to this direct contact inside the battery they contain low-levels of lead. The China reference plant sends these partition plastics back into the furnace as high-calorific fuel replacement, but the Hazelwood plant design will segregate this and send it to landfill, after thorough washing to remove residual lead. In balancing the environmental value of reduced fuel-based emissions with the potential for dioxins formation and subsequent emission (caused by the slim possibility of some halogenated species in the plastic), the latter was seen as a more important consideration.

4.4.2 Waste acid processing for value-added fertilizer (zinc sulfate solution)

All the washing waters collected are neutralised and recycled in the onsite wastewater treatment plant.

Diluted sulfuric acid collected (typically 12-15% w/w) is diverted to a storage tank and then neutralised with zinc oxide sourced from galvanizing industries in Australia to produce zinc sulfate solution. Lead's advantage throughout many stages of the plant is its ability to be separated and controlled based on the extremely low solubility of almost all lead salts. Very low ppm levels of dissolved lead (lead salts) are then purified out of the zinc sulfate solution, taking advantage of the presence of small amounts of zinc metal fines in the zinc oxide, which preferentially displace lead from these salts, liberating very small amounts of lead metal which is then able to be separated by filtration and added to the smelter.

Zinc sulfate currently has a substantial market in Australia as a foliage spray to increase the size and quality of leaf structure in plants[2]. Zinc sulfate produced for this purpose will meet required agricultural standards for all heavy metals, including lead.

Small amounts of acid mist from diluted acid streams arise during breaking, which is vented into the scrubber. The scrubbed water is used in the zinc sulfate circuit for neutralising with zinc oxide. Remaining gaseous streams (including sulfuric acid mist) coming out of the scrubber are ducted to the main stack, via the emission control system.

4.4.3 Melting of lead grid for production of lead alloys

Lead grids are mainly composed of the metallic fraction and contain 95-98% metallic lead with the remainder made up of other metals used in the lead plate alloys, such as arsenic, copper, antimony, tin and cadmium. This is melted to produce lead metal at a relatively low furnace temperature of approximately 1,000 ^{0}C, fired by natural gas. By first melting instead of smelting, Chunxing's process can save a significant portion of the energy requirement in the overall process.

The melting step produces a molten alloy metal which must be further refined to produce a lead alloy product suitable for re-manufacture as battery plates. This requires a specification of metal composition in the alloy, which occurs in the refining step (Section 4.4.6).

All air emissions from the area are vented into the emission control system and subsequently discharged via the main stack.

4.4.4 Pre-desulfurisation of lead paste fraction

The purpose of this step is to reduce sulfate content from the lead paste fraction, which will be further removed in later steps, both within the furnace and via pollution control scrubbers. This provides efficiency benefits to the smelting step and also markedly reduces sulfuric acid fume and SO_x emissions, discharged later in the process.

Typically lead paste generated from the batteries is a mixture of lead oxide and lead sulfate with some free waste acid. The paste is further washed with either ammonium bicarbonate solution or lime, the former to:

- neutralise any free sulfuric acid, converting it to ammonium sulfate, which is highly soluble so remains in solution; and
- to convert the lead sulfate in the paste to lead carbonate (insoluble) and ammonium sulfate solution (highly soluble), thus maximising the recovery of lead in the solid phase and stripping as much of the sulfur as possible into the liquid phase.

Lime (calcium carbonate) can also be used in place of ammonium bicarbonate, since it is typically cheaper. If lime is used, a slurry is added to the paste to:

- neutralise any free sulfuric acid (mostly that physically captured within paste particles' structure), converting it to calcium sulfate plus water, the former being highly insoluble so cannot be separated by filtration

[2] Zinc – the leaf enlarger: https://blog.nutri-tech.com.au/zinc-the-leaf-enlarger/

- to convert some of the lead sulfate in the paste to lead carbonate (insoluble) and calcium sulfate solution (also insoluble), assisting the recovery of lead in the solid phase and stripping some of the sulfur out of the paste.

This is achieved by mixing the paste in a slurry tank and filtering the slurry through a filter press (when using ammonium sulfate). In the case of lime, the resultant gypsum ($CaSO_4$) is separated from the paste by gravity and hydraulic means, using similar technology as used in the breaker, since lead compounds are significantly heavier than calcium sulfate and carbonate. The resultant calcium sulfate (gypsum) is then added to the gypsum formed from lime scrubbing for subsequent by-product use.

Finally, the semi desulfurised paste is sent to the smelting process. The filtrate is a dilute ammonium sulfate solution, which has value as a fertilizer in the agricultural market (for example: https://www.cropnutrition.com/ammonium-sulfate).

The choice of desulfurising agent is left open at this stage of the proposal – both have been used successfully at the China plant – because the decision of which way to go is driven by the viability of an offtake market for ammonium sulfate.

4.4.5 Lead paste smelting and desulfurisation

Conventional smelting processes typically feed untreated paste (containing lead sulfate) directly into the furnace for smelting. Such processes are inexpensive but can generate undesirably large quantities of hazardous slag containing sulphides and sulfates.

Chunxing's technology is different because seeks to remove much of the sulfur in the pre-desulfurisation step, leaving a much lower sulfur content to be dealt with in the smelting process. This in turn creates a smaller sulfur dioxide emission stream from smelting, which can be handled by scrubbing with hydrated lime to form gypsum by-product (calcium sulfate), which can be sold to plasterboard and cement manufacturers.

Lead Paste is smelted in the cylindrical furnace and mixed with iron pieces and white coal at elevated temperature (maximum 1,300 ^{0}C) in a reducing environment.

The chemical reactions occurring in the smelting furnace can be summarised as:

$2PbO + C = 2Pb + CO_2$
$PbO_2 + C = Pb + CO_2$
$PbO + CO = Pb + CO_2$
$PbSO_4 + 2C = PbS + 2CO_2$
$PbSO_4 + 4C = PbS + 4CO$
$2PbO + PbS = 3Pb + SO_2$
$PbS + Fe = Pb + FeS$
$PbSO_4 + PbS = 2Pb + 2SO_2$
$FeS + O_2 = Fe + SO_2$
$4Fe + 3O_2 = 2Fe_2O_3$ (includes some other Fe oxides)
$2CO + O_2 = 2CO_2$

Sulfur dioxide generated above is removed in the desulfurisation chamber (scrubber) to form gypsum as per the following reactions:

$$Ca(OH)_2 + SO_2 = CaSO_3.1/2H_2O + 1/2H_2O$$
$$2CaSO_3.1/2\ H_2O + 3H_2O + O_2 = 2CaSO_4.2H_2O.$$

Molten Lead from the smelting process is then diverted to refining kettles where the molten lead is further refined by stirring to produce very high-purity lead metal as product for battery manufacturing (lead content> 99.994%).

The above process is in operation currently in the Chunxing plant in China and other locations, and has a number of advantages such as energy saving (from low temperature smelting), low residence time, less consumables, significantly lower slag generation with very low lead level and significantly lower emissions of lead and sulfur species compared to traditional smelting.

All flue gases are ducted via a number of cooling stages into a comprehensive scrubbing system and sent to the main stack.

4.4.6 Lead refining

The last stage of production is refining, where final products are purified into forms ready for sale.

In the case of lead ingots, post-smelt refining is required to get to a level of 99.994% purity. Sodium nitrate ($NaNO_3$), sodium hydroxide (NaOH) and iron sulfide (FeS) are added as fluxing agents to the refining kettle to help impurities separate from the purified lead.

In the case of lead alloy production, refining is required to obtain the correct specification of alloy components, where lead is the primary alloy metal but small quantities of other metals are also required. Molten lead is transferred into the alloy kettles where the lead is mixed with trace levels of other metals as required (such as antimony, tin and cadmium) to produce finished products for reuse as battery plates in battery manufacturing. Because alloying is done exclusively from lead grid material, alloy metals are already present – their further addition uses only small amounts to ensure the end-product alloy's specification is met. Traditional approaches that combine all forms of lead together in the smelting furnace require a larger addition of alloying metals, which has the potential for larger emissions.

Either refining stage produces a layer of dross waste that contains antimony, tin and copper, as well as trace levels of other metals, which are all returned to the smelting furnace for recovery and reuse in the alloying step.

Table 4: Process and technology overview

Key process step	Key inputs	Key outputs	Key controls
ULAB receipt	EPA permitted waste transport trucks Received ULABs (50,000 tonnes/ yr)	Received ULABs Potential small quantities of acidic wastewater from battery leakage	• Waste delivery vehicles use enclosed payloads • Unloading carried out in an undercover enclosed area, Trucks are washed after unloading within the same area before leaving the site. • Wastewater treatment system and 100% onsite water re-use
ULAB breaking	Received ULABs Reused water from onsite wastewater treatment plant Energy to run hammer mill and conveyors	Lead paste (mostly lead sulfate with some PbO) 62% or 31,000 tonnes/ yr Lead grid/ wire (mostly metallic lead) 23% or 11,500 tonnes/ yr Plastics (mostly HDPP with some HDPE) 5-7% or 3,000 tonnes/ yr Separators made of HDPE and a small amount of rubber 2% or 1,000 tonnes/ yr Waste sulfuric acid 10-15% or 6,000 tonnes/ yr Sulfuric acid mist Acidic wastewater	• Fully enclosed automatic breaking and separation system • Breaker exit air exhausted to duct system enroute to scrubber • Wastewater treatment system and 100% onsite water re-use
Waste acid processing for value added fertilizer	Waste sulfuric acid 10-15% of 6,000 tonnes/ yr Zinc oxide 580 tonnes/yr	Zinc sulfate as agricultural product 6,580 tonnes/ yr at 7%.Zn w/w solution Wastewater Sulfuric acid mist	• Acid neutralisation exit air exhausted to duct system enroute to scrubber • Wastewater treatment system and 100% onsite water re-use
Melting of lead grid fraction in melting furnace and alloy production	Natural gas (see smelting step for total gas use) Lead grid/ wire (mostly metallic lead) 23% or 11,500 tonnes/ yr Trace levels of other metals for alloying	Lead alloy product for use in battery manufacture (11,270 tonnes/ yr) Particulate, lead, trace metals, SO_2, N_2O, dust in air exhausted from melting area	• Melting area exit air exhausted to duct system enroute to baghouse • Wastewater treatment system and 100% onsite water re-use
Pre-desulfurisation of lead paste fraction	Lead paste (mostly lead sulfate with some PbO) 62% or 31,000 tonnes/ yr Ammonium bicarbonate solution 612 tonnes/ yr	Lead oxide (solid), some lead carbonate (insoluble), CO_2 gas Ammonium sulfate solution for use as fertiliser (1,280 t of 40% solution)	• Wastewater treatment system and 100% onsite water re-use

Key process step	Key inputs	Key outputs	Key controls
		Traces of sulfuric acid in solution	
Smelting, in-furnace desulfurisation	Natural gas (1.8M m^3) Lead oxide/ sulfate (solid), small amount of lead carbonate (solid) Smokeless coal (3,000 tonnes/ yr) Iron pellets (2,400 tonnes/ yr)	Slag 4,500 tonnes Ducted removal of emission of particulate, lead, trace metals, SO_2, N_2O	• Smelting/ refining area exit air exhausted to duct system enroute to baghouse • Wastewater treatment system and 100% onsite water re-use • Slag removed from site, either to Category B landfill or immobilisation then landfill (depending on waste characterisation) • 24-hour CEMS monitoring of major pollutant air emissions • Staff OHS lead monitoring and lead in blood testing continuously carried out • Quarterly stack testing for other air emission pollutants • Sensitive receptor environmental monitoring
Refining	Natural gas Flux/ additives containing 120 tonnes/yr NaNO3, 350 tonnes/yr NaOH 70 tonnes/yr FeS_2	Refined lead (99.994%) 16,500 tonnes/ yr Ducted removal of emission of particulate, lead, trace metals, SO_2, N_2O Dross waste containing Sb, Sn and Cu, which is returned to the smelting furnace for metals recovery	
Flue gas cleaning via baghouse	Untreated flue gas from thermal processes containing particulate, lead, trace metals, SO_2, N_2O	Particulate-cleaned flue gas (trace levels of particulate, lead, metals, SO_2, N_2O remaining) emitted from main stack at levels <IED	Baghouse pollution control for particles and metals/ other species attached to particles
Flue gas cleaning via scrubber	Baghouse-treated flue gas containing trace levels of particulate, lead, trace metals, SO_2, N_2O Lime ($Ca(OH)_2$) (1,500 tonnes/ yr)	Gypsum ($CaSO_4.2H_2O$) 4,500 tonnes Scrubbed flue gas (trace levels of particulate, lead, metals, SO_2, N_2O remaining) emitted from main stack at levels <IED	Wet scrubber with lime pollution control for SO_2

4.4.7 Air pollution control system

4.4.7.1 Desulfurisation

A key feature of the Chunxing process is the multiple stages of desulfurisation: pre-desulfurisation (either with ammonium bicarbonate or with lime), furnace desulfurisation (with Fe filings followed by controlled air lance oxidation) and final desulfurisation through lime addition in the scrubbers. This ultimately reduces SO_2 to a very low level of emission, but Pb and particulate emissions are reduced through the scrubber as well.

The first stage is the treatment of battery paste (the $PbSO_4$ is the target material) with ammonium bicarbonate or calcium bicarbonate (lime) (as opposed to sodium salts used in other processes), to produce ammonium sulfate or calcium sulfate.

The solubility of ammonium sulfate is very high (70.6 g/100g water at 0^0C – 103.8 g/100g water at 100^0C), compared to the relatively moderate solubility of sodium sulfate (maximum of 49.7 g/100g water at 32^0C, decreasing as temperature increases further). This means that the use of ammonium bicarbonate (over sodium carbonate or similar sodium salts) results in greater removal of sulfate to the liquid fraction, leaving less as part of the solid.

In the case of lime use, the separation process is a hydraulic gravity separation, since both the lead salts in the paste and the produced calcium sulfate are in the solid phase. This is achieved due to the significant density difference between lead salts and gypsum/ lime.

The second stage of desulfurisation is perhaps the most critical of the three, because it relies on a high degree of process control. Iron pellets are used in the reducing conditions of the smelter to react with PbS to produce FeS and Pb metal. Other smelters use this process to tackle their sulfur emission problem by dropping it out as high FeS-slag. But Chunxing don't do this. The furnace conditions are switched from reductive (to maximise Pb recovery) to oxidative later in the smelting cycle, through close control of the O_2 lance, to oxidise the FeS-bound sulfur back to SO_2 ($FeS + O_2 \rightarrow Fe + SO_2$ and $4Fe + 3O_2 \rightarrow 2Fe_2O_3$). This control of oxidative and reductive chemistry results in lower slag volume (because the S shifts from solid to gaseous phase for removal as SO_2 in the scrubber) and lower slag Pb content (because the excessive oxidation conditions further limits the formation of PbS that would have remained in the slag).

The final stage of desulfurisation takes place after smelting, where off gases are passed through the first cooling system, then into the baghouse, followed by further cooling (in the heat exchanger). Next the flue gas slows into <u>two</u> wet scrubbers in series, that are dosed with lime in excess of stoichiometric requirement. As per the series of chemical reactions shown in Section 4.4.5, the remaining sulfur (from pre-desulfurisation) is converted to SO_2 late in the smelting cycle then sprayed with lime in the scrubbers to form gypsum, achieving a removal efficiency (of SO_2) of 99.95%.

This results in a very low concentration of SO_2 exiting the stack - below 10 mg/m^3 - which is beyond what traditional ULAB smelting can achieve. (Traditional ULAB smelting uses a baghouse but typically not a scrubber.) Including two lime scrubbers in series achieves very low SO_2 emissions, further reduces metal contaminants via fine polishing of particulates and provides some redundancy in pollution control in the event of process variation, blockages or failures.

As a further redundancy feature, two more scrubbers sit in parallel to the operating scrubbers as standby equipment. This is to allow simple changeover for maintenance and cleaning of the in-line scrubbers, since lime/ gypsum caking occurs from time to time. It is also in recognition of the importance of the scrubbing step to the plant's pollution control.

Each scrubber is a large capacity design: 3m diameter and 7m high, with cascaded packing to spread the upward gas evenly and allow the lime slurry to flow through counter-current with even spray from the top. The outlet from the 2nd scrubber to the stack is maintained at below 50 ^{0}C.

Flue gas containing around 1% SO_2 enters the first scrubber, where it is dosed with a lime concentration of 10% w/w at flow rate of 0.166 m^3/min (10m^3/hr). Lime is recirculated constantly from the lime slurry tanks, which is continuously topped up with lime in accordance with inline monitoring and pH controls. The gypsum produced is continuously filtered and removed by press filters, so as not to enter the lime slurry tanks.

A visual depiction of the scrubber system is shown in Figure 5.

The entire pollution control schema, which places the scrubbers in context, is shown in Figure 6.

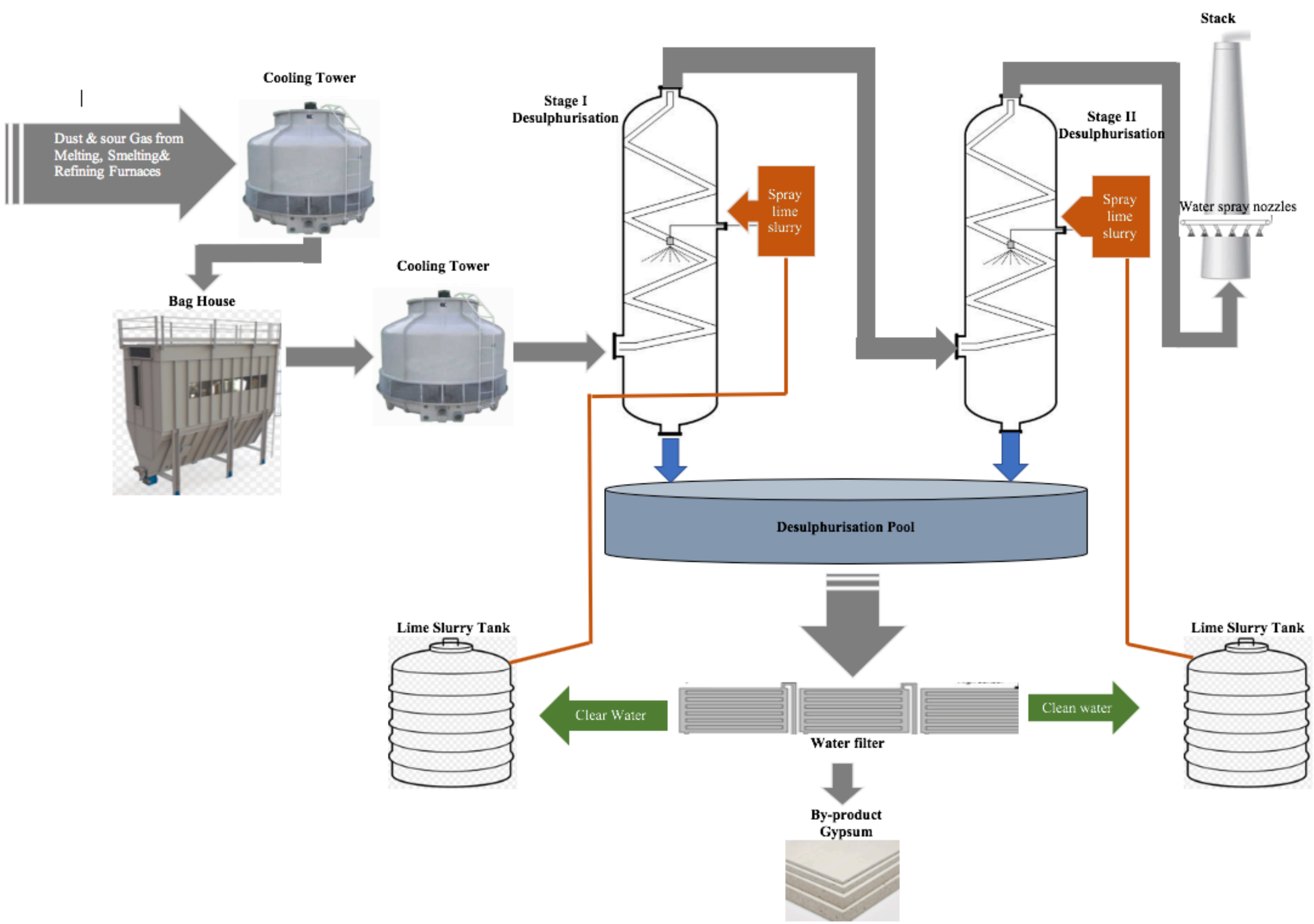

Figure 5: Scrubber system used by Chunxing

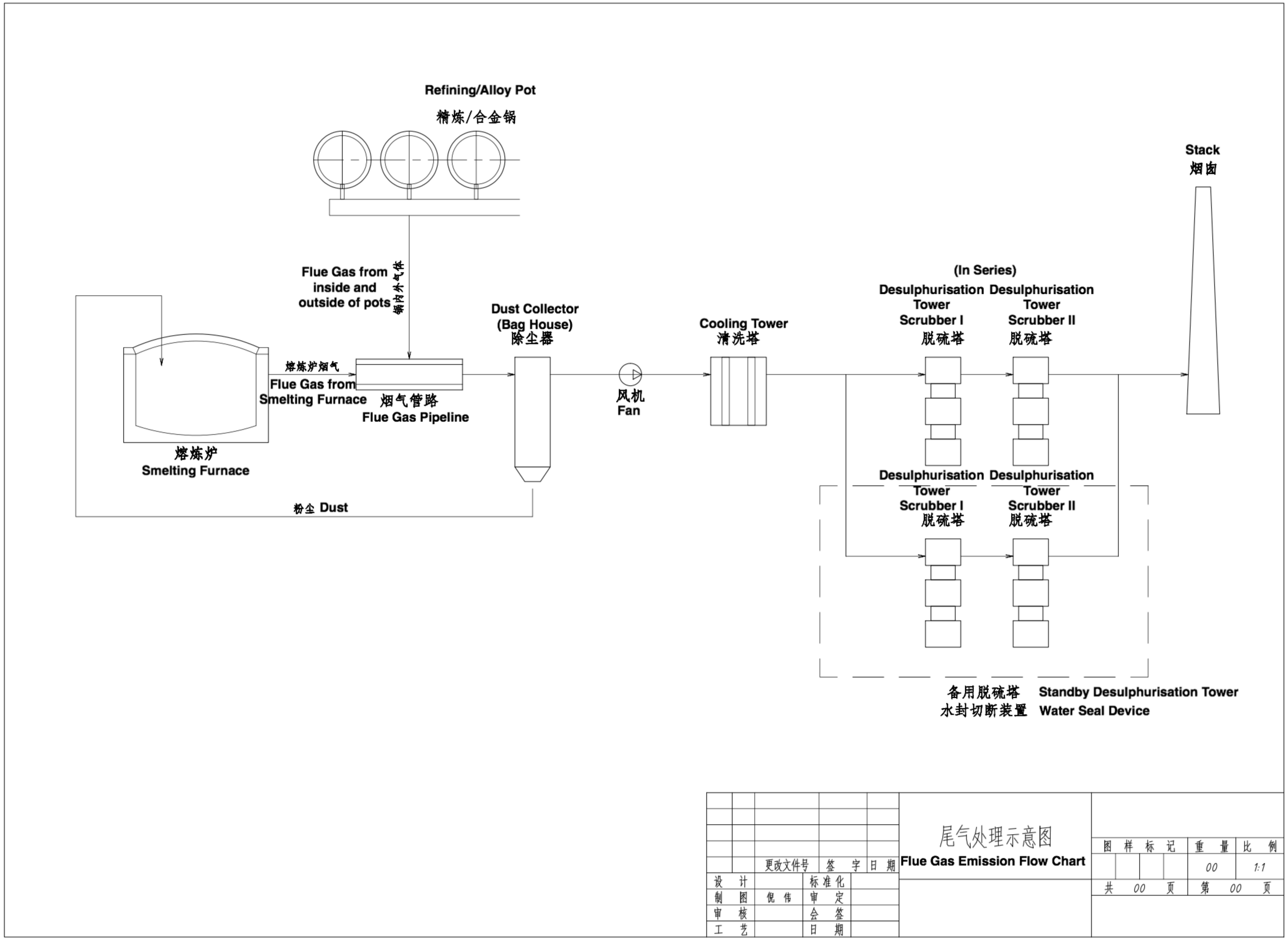

Figure 6: Pollution control system used by Chunxing

4.4.7.2 Baghouse particulate removal

A fabric filter (baghouse) operates in tandem with the scrubber, and is placed before it to remove particulates, leaving the SO_2 to pass through to the scrubber, allowing clean reaction with the target species rather than have its surface area blocked by solid particles. The baghouse receives flue gas and other sources of vent gases from the remainder of the plant, at a rate of up to 600m^3/min, and has a large volume of filtering capacity (total size 6.2m length,12m height and 3.7m width). Fabric filters are very effective at removing particulates; Chunxing's operates with a typical removal efficiency of 99.98%. In addition to particulates it collects those pollutants such as heavy metals that adhere or form part of them. Removal efficiency calculations for whole-of-process pollution control is discussed in Section 4.4.7.3.

This particulate removal step is very important to the operation of the scrubber, which functions at an exceptionally high removal efficiency (99.95%) because it is not having to also manage a particulate load.

4.4.7.3 Integrated pollution control system

In additional to dual in-series scrubbers (with dual back up units, making four scrubbers in all), there are further pollution control points throughout the whole system. A schematic of the whole pollution control system is shown in Figure 7. Gaseous exhaust from the furnaces passes through the first cooling system: a heat recovery boiler and heat exchanger (a system of cooling pipes), then the baghouse, followed by the cooling tower. Next the major desulphurisation process is done through the two lime scrubbers in series, and finally the exhaust is sent to the stack, which also includes a water scrubber at its base.

Figure 8 depicts the pollution control system of traditional secondary lead smelters, such as the one in operation in Wagga Wagga. Comparison of the Chunxing pollution control system (Figure 7) with the traditional pollution control approach used by secondary lead smelters (Figure 8) shows the additional layers of Chunxing's approach to pollution control, namely:

- Traditional plants have no scrubbers installed for the exhaust air post-furnace, Chunxing employs two lime-dosed wet scrubbers in series, with two on standby (for easy connection during maintenance)
- Chunxing uses a cooling tower after the baghouse, which further reduces particulate and gaseous emissions
- Chunxing employs a water scrubber within the base of the stack.

At each of these major cooling/ pollution control points, there is a proportional reduction in emissions of both gaseous and particulate-laden pollutants, which ultimately produces the highly controlled and consequentially low emissions result from the stack. A block diagram of these temperature and major pollutant reductions is shown in Figure 9, which depicts the exhaust air pollution concentration performance of the China plant at each stage, with figures taken from indicative CEMS data from the China plant.

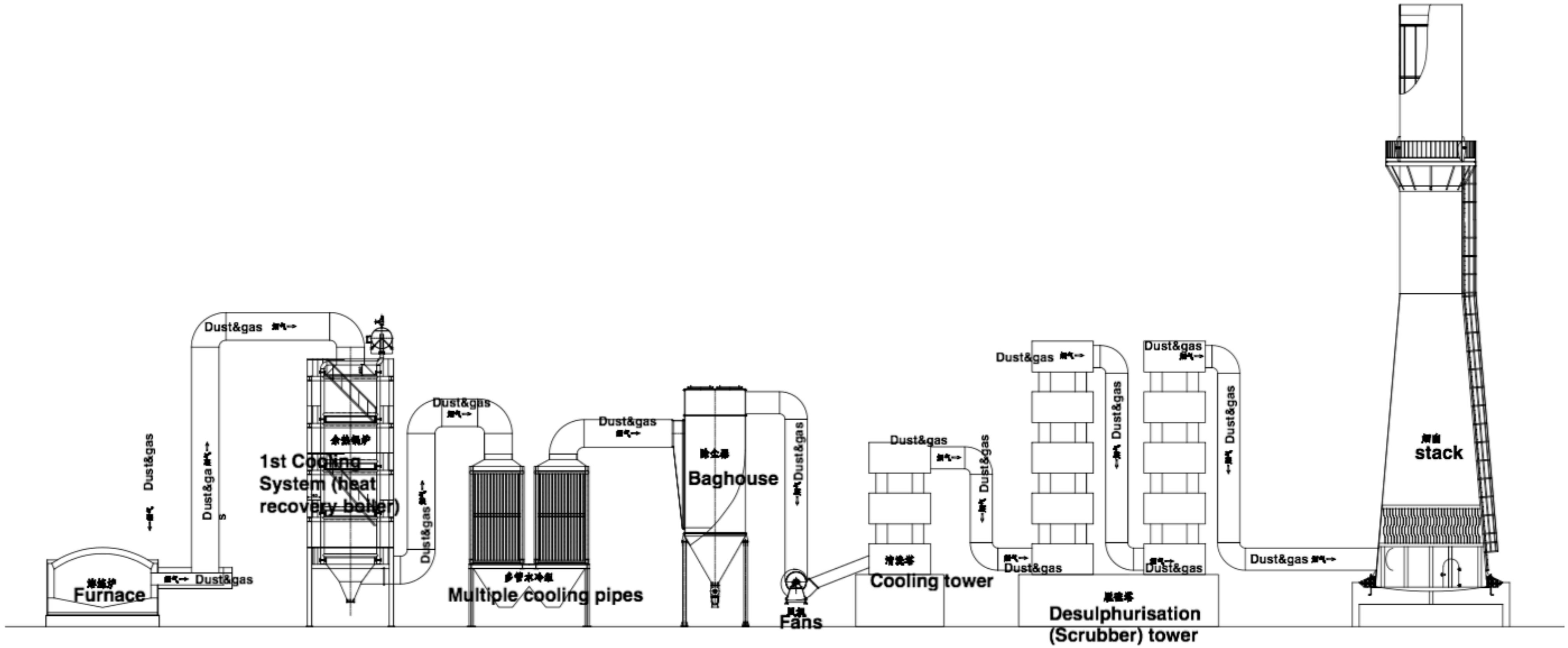

Figure 7: Schematic flow diagram of Chunxing pollution control system

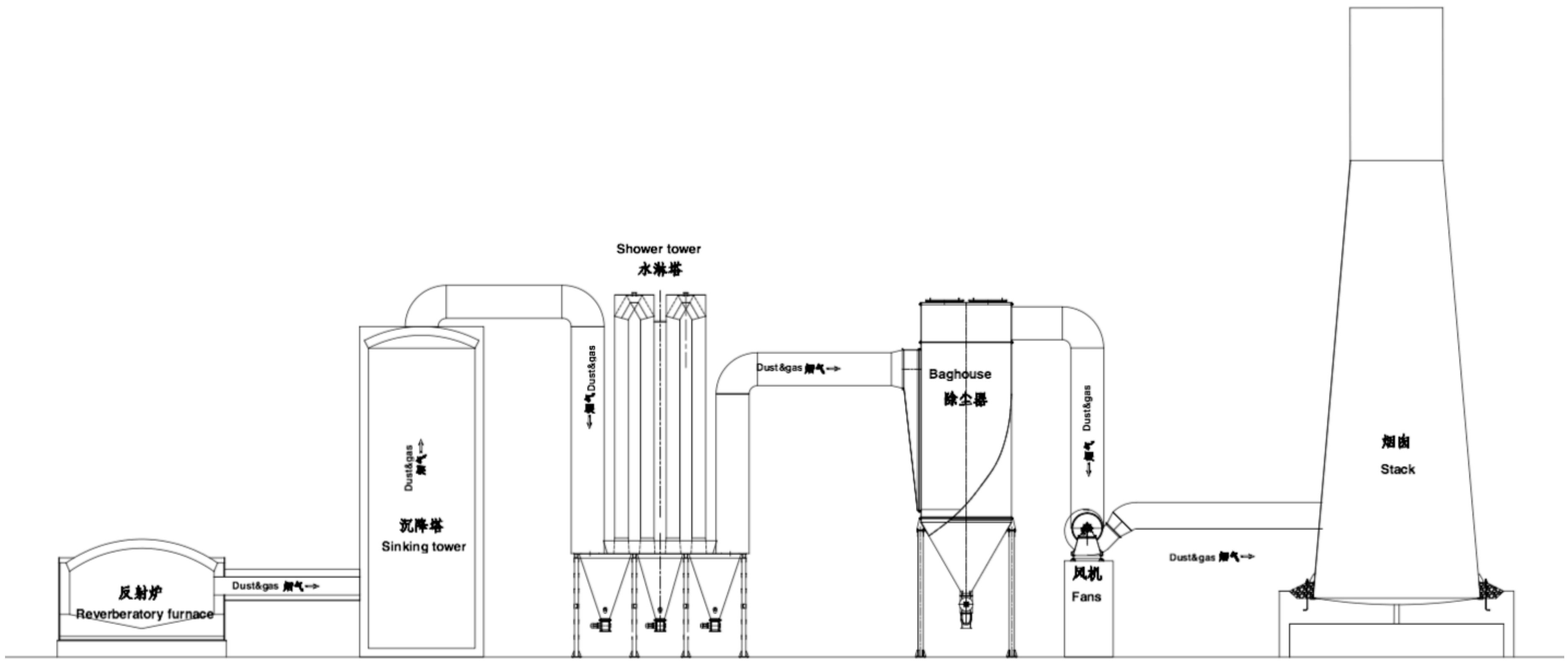

Figure 8: Schematic flow diagram of the traditional emission control system (employed by other secondary lead smelters)

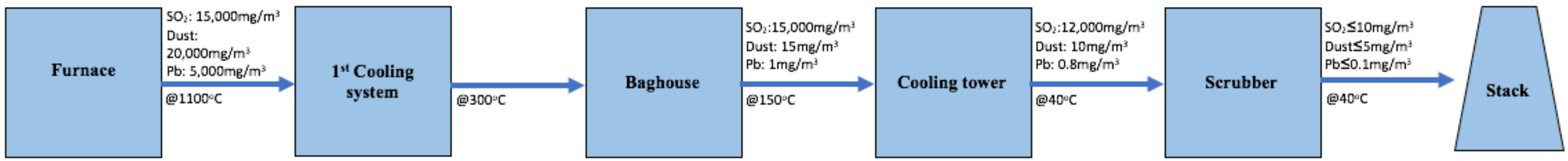

Figure 9: Block diagram of exhaust pollutant concentrations at each stage of the pollution control system

Following SO_2 through the process in Figure 9 shows that most of its removal occurs via the scrubbers, which have a rated removal efficiency of 99.95%. Traditional secondary lead smelters do not employ scrubbers because they focus on maintaining reducing conditions in the furnace to minimise SO_2 emissions, resulting in higher sulfides (than Chunxing) in the slag. This has a consequence of drawing more lead out into the slag (as PbS). Chunxing controls its furnace conditions from reducing to oxidative (in the latter part of the smelting cycle), which strikes a balance between higher Pb yield, lower Pb in the slag and they know that the consequence of higher SO_2 in the flue gas can very effectively be controlled with dual lime scrubbing.

Lead on the other hand is substantively reduced at the baghouse (99.98%), which includes a small reduction via the pre-baghouse cooling system, then the cooling tower reduces it by a further 20% (of the cooling tower inlet concentration) and finally the scrubbers provide a further polishing effect, removing 90% of scrubber-inlet Pb levels.

The net result of this pollution control system is that it enables the plant to meet emissions standards set in the European Union's *Industrial Emissions Directive 2010/75/EU* (IED), as shown in Table 5. The IED is a stack-concentration benchmark of performance for low emissions operation that is used by environmental regulators around the world.

Table 5: China plant emission concentrations compared to IED emission limits

Pollutant	Unit	Stack emission concentration	
		Average (China reference plant)	IED limit
Sulfur dioxide	mg/m³	9	50
Nitrogen oxides	mg/m³	49	200
Total dust	mg/m³	11	10
Sum of Sb, As, Pb, Cr	mg/m³	0.22	0.5
Cadmium	mg/m³	0.002	0.05
Dioxins and Furans (as TCDD I-TEQs)	ng/m³	0.07	0.1

Notes:
1. All figures quoted are directly from stack emission testing of China reference plant, unadjusted for additional controls planned for Hazelwood facility
2. Averages cover all quarterly data points measured from 2017 Q1 – 2019 Q3

4.4.8 Air quality monitoring

Potential pollutants such as SO_2, N_2O, and particulates from the melting, desulfurisation, smelting and refining processes are monitored through a continuous emissions monitoring system (CEMS). Since lead is emitted in solid form there is a direct relationship between dust (particles) measurement/ emission and lead emission. CEMS detectors are located both at the stack and also at the inlet to the 2nd scrubber to ensure any emission is well controlled.

In addition, the above pollutants and others such as sulfuric acid mist, chromium, arsenic, cadmium, antimony and dioxins are measured on a quarterly or annual basis at the China plant, by independent stack testing samplers and laboratories, with reporting required against compliance with local environmental limits. The same monitoring approach will apply to the Hazelwood plant.

Chunxing have committed to providing real time access to the CEMS monitoring data online to the public. They are also investigating the possibility of deploying community monitoring stations in the local area around the site, accessible by the public online, which could measure for lead and other pollutants of concern. One option to enable this is to collaborate with an existing resource, such as EPA monitoring stations (EPA AirWatch)[3], Latrobe Valley Air Monitoring Network (LVAMN)[4] or the recently established Latrobe Valley Information Network (LVIN)[5].

4.4.9 Wastewater treatment and reuse system

All wastewater is collected and treated onsite. This system is discussed in Section 7.

4.5 Choice of process and technology versus alternatives

At a high level, there are five types of technology that could be considered for adoption at the Hazelwood site to recycle ULABs:

1. Battery breaking and on-selling the separated components
2. Secondary lead smelting, using a rotary furnace
3. Hydrometallurgical (electrolytic) lead reduction
4. New hydrometallurgical technologies under development
5. Chunxing's secondary lead smelting technology, modified Isasmelt process

Outdated technologies, such as blast furnace smelting and/or manual battery breaking, have not been considered as they are not sufficiently modern options.

4.5.1 Battery breaking and on-selling the separated components

Battery breaking historically occurred manually, and rudimentary manual breaking still occurs in some developing countries, with major environmental and human health consequences. Modern, well-regulated ULAB recycling techniques worldwide use automatic battery breaking technologies.

Batteries are processed in hammer mills or other crushing mechanisms, that break them into small pieces. This breakage procedure ensures that all components, such as lead plates, connectors, plastic boxes and acid electrolyte are easily separated in the subsequent steps.

After breakage, the lead oxides and sulfates are separated from the other materials by gravity in water by a system of moving mesh conveyers. After separation, they are either directed into an onsite recovery process, such as a furnace or, in the case of a number of battery breakers in Australia, sent overseas to such processes via a Basel export permit.

Battery breaking typically occurs in enclosed chambers with reasonable to high levels of automation.

[3] https://www.epa.vic.gov.au/our-work/monitoring-the-environment/epa-airwatch
[4] http://lvamninc.com.au
[5] https://lvin.org/#/

Battery breaking has the disadvantage that it does not fully recycle the ULAB and, as a technology option for the Latrobe Valley plant, it is inferior to other options on two counts: a) it still requires export of the broken and separated material (bringing additional transport greenhouse gas emissions and handling inefficiencies), and b) there is arguably limited market space for a further battery breaker in Australia.

It is noted that battery breaking alone does not have the issue of air emissions, beyond fugitive mists and dust, since it is not a thermal process.

4.5.2 Secondary lead smelting, using a rotary furnace

Smelting was traditionally performed in a blast furnace in a similar way to the extraction of primary lead. This approach essentially used all lead-containing components as feed, and relied on scale to make its high energy use economic. Blast furnaces also produced high SO_2 and lead emissions, high slag lead content and high slag volumes compared to more modern rotary furnaces.

Rotary furnaces have essentially replaced blast furnaces in secondary lead smelting. Rotary furnace design can vary, resulting in different performance characteristics, but for the purposes of this assessment the Engitec Technologies furnace supplied to the only existing secondary lead smelter in Australia, the Enirgi Power and Storage facility in Wagga Wagga, NSW (formerly known as Renewed Metal Technologies), will be used for comparison. This is because, at the time of its installation and commissioning in 2012, it was deemed to be best practice technology, and was the prevailing practice in Europe at that time. Enirgi's fact sheet[6] claims its Wagga site to be 'best-in-breed' and 'global best practice for environmental standards from battery collection to lead ingot production', and we have no reason to challenge its credentials. This is a modern plant that has demonstrated itself to operate within its licenced environmental limits at all times, showing a strong track record of performance (including environmental performance) in the industry.

The Wagga Wagga facility has an operational capacity of 46,000 tonnes per year[7] of ULABs and 24,000 tonnes per year of lead products. The process components onsite include a battery breaking plant, paste desulfurisation with sodium sulfate, a 5m^3 (molten lead) tilting rotary furnace[8] (with baghouse) and a six-kettle refinery (with baghouse).

The objective of any smelting technology is to chemically reduce all metallic compounds to their metallic, or reduced forms by means of heating and providing adequate fluxing and reducing substances to do so. The former substances lower smelting temperatures and remove some unwanted contaminants, while the latter reduce the lead oxide and lead hydroxide to metallic lead. Different smelting technologies use different processes; some accept all lead-containing components into the furnace at once, whereas others use different treatment steps for dealing with different components.

In this rotary furnace process, prior to smelting, Na_2CO_3 and NaOH are used as a means of de-sulfurisation of the lead paste and neutralisation of the sulfuric acid electrolyte. The metallic fraction and the lead compounds derived from the de-sulfurisation and neutralisation processes are then added to the furnace and smelted with fluxing and reducing agents. The

[6] http://www.enirgipower.com.au/media/1559/battery-recycling-market-info-sheet-eps.pdf
[7] http://www.engitec.com/en/rmt__pty/
[8] http://www.engitec.com/public/media/content_documents/pb_recycling/5_Tilting_Rotary_Furnace.pdf

necessary heat is provided by natural gas and electricity. Refining of the smelted material occurs to further purify the final lead product.

In the Australian hazardous waste context, slag from these types of industrial processes is often characterised as *D300 non-toxic salts*, with contaminants (in this case lead) recorded. Analysis in Hazardous Waste in Australia 2019[9], shows that 19,698 tonnes of D300 was generated in 2017-18, and 51% of this came from the 'Copper, Silver, Lead and Zinc Smelting and Refining' industry. Since secondary lead smelting would be expected to make up the majority of this in NSW, it is assumed that 51% of 19,698 tonnes, or approximately 10kt, of D300 is waste slag from the Wagga facility. This is in good agreement with the Basel Convention's *Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries*[10], which suggests that, on average, 300-350 kg of slag is produced for each tonne of metallic lead smelted. These guidelines also suggest a slag lead content (in terms of 'lead compounds') of around 5%.

National Pollutant Inventory (NPI) data for 2017-18[11] can be accessed at a facility level, and provides company-reported data for emissions of pollutants to air (in kg per year) and transfers of pollutants to land (also in kg per year). The Wagga facility's NPI report[12] provides the following detailed data for lead in 2017-18:

- 270 kg were emitted to air
- 350,000 kg was sent for off-site immobilisation.

The latter allows a slag concentration to be deduced, based on 350 tonnes of lead per 10kt of slag, of approximately 3.5%, which is reasonable agreement with the generic smelting Basel guideline figure of 5%.

Since emissions of lead (and other pollutants) to air and slag production and contaminant concentration are key environmental considerations for this project, these figures for the Wagga facility (for potential lead pollution impacts) represent an Australian benchmark to measure the Chunxing proposal against.

4.5.3 Hydrometallurgical (electrolytic) lead reduction

Lead can also be separated (chemically reduced) from battery broken components using a non-thermally intensive process, such as those that can be described as hydrometallurgical (since the lead species are dissolved) and/or electrolytic, since those dissolved lead ions are then converted to reduced metallic lead via electrolysis techniques. This type of process is also known as hydrometallurgical electrowinning.

The chemical concept behind the electrolytic process is the conversion of all lead compounds into a single chemical species, lead in oxidation state +II, which is then electrolytically reduced, through the application of a cathodic potential, to produce metallic lead.

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[9] Blue Environment and Ascend Waste and Environment (2019), *Hazardous Waste in Australia 2019*, prepared for the Australian Government Department of the Environment an Energy, available at: (TBA)

[10] Basel Convention 2003, *Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries,* available at: http://archive.basel.int/pub/techguid/tech-wasteacid.pdf

[11] Available at: http://www.npi.gov.au/npi-data/latest-data

[12] Available at: http://www.npi.gov.au/npidata/action/load/emission-by-individual-facility-result/criteria/state/NSW/year/2018/jurisdiction-facility/1348

The lead paste is dissolved into lead salts in a liquid medium, then the electrolysis deposits lead as dendrites or sponge, which are subsequently shaken off and collected on a conveyor belt and pressed to form platelets of pure lead (99.99%), which can then be conveyed to a melting kettle for casting into ingots. Although significant electricity is still required for the electrolysis steps, smelting related fuel use and subsequent air emissions are eliminated, as is the formation of slag, since high purity lead is obtained without high temperature thermal process.

Such approaches are quite new in comparison to smelting and not routinely commercialised as yet – despite the fact that the majority of China's secondary lead smelting capacity has only come on line in the last 15 years, approximately 90% of this infrastructure uses smelting technology.

The hydrometallurgical approach is environmentally promising from an emissions point of view, but at present its lack of commerciality is because of two limiting factors:

1. Lead salts, particularly oxides, have poor solubility across a variety of different solvents with PbO, PbO_2 and $PbSO_4$ being insoluble in water. To overcome this, strong acids such as HBF_4 and $HSiF_6$ have been used, but these have significant safety (and some environmental concerns)concerns.
2. These processes have also been limited by high cost, compared to smelting.

4.5.4 New hydrometallurgical technologies under development

There are also a number of novel technologies under development, that have yet to lead to commercial adoption, at scale at least. There are new technologies that are based on the model of dissolution using more benign solvents, followed by electrolysis.

The PLACID process uses acidic brines as solvent, which demonstrated moderate solubility of lead salts, followed by electrolytic reduction to lead metal. This process has proceeded to the pilot plant stage. A company called Aquametals developed a process using an aqueous solution of methylsulfonic acid and EDTA, which provided a higher solubility of lead salts than the PLACID process. As a means of avoiding strong acids to improve solubility of lead salts, a more recent study[13] has been conducted using a novel class of solvents called deep eutectic solvents (DESs). While only at lab scale, Ballantyne *et. al* 2018 are developing an iono-metallurgical process using Ethaline 200, a liquid formed when a 1:2 molar ratio of choline chloride and ethylene glycol are mixed together. The resulting Pb2+ species are then reduced and electrodeposited as elemental lead at the cathode of an electrochemical cell.

A US company (Aqua Metals) has very recently patented a process for extracting lead using methanesulfonic acid (MSA) as a solvent, then recovering it using electrowinning. It established its first (and currently only) facility in Nevada USA in 2017, a very small-scale demonstration plant whose largest production month (September 2019) was 160 tonnes of lead product. Chunxing's proposed plant is small by world standards, but its output is planned to be 15 times larger than this.

Aqua Metals own website (https://www.aquametals.com/aquarefining/) illustrates this process as suitable only for the lead paste component, noting that the lead metal plates and grid are "shipped to smelter for processing." Therefore, aquarefining is not a full solution for

[13] Ballantyne AD, Hallett JP, Riley DJ, Shah N, Payne DJ. 2018 *Lead acid battery recycling for the twenty-first century*. R. Soc. open sci. 5: 171368. http://dx.doi.org/10.1098/rsos.171368

ULAB recycling – such a plant would either require a smelter onsite as well or need to ship lead grid back out again to a smelting facility elsewhere.

Aqua Metals' aquarefining technology is promising but far too early in its development to demonstrate scale, commerciality and safety, and still requires the use of a smelter.

None of these hydrometallurgical/ electrolytic technologies are at sufficient scale or commercial viability to be considered for the proposed Latrobe Valley plant.

4.5.5 Chunxing's secondary lead smelting technology, modified ISASMELT process

According to *Thornton, Rautiu and Brush 2001*[14], an example of a 'more modern approach to secondary smelting' than rotary furnace smelting is the ISASMELT process. The battery paste is treated with an alkaline solution to remove most of the sulfate, yielding a lead rich paste which is low in sulfur. This paste is charged to the furnace and oxygen and fuel are injected through a lance causing heating and stirring which facilitates rapid chemical reaction. Off-gases are cooled and passed to a baghouse to remove dust and fume, which are returned to the furnace.

The Chunxing technology is a modified version of the ISASMELT process, known as a Vertical Smelt Furnace (VSF), a completely electronically operated closed furnace which has been granted a Chinese Invention Patent.

While the broader Chunxing process is described in Section 4.4, more detail on the furnace is described here.

One set of furnaces contain two chambers of vertical cylindrical design with stirrers inside. Each furnace has a working volume of 45 m^3 with capacity to feed up to 150t of a total batch weight. The shell of the furnace is 16 mm thick steel plates and linings are built from high-alumina firebricks. Each chamber has a combustion device to ensure warming; the feeding and smelting process can cross interchangeably. When one of the chambers is heated, high temperature flue gas will enter into the other chamber to preheat the material. The process saves energy and the second pass flue gas has its particulate load reduced before exiting the second chamber.

A sectional drawing of the dual-chamber furnace design is shown in Figure 10 (dimensions per chamber in mm: 5,000 diameter, 2,380 height). The processing period of each furnace from the charging of materials (paste, coal, and iron) to the discharge of lead and slag is 36 hours. This makes 4 batches in 72 hours (2 furnaces in 3 days). For 50,000 tonnes of ULAB input per year, there is approximately 30,000 tonnes of paste to process. Assuming a typical year of 300 operating days, this results in a total of 400 individual smelting furnace batches in one year. Dividing the 30,000 tonnes of paste by 400 batches gives 75 tonnes of lead paste per batch, which proportionally requires charging with 7.5 tonnes of coal and 6 tonnes of iron.

[14] Thornton I, Rautiu R and Brush S (2001), *Lead the facts*, available at: https://www.ila-lead.org/UserFiles/File/factbook/leadTheFacts.pdf

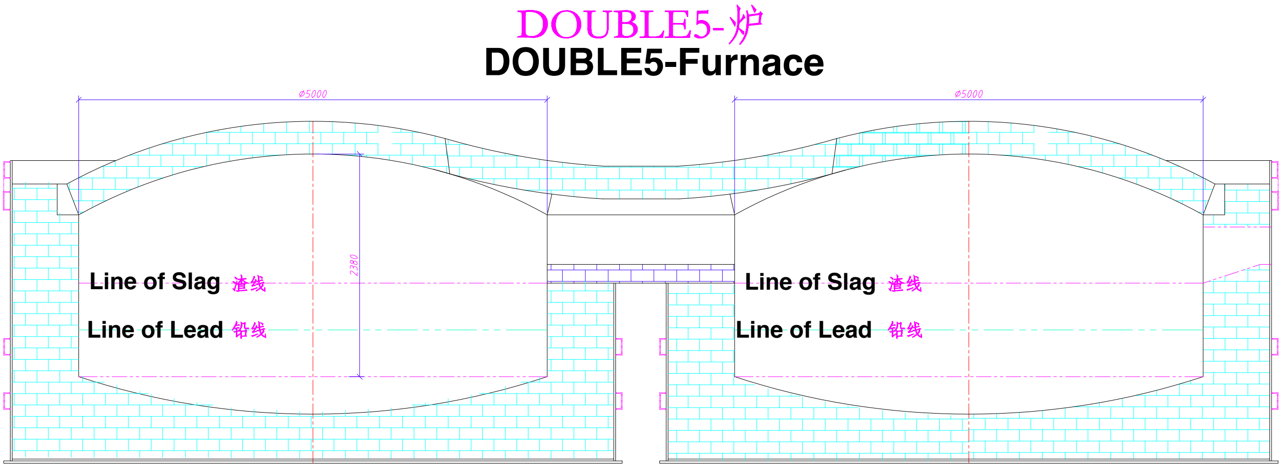

Figure 10: Dual chamber VSF furnace to be used in Hazelwood facility

This process, and ISASMELT more generally has a number of advantages over traditional rotary furnaces: higher thermal efficiency; lower operating costs; direct production of both soft and antimonial lead alloy, which allows for blending to suit some applications; slags of low lead content, which reduce disposal problems; and good process hygiene.

Based on data supplied from Chunxing's reference plant in Jiangsu Province China, the proposed Latrobe Valley plant is estimated to emit just 16 kg of lead per year to the air environment and approximately 4,500 tonnes of slag, at approximately 0.2 – 0.56% lead content. Estimates of air emissions and slag generation for the proposed plant are discussed in detail in Section 8.4.3.1 and Section 12 respectively.

4.5.6 Assessment of technology choices

A comparison of the technology choices overviewed in the previous sections is provided in Table 6.

Table 6: Comparison of technology choices

Technology choice	Advantages	Disadvantages	Conclusion
Battery breaking only	• No thermal emissions • Simple and inexpensive technology	• Only partial recycling solution • Higher GHG (lifecycle) emissions due to overseas transport • Battery breaking market capacity is sufficient • No Basel permitting advantage	Not economically feasible due to insufficient market advantage.
Secondary smelting (rotary furnace)	• Deemed best practice in 2012 and current best practice in Australia • Emissions to air likely to meet SEPP requirements • Existing plant in Australia to observe performance • Would gain Basel permitting advantage to redirect currently exported Pb scrap	• As with any smelting, energy use is high • Emissions to air are significantly higher than Chunxing technology per tonne of lead produced • Quantities of slag and lead levels in slag are higher than Chunxing technology – higher PIW Category therefore higher slag disposal costs • Higher operating costs than Chunxing technology: energy use	Could be economically feasible but Chunxing technology produces lower emissions and lower quantities of slag.
Hydrometallurgical (electrolytic) reduction	• No thermal emissions • No slag produced	• High electricity use • Safety and environmental concerns through use of strong acid solvents (F-based) • Potential for F gas emission, with health, environment and metal equipment corrosion impacts • Significant quantities of un-leached residue (containing lead), which requires stringent immobilisation procedures before disposal • Low Pb salt reduction efficiency compared to smelting • Higher operating costs compared to smelting • Limited commercial reference plants (at scale) around the world	Not sufficiently proven technically or economically. Environmental benefits in key emission areas somewhat outweighed by safety and environmental concerns with use of fluorinated acid solvents.
New hydrometallurgical technologies (including Aqua Metals)	• Reduction in thermal emissions • No slag produced • Developing technology with DESs appears to avoid the safety and environmental problems of fluorinated acids • Higher Pb salt solvation than other hydrometallurgical technologies	• Not proven beyond lab scale • High electricity use • Doesn't process lead metal (paste only), so still requires smelting elsewhere • Cathode-deposited lead must be (carefully) melted to produce ingots • Significant quantities of un-leached residue (containing lead), which requires stringent immobilisation procedures before disposal • Likely higher operating costs compared to smelting • No commercial reference plants around the world	Not proven at commercial scale. Not a full-lead recycling process – smelting still required. No slag but still produces un-leached residue containing lead.
Chunxing VSF	• Stronger environmental performance than	• As with any smelting, energy use is relatively high	The Chunxing technology is the most efficient

Technology choice	Advantages	Disadvantages	Conclusion
	current Australian ULAB smelting best practice • Emissions to air will meet SEPP requirements by a significant margin • Slag Pb levels much lower than other smelting practices; likely to be Cat B PIW (instead of Cat A) so disposal costs lower than other Australian ULAB smelter • Identical technology plant is operating in China –reference plant provides clear evidence of performance • Lower cost higher energy efficiency than other Australian smelter technology • Market advantage: would gain Basel permitting advantage to redirect currently exported Pb scrap	• As with any smelting, slag waste is produced • As with any thermal process, some emissions of heavy metals, particulates and combustion gases will occur, although these are likely to be at exceptionally low levels	(lowest operating cost) option, proven in current large-scale operating plant (China) and has better environmental performance than current Australian best practice (key pollutant emissions to air, energy use, slag volume and Pb content). Would gain market advantage by re-directing current ULAB scrap exported overseas to the increased Australian capacity due to this plant – Basel export permits for 50kt of current scrap would not be granted.

Chunxing's VSF smelting technology is the clearly preferred technology option, with the smelting technology of the Wagga ULAB smelter second placed. The most compelling considerations in this assessment are the Chunxing technology's advantages in the areas of:

- thermal energy efficiency through lower gas use requirements than rotary furnaces such as the Wagga plant
- significantly lower emissions to air than the Wagga plant; particularly with respect to lead
- significantly lower lead concentration in the slag than the Wagga plant; and less than half the slag volume produced, per tonne of ULAB processed
- lowest operating cost plant, due to energy efficiency, reuse of process heat and high levels of automation.

4.6 Integrated environmental assessment

The integrated environmental management principle states that "if approaches to managing environmental impacts on one segment of the environment have potential impacts on another segment, the best practicable environmental outcome should be sought."[15]

An integrated environmental assessment is a relevant consideration of best practice, which is investigated holistically in Section 5 and as required in the individual environmental

[15] *Environment Protection Act (1970)*, Section 1J, available at: http://www.legislation.vic.gov.au/domino/Web_notes/LDMS/PubLawToday.nsf/95c43dd4eac71a68ca256dde00056e7b/c7131dc25197a476ca257347000a99b1!OpenDocument

segment assessments in this application (Sections 6.2, 8.4 and 12.6). Table 7 summarises each section's environmental assessment, and places a qualitative description on the level of impact to that segment of the environment.

Due to aspects of the process' technology, the plant's scale compared to other facilities in the Latrobe Valley region, emission controls employed, site selection and the overarching purpose of the plant (to maximise recovery of lead for reuse in battery manufacturing), none of the environmental assessments in Table 7 predict any more than low-medium impact on any environmental segment.

The waste segment is deemed low-medium impact not based on the potential for direct environmental impact but more because Pb-containing slag is not a current waste managed in Victoria (although it was until the relatively recent closure of Laverton's smelter), so it will add 4,500 tonnes of a 'new' waste stream to landfill. However, given that this volume is not large in relative terms, the slag's total lead is low (0.2-0.6%[16]), leachable levels are very low[16] and landfill infrastructure such as the Lyndhurst facility is perfectly suited to accept it (in hazard and volume terms), this simply adds an increment to the waste management system.

The best practice assessment for air emissions provided a perfect example where the project design was changed due to an integrated environmental assessment. The China reference plant returns battery separator plastics to the smelting furnace, as a nominal means of recovering energy to offset natural gas use and thereby save on waste disposal costs. This is a feasible option for the Hazelwood proposal so was part of the original design. However, the air best practice assessment had to demonstrate reduction of Class 3 indicator emissions to 'maximum extent achievable' (MEA), and while dioxins are not a specific concern for ULAB smelting it is a relevant air pollutant consideration. Dioxins have to have a number of process conditions to form, and one of the important ones is the potential for organic compounds containing halogens as feedstock to the thermal process. Separator plastic can sometimes be made of PVC, so this was assessed as a risk for dioxin formation. The balance of the reduction in fuel use, and therefore GHG emission, gained from burning separators, versus the reduced risk of dioxin formation from their removal from the process was deemed to fall in favour of the latter, despite the fact that this choice adds a relatively small volume of new waste to landfill. This decision was made clearer by the policy need to achieve MEA for dioxins.

In summary, from an integrated environmental management perspective, Table 7 shows that the facility is not constrained in any segment if further (resource consuming or emission-positive) plant or machinery was deemed necessary to better manage impacts in one segment over another. However, Table 7 also demonstrates that no particular (environmental) improvements, or 're-balancing' of environmental considerations, are pressing to be made.

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[16] See Table 37, "Laboratory test data of slag from the China reference plant".

Table 7: Summary of environmental assessments in this application

Section no.	Environmental segment	Assessment summary	(Negative) impact on environment
6	Energy use and GHG emissions	• Annual 10kt CO_2-e emission is low compared to other Latrobe Valley sources (0.02%). • Due to avoided primary lead extraction/ manufacturing emissions, Chunxing ULAB plant is a net GHG reducer (net emissions -39kt CO_2-e) • Chunxing ULAB plant is twice as energy efficient as traditional ULAB smelting processes • Demonstrated to meet best practice	None – net positive impact
7	Water resource use	Below the WAA Guideline threshold of 10 ML/year due to wastewater reuse and full harvesting of site water runoff	Negligible
8	Air (pollutant) emissions	• Air pollutant emissions are assessed as being orders of magnitude below GLCs specified in SEPP (AQM) design criteria. • Class 3 indicators are assessed as meeting SEPP (AQM) requirements for reduction to MEA. • All emissions meet EU IED emission limits • Demonstrated to meet best practice	Low
9	Noise emissions	The noise from plant equipment sources is assessed to be well in compliance with the *recommended maximum noise levels* calculated at the nearest *noise sensitive area* (1.1km away), according to EPA's NIRV guideline during day, evening and night periods.	Low
10	Water emission	The proposed plant will not: • discharge to waterways • discharge contaminated runoff to stormwater	Negligible
0	Land & groundwater	The proposed plant will not: • store petroleum products underground • transfer petroleum products by pipeline • extract groundwater or inject waste or other materials into groundwater. • discharge to land, and risk of accidental discharge will be controlled through bunding and drainage/ collection through the waste water treatment system.	Very low
12	Waste	• PIW generation of 5,500 t yr is made up mostly of Pb-containing slag (4,500 t/yr). • Slag volumes are well below those from alternative smelting technologies – managed under the PIW framework by landfill or treatment followed by landfill, depending on hazard categorisation • Pb levels in slag are well below those from alternative smelting technologies • Strong overall circular economy outcome due to diversion of 50,000t/yr of Pb scrap currently exported.	Low-medium

5 Environmental best practice

EPA works approval guidance[17] defines best practice directly from Part IV of SEPP (AQM):

> *'the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity.'*

'Eco-efficient' is defined as 'producing more goods with less energy and fewer natural resources, resulting in less waste and pollution'.

This assessment is a summarised collation of the individual environmental segment best practice analyses conducted elsewhere in this application. These assessments have been done for energy and GHG emissions (Section 6.2), air emissions (Section 8) and prescribed industrial waste (PIW) generation (Section 12.6).

5.1 Environmental risk assessment

The process of developing the works approval template, using EPA's works approval application checklist[18], provides the basis for environmental risk assessment. The checklist approach uses input data about the proposal to distinguish the level of detail required for each segment assessment, based on the relative risks posed to the environmental segment.

From this exercise, the most significant risk areas are highlighted in boxed sections below.

- Energy use and GHG emissions were significant enough to require a detailed assessment, including an assessment of best practice, due to the proposal's energy use being >10TJ.
- Water use (from mains or other external supply) is << 10ML/ yr, due to significant recycling of water onsite as well as rain and stormwater capture, all managed through onsite waste water treatment. Consequently water use impacts were assessed as negligible.
- Air emissions are a critical consideration, since smelting is a high temperature process and metals smelting involves heavy metals, most notably lead. The air assessment is the most detailed in this application. The process of best practice assessment resulted in an improvement to the design from the China reference plant: removal of separator plastics (that could contain PVCs) from the furnace due to their risk of dioxin formation.
- Noise emissions were estimated to be below the recommended maximum noise levels at the nearest noise sensitive area, due to the distance of the buffer available (more than twice the recommended buffer zone to the nearest sensitive receptor and five times this to the nearest town) and the enclosed nature of all major noise emitting components of the plant.
- Stormwater or direct watercourse emission impacts were assessed as negligible due to the full capture of stormwater onsite (managed through onsite wastewater treatment) and the fact that no emissions occur to waterways.

[17] EPA Victoria Works approval application guideline, publication 1658 (June 2017), available from: https://www.epa.vic.gov.au/our-work/publications/publication/2017/june/1658

[18] EPA Works approval application checklist, available at: https://www.epa.vic.gov.au/business-and-industry/forms/licence-and-works-approval-forms/works-approval-application-checklist

- Land and groundwater emission risk was assessed as very low due to the fact that all spills, leaks and storages are controlled by bunding and full building-enclosed activities, with impervious floors draining to the onsite wastewater treatment system.

- Waste generation, handling and receipt (of ULABs as D220 PIW) was determined to require a detailed assessment, including an assessment of best practice, since 50,000 tonnes/ yr of PIW is received in the form of ULABs and 5,500 tonnes/ yr is produced, mostly in the form of Pb-containing slag.

5.2 Options analysis

Section 4.5 describes five types of technology options for management of ULABs:

1. Battery breaking and on-selling the separated components
2. Secondary lead smelting, using a rotary furnace
3. Hydrometallurgical (electrolytic) lead reduction
4. New hydrometallurgical technologies under development
5. Chunxing's secondary lead smelting technology, modified Isasmelt process

Outdated technologies, such as blast furnace smelting and/or manual battery breaking, were deemed as not sufficiently modern options necessary for assessment.

Of these, only options 2 and 5 could be considered to be in the frame of best practice processes, since options 3 and 4 were not sufficiently proven, technically or economically, at plant scale, and option 1 is only a partial process, so must be less eco-efficient by definition, especially as it implicitly involves export of lead scrap, since onshore secondary lead smelting capacity is currently constrained.

Option 4 (using the specific example of the Wagga Wagga ULAB facility, the only other secondary lead smelter in Australia) was considered best practice at the time of its approval and establishment (approximately 2012). This indicates that it is likely to be a relatively modern and efficient operation. While its detailed environmental impact assessment is not required for this proposal, the plant has been examined at length for the purpose of an Australian comparison to the Chunxing technology. This examination would suggest that it would meet Victorian statutory policies, since it currently meets similar requirements imposed on it by the NSW EPA. On a best practice basis however, it has been assessed as falling short of the newer Chunxing technology in the following areas:

- Air emissions performance: Data from licence stack monitoring, supported by data from the National Pollutant Inventory show that the Wagga plant is typically higher in air emissions. Table 25 from the air best practice section (Section 8.4) shows the Wagga plant to emit 16 times more lead than the proposed Hazelwood plant.
- Slag volumes produced: Data reported in *Hazardous waste in Australia 2019*, supported by literature data for rotary furnace secondary lead smelting, shows that the volume of slag is around double that achieved by the Chunxing technology.
- Slag Pb content: Waste transfers data reported by the facility to the National Pollutant Inventory, supported by literature data for rotary furnace secondary lead smelting, shows that the Pb content of this slag is 10-fold greater than that achieved by the Chunxing technology.

- Energy efficiency: Because the Wagga process involves smelting of grid and paste together without a separate melting process for Pb grid, energy use is likely to be higher than Chunxing's technology. It's rotary furnace design is also a factor in higher energy use. Thornton et.*al* 2011[14] describes a number of advantages of the IsaSmelt process over traditional rotary furnaces, most notably higher thermal efficiency.
- Limited manual handling: Compared to traditional rotary smelting, Chunxing technology is highly automated, which greatly reduces any manual handling and therefore worker exposure risk.

The Chunxing technology (option 5) is therefore demonstrated to be the most eco-efficient and lowest environmental impact process choice, for recycling of ULABs, as detailed in the respective best practice assessments of the Energy and GHG emissions, air emissions and waste sections of this application.

5.3 Site selection and separation distance

CA 2047 Fourth Rd, Hazelwood North (near Morwell) is in the middle of an Industrial 2 Zone. Surrounding land is developed Industrial 2 Zone, containing other industrial premises The next layer of land radiating outwards from Fourth Road is zoned as Industrial 1, and the land zone of the nearest sensitive receptors is farming (FZ).

The WAA Guideline Appendix C-35 (for *I02 Metal Melting*) quotes best practice separation distance as 500m from EPA Publication 1518 (*Recommended separation distances for industrial residual air emissions*), for such plants that produce <1,000,000 tonnes/yr of metal products. The Chunxing proposal is to produce 28,000 tonnes of Pb metal products.

Section 2.3 of this application shows that the nearest sensitive receptor is 1.1km away, and the nearest town (the southeast of Morwell) is over 2km away.

This facility is well located from the perspective of land use and its separation distance of 1.1km (from the nearest sensitive receptor) is a more than satisfactory according to the EPA references above. Furthermore the proposed land is surrounded by related recycling activities and heavy industries, some of which have the potential to be either direct users of Chunxing by-products or direct service providers.

5.4 Principles of environment protection

EPA's *Application of the environment protection principles to EPA's approvals process* guideline[19], introduces the EP Act's 11 environment protection principles, and indicates the significance of each for approval processes like Works Approvals.

Based on this guideline and the nature of Chunxing's proposal, the following have been deemed relevant to assessing best practice:

- the wastes hierarchy
- integrated environmental management
- Integration of economic, social and environmental considerations

[19] EPA Victoria (2013) *Application of the environment protection principles to EPA's approvals process* guideline, (Publication 1565), available at: http://www.epa.vic.gov.au/~/media/Publications/1565.pdf

5.4.1 The wastes hierarchy

The credentials of the Chunxing option with respect to the wastes hierarchy have been well-documented throughout this application. These references have been collated against their intersection with each management options of the wastes hierarchy, listed in order of most preferable to least preferable in Table 8.

Table 8: Assessment of Chunxing proposal aspects against the wastes hierarchy

Wastes hierarchy management option	Relevant env. segment	Aspect of Chunxing operation
Avoidance	Energy and GHG emissions	There is major GHG emissions avoidance due to the replacement of the emissions-intensive *Pb ore mining/ primary smelting* business model with the *ULAB collection/ secondary smelting/ direct Pb outputs back into battery manufacturing* business model. These avoided emissions are approximated in Section 6.2.1.
	Waste	Slag volume around 4,500 tonnes/ yr or 160 kg/ slag per t of Pb product; much lower than other smelting practices Slag Pb levels around 0.20 – 0.56% Pb; much lower than other smelting practices Avoids exporting 50,000 tonnes of waste lead scrap, as is currently the case with battery breakers in Australia
Reuse	Waste	Preliminary discussions have been had with local interested parties about the potential for diversion of those ULABs with significant remaining battery life, back into operation via local projects to develop low cost 'battery banks', to eliminate night-time electricity use costs from schools and other public facilities.
Recycling	Waste	Chunxing's process is recycling, as opposed to lower-hierarchy options such as breaking/ export, landfilling or illegal dumping outside of the waste system. Lead ingot product and lead alloy products are recycled back into battery manufacturing, for making lead oxide paste and battery plates, respectively. Chunxing also produces four saleable by-products, as a consequence of processing or pollution control, which are recycled: - chipped HDPP back into battery manufacturing for new casings - zinc sulfate solution, for foliage spray, to promote leaf growth in the agricultural sector - ammonium sulfate solution, as a liquid soil fertiliser for the agricultural sector - gypsum,, as a soil amendment for Ca/ S nutrition, acid neutralization, water infiltration and P retention.
Recovery of energy	Energy and GHG emissions	Waste heat from one furnace pre-heats the other. Smelting furnaces and other key plant are fully enclosed, which maintains heat, resulting in lower energy demand.
Treatment	Waste	Lead slag is the major waste stream from the process and is expected to be Cat B PIW, based on lead concentration. Should this Pb concentration prove higher than the China reference plant, it could become Cat A PIW, which may

Wastes hierarchy management option	Relevant env. segment	Aspect of Chunxing operation
		require treatment although, as it is below IW ASLP Pb levels anyway, this step may not achieve much.
Containment		Not directly applicable at this time.
Disposal		Slag and lead-contaminated plastic separators will be disposed to landfill

5.4.2 Integrated environmental management

This principle states that if approaches to managing environmental impacts on one segment of the environment have potential impacts on another segment, the best practicable environmental outcome should be sought.

A specific example of this type of judgement resulted in modification of the project design, due to an imperative to improve air emissions (dioxins) to meet best practice, that had a consequence of removal of a minor fuel substitute (increased energy use) and addition of a maximum of 1,000 tonnes/ yr (of lead-contaminated plastic separators) to landfill. The judgement was that the elimination of a risk to community health (from air emission impacts), however small that was, outweighed the company cost reduction from a small lowering of energy use, the trivial reduction it would account for in GHG emissions and the addition impost of a higher landfill tonnage, which is primarily a business cost than an environmental risk.

This assessment is discussed in Section 4.6 and throughout the air and waste sections of this application.

Other than the competing tension of this example, there are no other competing environmental impacts that require trade-off.

5.4.3 Integration of economic, social and environmental considerations

This proposed project will bring financial, social and environmental benefits to both the Latrobe Valley region and Australia; the former through increased economic activity that will bolster the local recycling industry base, and the latter through higher rates of recycling of ULABs and a more complete 'circular economy' approach.

It is anticipated that the project capital cost will be in the vicinity of A$30 - $40 million. Of this, the project is expected to inject at least A$10 million per year into the Latrobe Valley community.

The expected employment will be about 50 direct full-time positions. In addition, there would be indirect employment created and other benefits to the local area due to the expected annual expenditure on local services.

5.5 Best practice analysis

Segment based assessments analyse best practice in their specific terms as follows:

- Section 6.2 (energy and GHG emissions)
- Section 8.4 (air emissions)
- Section 12.6 (prescribed industrial waste (PIW) generation).

5.6 Best practice assessment

Segment-specific outcomes of each best practice assessment are detailed in the following sections:

- Section 6.2.3 (energy and GHG emissions)
- Section 8.4.5 (air emissions)
- Section 12.6.4 (prescribed industrial waste (PIW) generation).

5.7 Best practice summary

The best practice assessment outcomes of this application, as they relate to the techniques, processes and technologies employed in the Chunxing proposal are summarised below, primarily from the analysis of segment-relevant best practice sections of this report as well as overarching analysis relevant from this section.

Chunxing's facility is assessed as *meeting best practice in energy and GHG emissions management* because it satisfies a best practice evaluation in each of the following elements:

1. avoidance and reduction of emissions: through life-cycle assessment shows the plant to be a net-reducers of GHG emissions of around -39,473 tonnes CO_2-e per year
2. Its contribution to Latrobe Valley regional GHG emissions and Corporate Australia's emissions are very small, at less than 0.02% of the former.
3. Operating equipment and technologies are highly efficient in their use of energy through automation, plant process enclosures (heat recovery and transfer), furnace design and use of high efficiency three phase induction motors.
4. Chunxing's energy use per tonne of lead produced is higher than conventional smelting alternatives, using approximately 100 kWh per tonne of Pb produced, versus 200 kWh per tonne of Pb produced in reverberate and rotary ULAB furnaces.

Chunxing's facility is assessed as *meeting best practice in air quality management* because it satisfies a best practice evaluation in each of the following elements:

5. Very low emissions compared to the other operational ULAB smelter in Australia, itself deemed best practice technology when installed in approximately 2012. This is due to a combination of unique chemistry and process technologies:
    a) multiple desulfurisation steps
    b) manipulating O_2 concentration in the furnace to first reduce SO_4^{2-} and then subsequently oxidise S^{2-} to SO_2; and final treatment with lime in a high efficiency scrubber

   c) dual Vertical Smelt Furnaces, with pre-heating and continuous stirring, to ensure fast reaction times and efficient stoichiometry, lowering residual (unreacted) lead oxides in the flue gas (the source of lead emission)

   d) and advanced air pollution controls (as described below).

6. Best practice process controls including fully automated, enclosed and negative pressurised environments throughout battery breaking and pre-sorting, melting, smelting, refining, acid neutralisation and by-product purification; fume and off-gas collection, temperature control and high smelting temperatures.

7. Best practice air pollution controls by:

   a) capturing particulates in air discharge with a baghouse (fabric filter) design

   b) removing SO_2 and other pollutants from air emissions with a lime-dosed wet scrubber

8. For class 3 indicators, as part of demonstrating 'maximum extent achievable' emission reduction, the plant meets the emissions standards set in the European Union's Industrial Emissions Directive 2010/75/EU (IED), namely:

   a) <0.5 mg/m^3 for the sum of Sb, As, Pb, Cr

   b) <0.05 mg/m^3 for Cd

   c) <0.1 ng/m^3 for dioxins and furans

9. The plant also meets the IED's requirements for:

   a) installation of continuous emissions monitoring system (CEMS) for major combustion pollutants

   b) at least non-continuous air emission monitoring of other pollutants such as heavy metals, dioxins and furans

   c) keeping combustion or co-combustion gases at a temperature of at least 850°C for at least two seconds after the last injection of air

   d) Eliminating plastics from furnace feedstock to ensure less than 1 per cent of halogenated organic substances, expressed as chlorine, is combusted.

10. The Chunxing plant's emissions comparison to the only operational ULAB smelter in Australia (the Wagga Wagga facility), shows it to be substantially lower in emissions of most pollutants, including those of primary concern to secondary lead smelting (Pb, SO_2, dust and H_2SO_4 fume).

11. The only pollutant modelled to be a higher emission than the Wagga Wagga facility is dioxins, which the China plant emits below the IED limit (0.1ng/m^3) anyway, and will be significantly lower in the Hazelwood facility due to its decision to exclude feed plastic separators from the furnace.

12. Air quality modelling shows each pollutant's ground level concentrations to be substantially within SEPP design criteria.

13. All plant emissions are substantially lower than what is currently contributed to the Latrobe Valley airshed (including the projected emissions from the recently approved energy from waste plant at Paper Australia). The major pollutant emissions of concern for secondary lead smelting (Pb, SO_2, H_2SO_4 mist and PM_{10}) contribute only 1.2%, 0.001%, 0.4% and 0.02% respectively of airshed emissions, despite the fact

that power generators are relatively low lead emitters due to its low incidence in Latrobe Valley brown coal.

Chunxing's facility is assessed as *meeting best practice in prescribed industrial waste generation* because it satisfies a best practice evaluation in each of the following elements:

14. Slag volume around 4,500 tonnes/ yr or 160 kg/ slag per t of Pb product; which is much lower than other smelting practices

15. Slag Pb levels around 0.20 – 0.56% Pb; which is much lower than other smelting practices

16. The Chunxing technology rates high against the *wastes hierarchy* because:
    a) Chunxing's process is recycling, as opposed to lower-hierarchy options such as breaking/ export, landfilling or illegal dumping outside of the waste system. Lead ingot product and lead alloy products are recycled back into battery manufacturing, for making lead oxide paste and battery plates, respectively.
    b) Chunxing also produces four saleable by-products, as a consequence of processing or pollution control, which are recycled:
        a. chipped HDPP back into battery manufacturing for new casings
        b. zinc sulfate solution, for foliage spray, to promote leaf growth in the agricultural sector
        c. ammonium sulfate solution, as a liquid soil fertiliser for the agricultural sector
        d. gypsum, as a soil amendment for Ca/ S nutrition, acid neutralization, water infiltration and P retention, and also as a constituent in cement manufacture (kilns).
    c) It improves overall Australian environmental outcomes for ULABs by reducing the reliance on overseas export of Pb scrap by as much as 50,000 tonnes/ yr, increasing the Australian ULAB circular economy.
17. It aligns with the State-wide Waste and Resource Recovery Infrastructure Plan, (SWRRIP) to the extent this policy applies to ULABs management.

SECTION 2 – ENVIRONMENTAL INFORMATION

6 Energy use and greenhouse gas emissions

All calculations and assumptions for calculating energy use and greenhouse gas (GHG) emissions are provided in the excel workbook *Chunxing WAA_GHG emissions.xls*, provided separately with this application and depicted in ***Appendix F***.

Energy use and GHG emissions data are provided in Table 9. GHG emissions data is separated into scope 1 and 2 emissions, consistent with National Greenhouse and Energy Reporting requirements (NGER). Also consistent with NGER, transport emissions (from EPA-permitted vehicles that truck used batteries to the site) are not in scope. Trivial onsite scope 1 emissions, such as refrigerant gas emissions from fridges in lunchroom facilities, are also not included.

Other excluded emissions sources, and the reasons why are:

- Onsite wastewater treatment emissions of methane (scope 1) are excluded because wastewater from smelting does not contain an appreciable organic waste component
- Scope 1 emissions from trucks carting ULABs that occur while unloading and loading, onsite, because they are trivial compared to other scope 1 emissions and difficult to isolate from emissions that occur on-road.

Calculation methods used and discussion of results are provided below Table 9. The National Greenhouse Accounts Factors July 2017 have been used for calculation of all emissions except process emissions of CO_2 from the use of coal fines as a reductant in the smelting process, the method for which is described below.

6.1 Process CO_2 emissions method

Carbon dioxide, CO_2 (and carbon monoxide, CO) are produced from a range of reactions in the smelting furnace. The chemical equations are reproduced (from Section 4.4.5) below:

$2PbO + C = 2Pb + CO_2$
$PbO_2 + C = Pb + CO_2$
$PbO + CO = Pb + CO_2$
$PbSO_4 + 2C = PbS + 2CO_2$
$PbSO_4 + 4C = PbS + 4CO$
$2PbO + PbS = 3Pb + SO_2$
$PbS + Fe = Pb + FeS$
$PbSO_4 + PbS = 2Pb + 2SO_2$
$FeS + O_2 = Fe + SO_2$
$4Fe + 3O_2 = 2Fe_2O_3$ (includes some other Fe oxides)
$2CO + O_2 = 2CO_2$

The method used to calculate direct process emissions of CO_2 is based on these equations as follows:

- CO_2 is produced primarily from the oxidation of C fines added to facilitate the reduction of Pb oxides and sulfates to Pb.

- But the Pb paste salts are the limiting agents, because the objective of smelting is to maximise Pb recovery, not maximise C oxidation. Coal-C is added in excess to ensure this maximum recovery, so using this reactant (stoichiometrically) to estimate CO_2 will over-estimate emissions.
- Therefore, the most accurate way to calculate direct process CO_2 emissions is to use the stoichiometry of these equations based on Pb paste input quantities (31,000 tpa total paste).
- Lead paste has approximately 10% entrained water, so the dry weight of lead paste is 90% of 31,000 = 27,900 tonnes.
- Pb paste is a mixture of Pb salts - this calculation assumes the breakdown to be: PbO 25%, PbO_2 25%, $PbSO_4$ 50%
- From the equations listed, stoichiometric molar amounts are:
  - 5 moles of PbO, 1 mole of PbO_2, 3 moles of $PbSO_4$ produce (via a number of reactions) 7 moles of CO_2.

Using the atomic/ molecular weights of all relevant reactants and products of the above reactions, CO_2 process emissions can be calculated as follows:

Direct process CO_2 (t/yr) = m/MW (sum all Pb paste components) x 7/9 x MW (CO_2), where:

m = mass of each paste component (31,000 tonnes x % of component)
7/9 is the molar ratio of paste reactants to CO_2 produced in the total set of equations
MW = molecular weight of each paste component
MW (CO_2) = molecular weight of CO_2 = 44

Applying this equation, direct process CO_2 (t/yr):

= [(0.25 x 27,900/(207+16)) + (0.25 x 27,900/(207+32) + (0.5 x 27,900/(207+32+64))] x 7/9 x 44
= ***3,645 tonnes per year***.

This result can be checked via two other methods:

1. From molar ratios of lead ingots produced per year (likely to be less accurate)
2. From literature emission factors for secondary lead smelting (likely to be least accurate).

6.1.2 Process CO_2 emissions – lead ingot ratio check

Pb ingots produced from smelting = 17,000 tonnes per year, and the chemical reactions in Section 6.1 show that 10 total moles of Pb are produced alongside 7 moles of CO_2.

n (CO2) = n (Pb) x 7/10, which gives:
Direct process CO_2 (t/yr) = m/MW (Pb ingot produced) x 7/10 x MW (CO_2)
= 17,000/207 x 7/10 x 44
= 2,529 tonnes per year.

6.1.3 Process CO_2 emissions – default emission factor check

The National Greenhouse Accounts Factors do not include process emission factors for second (or primary) lead smelting. The 2006 IPCC Guidelines for National Greenhouse Gas

Inventories includes an emission factor for lead production "treatment of secondary raw materials", which is assumed as equivalent to ULABs. This factor is 0.20 tonnes of CO_2 per tonne of lead produced. Applying this factor gives:

Direct process CO_2 (t/yr) = m (Pb ingot produced) x 0.20
= 17,000 x 0.20
= 3,400 tonnes per year.

6.1.4 Process CO_2 emissions – conclusion

Since the primary method is likely to be more accurate than either of the checking methods, and the primary method gives the highest (most conservative) result, this has been chosen.

Consequently, the direct process CO_2 emission chosen is 3,645 tonnes per year.

Table 9: **GHG Emissions - estimates for Hazelwood North facility**

Emissions source	Activity data	Activity data unit	Energy content factor	Energy content factor unit	Emission factor(s)	Emission factor unit	GHG emission (t CO2-e) per year	Notes
SCOPE 1								
Natural gas combustion (furnaces)	1,680,000	m^3	0.0393	GJ/m^3	51.4	CO_2, as kg CO2-e/GJ	3,394	*Natural gas distributed in a pipeline* emission factors
Natural gas combustion (furnaces)	1,680,000	m^3	0.0393	GJ/m^3	0.1	CH_4, as kg CO2-e/GJ	6.6	*Natural gas distributed in a pipeline* emission factors
Natural gas combustion (furnaces)	1,680,000	m^3	0.0393	GJ/m^3	0.03	N_2O, as kg CO2-e/GJ	2.0	*Natural gas distributed in a pipeline* emission factors
Direct process emissions (smelting)	-	-			-	-	3,645	Calculated from coal fines in smelting, assuming 100% of coal is C and all C -> CO_2
Onsite forklift (LPG) emissions	10	kilolitres of LPG	25.7	GJ/kL	60.2	CO_2, as kg CO2-e/GJ	15.5	LPG emission factors
Onsite forklift (LPG) emissions	10	kilolitres of LPG	25.7	GJ/kL	0.2	CH_4, as kg CO2-e/GJ	0.1	LPG emission factors
Onsite forklift (LPG) emissions	10	kilolitres of LPG	25.7	GJ/kL	0.2	N_2O, as kg CO2-e/GJ	0.1	LPG emission factors
						Total Scope 1	**7,063**	
SCOPE 2								
Site-wide electricity use	2,800,000	kWh			0.00108	t CO2-e/kWh	3,024	Victorian Electricity Factor
						Total Scope 2	**3,024**	
Total scope 1 & 2 GHG emissions							**10,087**	
ENERGY USED								
Electricity	2,800,000	kWh	10.1	TJ				1 kWh = 3.6MJ
Fuel (natural gas)	1,680,000	m^3	66.0	TJ				1TJ = 1,000,000MJ; 1TJ = 1,000GJ
Total			**76.1**	**TJ**				

Table 10 provides context to the Scope 2 (electricity use) emissions by describing the major equipment systems used in the plant and the total rated power of each.

Table 10: Equipment Power Configuration List

#	名 称 Name	总功率 Total Power (KW)	备 注 Note
1	破碎系统 Breaking System	620	含压滤系统 Including pressure filter system
2	中和系统 Neutralizing System	150	
3	铅泥输送系统 Lead paste conveying system	180	含混料机/白煤/铁销 including mixer/smokeless coal/scrap iron
4	熔炼系统 Melting System	720	含除尘/气化炉 including Dust removal /gasifier
5	熔炼炉燃烧系统 Furnace combustion System	75	
6	碎渣系统 Slag System	180	
7	脱硫系统 desulfurisation system	300	
8	精炼系统 Smelting System	400	
9	精炼燃烧系统 Refined Combustion System	120	
10	化验设施 Laboratory facilities	55	
11	雨、污水处理系统 Rainwater, sewage treatment system	120	
12	消防设施 fire-fighting facilities	200	
13	厂区供水及净化水设施 plant water supply and purification facilities	200	
14	起重设施 Cranes	160	
15	塑壳分选系统 Plastic sorting System	300	
16	岗位送风系统 Fan System	110	
17	办公及公用照明 Office and Public Lighting	300	
	合计 total	**4,190**	

Site electricity and natural gas use per year are obtained by scaling figures from the operational China reference facility (800,000 tonne ULAB per year) to fit a 50,000 tonne per year facility.

6.2 Best practice energy and GHG emissions management

EPA publication 1658 (June 2017) ("the WAA guideline") requires a best practice assessment by virtue of the Greenhouse PEM, which is subordinate to *SEPP (Air Quality Management - AQM*), if emissions are greater than 1,000 t CO_2-e/year, or <10 TJ/year of energy is used. Chunxing's emissions are 10,087 t CO_2-e and their energy use is 76.1TJ.

SEPP (AQM) requires that generators of emissions of GHG avoid and minimise emissions in accordance with the wastes hierarchy, and must apply best practice to the management of their emissions.

EPA publication 1307.10 (April 2015) ("the old WAA guideline")' details specific process examples of best practice, including for energy use and greenhouse gas emissions, in its series of appendices per industry type. This document's Appendix C-35 describes examples of best practice under the heading of energy as:

- *"optimising furnace efficiency*
- *recovering heat*
- *using renewable energy*
- *installing efficient motors and boilers*
- *optimising the site power factor."*

EPA Guideline 1517 Demonstrating Best Practice defines best practice via SEPP (AQM), Part IV as:

> *'the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity', where 'eco-efficient' is defined as: 'producing more goods with less energy and fewer natural resources, resulting in less waste and pollution*..'

These guiding materials above have been used to distil the most relevant 'elements' of best practice for energy use and GHG emissions. These elements are listed in Table 11, alongside the Chunxing facility's design or operational response to implementing each.

Table 11: Best practice assessment for energy and GHG emissions

Element of best practice	EPA guidance reference	Chunxing assessment against best practice element
Avoid and minimise emissions in accordance with the wastes hierarchy	SEPP (AQM)	Avoidance, reuse, recycling, recovery of energy, treatment, containment, disposal Adherence to the wastes hierarchy is perhaps the strongest feature of the Chunxing technology and battery recycling in general. There is major emissions avoidance due to the replacement of the emissions-intensive *Pb ore mining/ primary smelting* model with the *ULAB collection/ secondary smelting/ direct Pb outputs back into battery manufacturing* business model. These avoided emissions are approximated in Section 6.2.1. Chunxing's process is recycling, as opposed to lower-hierarchy options such as breaking/ export, landfilling or illegal dumping outside of the waste system.
Contribution to regional GHG emissions	WAA Guideline 6.2.3	Overall, Chunxing Hazelwood will be a net reducer (not emitter) of GHG by 39kt CO_2-e per year, which is equivalent to removing 8,000 cars from the road. Excluding avoided emissions, Chunxing will emit 10kt of CO_2-e per year, which is a tiny fraction of the Latrobe Valley's industrial GHG emissions, which are virtually all from power generation. Excluding the now-closed Hazelwood power station, Loy Yang A, Loy Yang B and Yallourn generated 43,100kt CO_2-e of direct GHG emissions in 2016[20]. Chunxing's emissions would make up 0.02% of this total.
Optimising furnace efficiency; Recovering heat	WAA Guideline Appendix C	Energy saving measures implemented as part of the design of the plant include: the use of high-efficiency dual VSF furnaces, where waste heat from one furnace pre-heats the other. Smelting furnaces and other key plant are fully enclosed, which maintains heat.
Using renewable energy		The Hazelwood facility uses natural gas, which is not renewable energy. However, preliminary discussions have been had with local interested parties about the potential for diversion of those ULABs with significant remaining battery life, back into operation via local projects to develop low cost 'battery banks', which provide night-time storage for solar/wind daytime-generated electricity, to eliminate night-time electricity use costs from schools and other public facilities.
Installing efficient motors and boilers		High efficiency three phase induction motors are used in the plant
Optimising the site power factor		To be addressed at operation stage.
The best combination of eco-efficiency	Guideline 1517 Demonstrating Best Practice	The Chunxing smelting process is the most energy efficient ULAB smelting technology available, using approximately 100 kWh per tonne of Pb produced, versus 200 kWh per tonne of Pb produced in reverberate and rotary ULAB furnaces

[20] The State of Victoria Department of Environment, Land, Water and Planning 2018, *Victorian Greenhouse Gas Emissions Report 2018*, available at: https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0033/395079/Victorian-Greenhouse-Gas-Emissions-Report-2018.pdf

6.2.1 Avoided emissions from mining, processing and smelting of lead

The ULAB recycling process adopted by Chunxing produces Pb from ULABs in two forms: 99.99% lead ingot, sold as pure feedstock to make high-grade lead dioxide battery component; and lead alloy at an alloy specification suitable to be used to make lead battery plates. So the industry feeds a full-cycle supply loop connecting battery end of life to recycling to re-manufacturing back to use again, which is a good example of the 'circular economy'.

When assessing the GHG emissions that occur from the secondary smelting process, consideration should also be given to those emissions that have been displaced by the circular commoditisation of waste batteries – the mining and beneficiation of lead ore, followed by its smelting in a primary lead smelter. For simplicity, transport emissions of the lead ore to the primary smelter are assumed to be similar to the transport emissions of trucking ULABs to the secondary smelter, so both have been omitted from the scope of the GHG emissions assessment.

These emissions avoided from more traditional lead manufacturing routes, equivalent to the 28,000 tonne per year production level of the proposed Hazelwood plant, are shown in Table 12. Total avoided GHG emissions are estimated at 49,560 tonnes CO_2-e per year, when both Pb ore mining/ processing and Pb ore (primary) smelting are taken into account, assuming the latter occurs at the Nyrstar Port Pirie lead smelter. Since this is avoided it is a 'negative' emission, which is then summed with the Hazelwood plant's actual estimated emission of 10,087 tonnes CO_2-e per year, which gives a net emission of -39,473 tonnes CO_2-e per year.

This means that the GHG impact of operating the proposed Hazelwood ULAB plant is to add 10,087 tonnes CO_2-e per year, but in the context of total lifecycle emissions (subtracting those avoided from creating the same amount of lead from primary extraction and production activities) that impact becomes a ***net GHG reduction of 39,473 tonnes CO_2-e per year***. According to the US EPA's Greenhouse Gas Equivalencies Calculator[21], this is equivalent to removing 8,000 cars from the road, per year.

[21] US EPA Greenhouse Gas Equivalencies Calculator, available at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Table 12: Avoided GHG emissions due to the proposed Hazelwood facility

Emissions source	Activity data	Activity data unit	Emission factor(s)	Emission factor unit	GHG emission (t CO2-e) per year	Notes
AVOIDED EMISSIONS						
Primary lead smelting (i.e. Port Pirie)	28,000	t/yr Pb that Hazelwood would displace from primary smelting at Port Pirie	0.96	t CO2-e/ t Pb product	-26,880	GHG intensity (emission factor) taken from Govt of SA report (2013)[22]
Pb ore mining and concentrating	28,000		0.81	t CO2-e/ t Pb product	-22,680	GHG intensity (emission factor) taken from Nyrstar 2018 Sustainability Statements[23] page 4. Mining-specific GHG intensity is an average from whole of Nyrstar's worldwide metals business, which is almost exclusively Pb and Zn production
Total avoided emissions					-49,560	
Site-based emissions (Scope 1 and 2)					10,087	
NET EMISSIONS					**-39,473**	Equivalent to removing 8,381cars from the road per year (US EPA Greenhouse Gas Equivalencies Calculator[24])

[22] SA Department of Planning, Transport and Infrastructure (December 2013), *Assessment Report for the Public Environmental Report, Nyrstar Port Pirie Pty Ltd, Port Pirie Smelter Transformation, Mid North*, available at: https://www.sa.gov.au/__data/assets/pdf_file/0015/112380/Assessment_Report_Nystar_Port_Pirie_Smelter_Transformation.pdf

[23] *Nyrstar 2018 Sustainability Statements*, available at: https://www.nyrstar.com/~/media/Files/N/Nyrstar/sustainability/sustainability-reports/2018%20Nyrstar%20Sustainability%20Statements.pdf

[24] US EPA (2018) Greenhouse Gas Equivalencies Calculator, available at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

6.2.2 GHG emissions in the Latrobe Valley context

Chunxing's proposed Hazelwood plant will produce GHG emissions of 10,087 tonnes CO_2-e per year, made up of Scope 1 combustion of natural gas and direct smelting-process CO_2 emissions, plus Scope 2 electricity-use emissions.

Reference to corporate GHG emissions reporting under *the National Greenhouse and Energy Reporting Scheme* (NGER) shows Chunxing's GHG contribution to be very small, relative to other emissions from Australian companies. Four hundred and thirteen companies reported their GHG and energy emissions to the NGER program in 2017-18, with energy and mining companies the most prominent at the highest end of emissions. For example, the highest emitter was AGL Energy Ltd at 43,575,349 tonnes CO_2-e total scope 1 and 2 emissions, and all of the top 10 emitted more than 10Mt CO_2-e. If Chunxing's 10,087 t CO_2-e was added to this list, it would be last (lowest) because its emissions fall under the threshold requiring for reporting (25 kt CO_2-e or 100TJ of energy use).

In the Latrobe Valley context specifically Chunxing's emissions are equally tiny, because of presence of the three major brown coal fired Power stations, which are very large emission sources[25]. Comparison against emissions from Loy Yang A, Loy Yang B and Yallourn Power stations, ignoring other GHG sources in the region (such as Paper Australia), shows that Chunxing's proposed Hazelwood plant would make up just 0.02% of this total.

6.2.3 Summary of the best practice energy and GHG emissions assessment

Chunxing's facility is assessed as *meeting best practice in energy and GHG emissions management* because it satisfies a best practice evaluation in each of the following elements:

1. It rates very highly in an assessment against the wastes hierarchy because, not only is the facility a strong 'circular economy' example of recycling, it has strong avoidance and reduction credentials due to the replacement of the emissions-intensive Pb ore mining/ primary smelting model with the ULAB collection/ secondary smelting/ direct Pb outputs back into battery manufacturing business model.
2. Its contribution to Latrobe Valley regional GHG emissions and Corporate Australia's emissions are very small, at less than 0.02% of the former.
3. Operating equipment and technologies are highly efficient in their use of energy through automation, plant process enclosures (heat recovery and transfer), furnace design and use of high efficiency three phase induction motors.
4. Chunxing's energy use per tonne of lead produced is the most energy efficient ULAB smelting technology available, using approximately 100 kWh per tonne of Pb produced, versus 200 kWh per tonne of Pb produced in reverberate and rotary ULAB furnaces.

[25] Emissions from the major electricity generators are obtained from: The State of Victoria Department of Environment, Land, Water and Planning 2018, *Victorian Greenhouse Gas Emissions Report 2018*, available at: https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0033/395079/Victorian-Greenhouse-Gas-Emissions-Report-2018.pdf

6.3 Climate change considerations and the *Climate Change Act 2017*

The *Climate Change Act 2017* (CC Act) came into effect on 1 November 2017. The CC Act requires EPA to consider climate change in works approval decisions. This application must consider:

1. potential impacts of climate change on the proposed facility at Hazelwood North
2. potential impacts to the proposed facility under future climate scenarios with reference to the Victorian Government's Climate Ready Factsheets and Regional Data Sheets
3. potential contribution to Victoria's greenhouse gas emissions and adoption of best practice measures to reduce greenhouse gas emissions

Consideration 3 is addressed by Sections 6 and 6.2 respectively, as part of requirements for assessment of energy and GHG emissions outside of the CC Act.

6.3.1 Potential impacts of climate change on the proposed facility

DELWP's Regional Adaptation Snapshot Gippsland publication[26] notes about climate change impacts in the region: "*Compared to the rest of the state, it is projected to remain a relatively wet and mild area.*"

DELWP guidance[27] indicates the following numerical projections of future climatic conditions relevant for Hazelwood North:

- Temperatures (Traralgon, average number of days per year, above current):
  - in 2030: 3 more hot days (>35^{0}C); 7 less frost days (<2^{0}C)
  - in 2070 (low emissions scenario): 4 more hot days (>35^{0}C); 12 less frost days (<2^{0}C)
  - in 2070 (high emissions scenario): 8 more hot days (>35^{0}C); 17 less frost days (<2^{0}C).
- Rainfall (Gippsland region, approximate % changes) less in winter and spring:
  - in 2030: the mid-range estimate is approximately -4% (winter) and -6% (spring), with the range varying from +6 to -14% (winter) and +6 to -18% (spring)
  - in 2070: (low emissions scenario) the mid-range estimate is approximately -1% (winter) and -8% (spring), with the range varying from +9 to -20% (winter) and +5 to -28% (spring)
  - in 2070: (high emissions scenario) the mid-range estimate is approximately -9% (winter) and -11% (spring), with the range varying from +2 to -21% (winter) and +8 to -38% (spring).

Table 13 contains a list of climate risks, their potential impacts, an assessment of the likelihood of each impact on the facility and an assessment of the resilience of the facility's

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[26] https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0026/392921/D18-001.RegCCASnapshotReports_Gippsland_FALR.pdf

[27] https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0021/60744/Gippsland.pdf

design to manage each impact. These Gippsland-specific risk and impacts are identified using resources provided on DELWP's Climate Change information and resources website[28]. The future climatic conditions for Gippsland are used in determining the likelihood of impacts to the facility and its resilience to cope with that impact.

It is noted that a typical industrial facility such as this may have an operating lifetime of around 25 years, but has been conservatively assumed to still be operating in 2070.

None of Table 15's potential impacts from climate change-heightened risks are assessed as significant enough to warrant the implementation of any climate change adaptation measures beyond the facility's design. The facility's design relies on significant water harvesting, treatment and within-plant recycling, which provides a buffer for dry periods, but also has the ability to draw from town supply in such conditions. On the other end of the scale, heavy rainfall events can be used to maximise storage then release overflow to trade waste.

[28] https://www.climatechange.vic.gov.au/information-and-resources/climate-change-adaptation-resources

Table 13: Gippsland-specific climate change risks and impacts to the proposed Hazelwood North facility

Climate risks	Potential impacts to facility	Likelihood of impact to facility	Facility resilience
Increased temperatures More hot days	Increased disruption to services such as electricity supply	Medium. Worst case 8 more hot days per year, which could result in occasional blackouts due to high demand on these days. Unlikely to be of significant duration per event – batch process means the impacts are contained and production is easily resumed upon reconnection.	Appropriate. Facility has back-up power via onsite diesel generators, which would take ~30 minutes to changeover. Should power disruption occur, the supply of natural gas is immediately cut off to secure the combustion system.
Fewer frosts	No relevant impact to facility	None	N/A
Less rainfall in winter and spring	Less water for plant to harvest for operating needs	High. Average of mid-point rainfall reductions in winter/ spring is about -10% but could be -20 to -40%. The plant has significant capacity to store water and recycle use.	Appropriate. The plant has some resilience in dry conditions due to high storage capacity and the fact that a significant proportion of water needs are met by recycled water from the onsite treatment system. In the driest of times the plant will simply draw water from town supply – during normal rainfall conditions the draw from town water is extremely small.
More frequent and intense downpours	Increased flood damage Increased disruption to services such as transport network closures	Medium. Actual flood damage or disruption to the facility is unlikely, since all operations occur within enclosed buildings. Plant operational impacts due to road closures in flood conditions is likely during intense rain events; this would be in the form of ULAB or other delivery delays.	Appropriate. Road closures would be anticipated to be for short periods. ULAB and raw material storage is expected to be sufficient to maintain operations over such periods.

Climate risks	Potential impacts to facility	Likelihood of impact to facility	Facility resilience
Longer and harsher fire seasons	Increased fire risk Increased disruption to services such as transport network closures	Low to medium. External fire conditions unlikely to impact the facility, due to large areas of landscaped buffer within the land parcel. Internal procedures and controls are already in place for risk of fire within the premises. Plant operational impacts due to road closures from bushfires would be in the form of ULAB or other delivery delays.	Appropriate. Road closures would be anticipated to be for short periods. ULAB and raw material storage is expected to be sufficient to maintain operations over such periods.
Sea level rises	No relevant impact to facility	None	N/A
Increased frequency and height of storm surge events	No relevant impact to facility	None	N/A
Warmer and more acidic oceans	No relevant impact to facility	None	N/A

7 Water resource use

Water is used throughout the plant for the following tasks:

- truck washing
- battery breaking, component sorting, cleaning and flushing
- pre-desulfurisation slurrying
- waste acid rinse water
- piped cooling for melting and smelting furnaces
- cooling tower (heat exchanger) flue gas cooling
- alloy cooling
- slag cooling
- desulfurisation (scrubber) water for lime slurrying and gypsum collection
- general plant clean-up, dust suppression water
- laboratory water
- laundry, toilets and kitchen.

Very little mains water is sourced for the above tasks, since rainwater is captured from building roof space, stormwater is contained and collected onsite and residual acidic water from battery acids (dilute sulfuric acid) is collected, neutralised and recycled to service the facility's water-use needs.

A high level mass balance of water volumes in terms of plant water supply (from mains, rainwater and stormwater), storage, treatment, steam and evaporation losses and discharges after treatment are shown in Figure 11.

The plant is designed to run predominantly on collection, treatment and recycling of its own internal water resources. Town water use in the plant is nominally up to 10m^3 per day (equivalent to less than 20 households' water use) in the event that rainfall deviates significantly from historical averages, either in quantity or distribution of rain events, and more regular top-up is required. Both the storage systems and the plant treatment/ use circuit itself are designed to enable retention of water significantly beyond plant use needs. Town water is used in-plant for the laboratory, truck washing and worker laundry/ bathroom facilities, with subsequent wastewater fed back to the treatment and recycling circuit.

Kitchen and office sanitary amenities are also required to be sourced from town supply, with wastewater disposed directly to domestic sewer.

Rainwater is harvested from a building roof area of about 17,000m^2 plus stormwater from around the site (49,000m^2); using 3-year rainfall averages this corresponds to approximately 115m^3/ day or 42,000m^3 per year. This water is collected in the storage infrastructure onsite (tanks and ponds) which total 550m^3 capacity, or around 5 days of average daily rainfall. From storage, rainwater collections are sent to the physical treatment plant then into recirculation for process water. On some occasions, rainwater may also require simple chemical treatment (typically pH adjustment) between physical treatment plant and plant use, and in high rainfall situations stormwater may require disposal via trade waste, where it requires checking and/or treatment (in the chemical treatment plant) before discharge, to ensure trade waste agreement quality specifications are met.

Recirculating plant water balances the assumed plant losses of 80m^3 per day to evaporation and steam. The plant's wastewater collection, storage, physical treatment and chemical treatment components allow for a total in-use circuit volume of 640m^3 per day, in excess of plant needs. Should there be an excess of treated wastewater beyond all plant storage, treatment and use circuit capacities, the aforementioned allowance for emergency discharge to sewer (via trade waste agreement) is as much as 40m^3 per day.

Plant task or sub-component level water is drawn from the wastewater recycling circuit. The annual replacement volume by plant task requirement is shown in Table 14. Note that the nominal daily mains supply volumes shown in Figure 11 are approximately seven-times higher than those annualised in Table 14. This discrepancy accounts for the fact that rainfall is not continuous, so daily mains drawdowns may be required on some days and completely absent on others.

Table 14: Annual task-level replacement water requirements

Water usage items	Replacement / yr (m^3)	Replacement / yr (ML)
Car wash drainage	200	0.2
Laboratory drainage	40	0.04
Laundry drainage	200	0.2
Domestic sewage (kitchen, bathroom amenities)	600	0.6
Lead paste pre-sulfurization wastewater	Uses direct from water recycle circuit	
Breaking & selection flushing floor waste water	Uses direct from water recycle circuit	
Desulphurization and dust removal wastewater	3,750	3.75
Melting furnace water coating and flue pipe cooling	6,600	6.6
Slag cooling & alloy lead cooling, plant flushing wastewater	2,080	2.08
Total plant replacement (make-up) water drawn from recycling circuit	12,430	12.43
Total plant replacement (make-up) water drawn from mains supply	1,040	1.04
Total plant replacement (make-up) water	**13,470**	**13.47**

Table 14 estimates an annual mains water usage requirement of 1.04 ML/ year which is well below the WAA Guideline threshold of 10 ML/year.

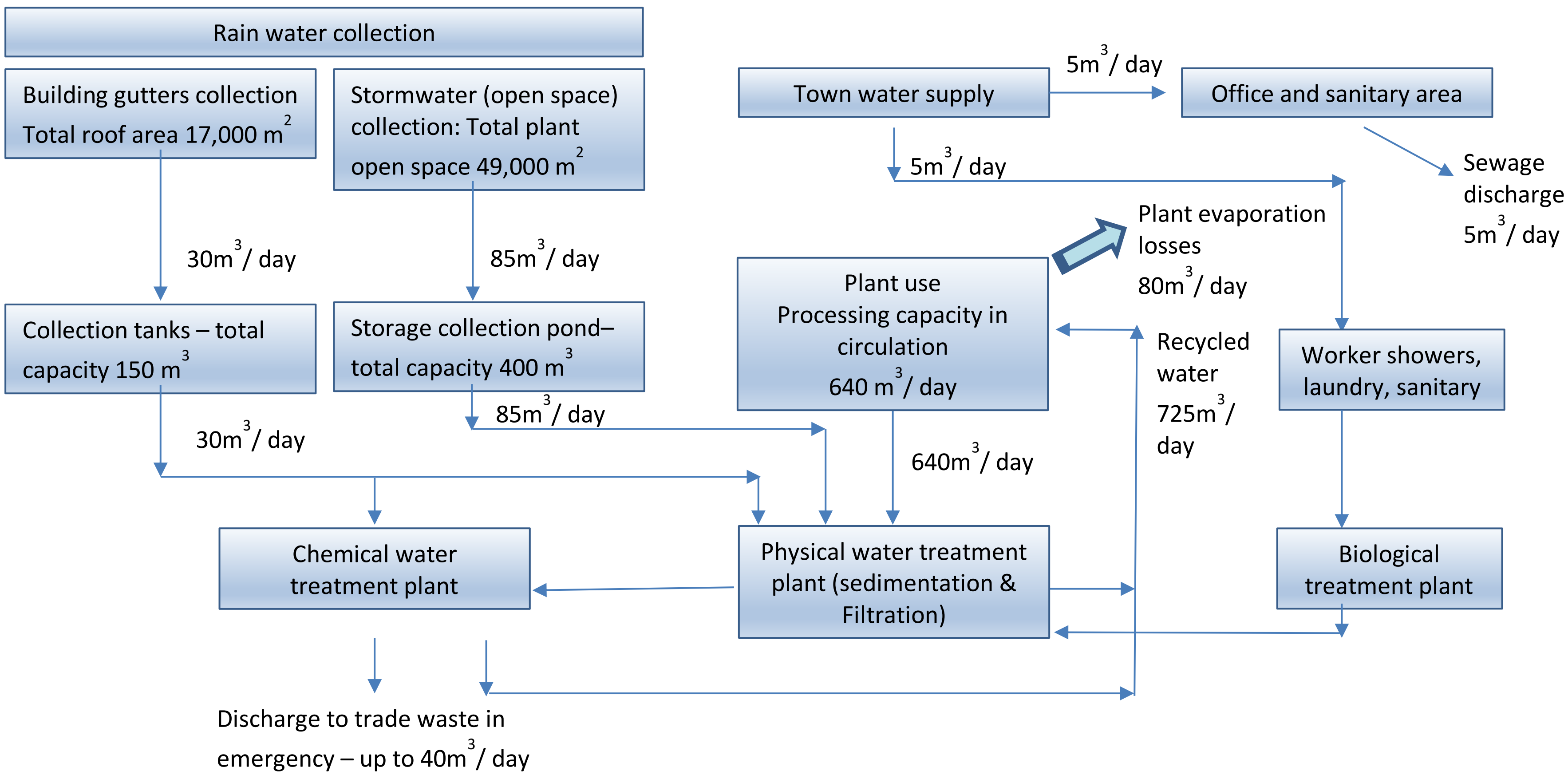

Figure 11: Water treatment and reuse system including rainwater management

8 Air emissions

Operation of the Chunxing ULAB recycling facility has the potential for the following emissions to air:

- Stack emissions of heavy metals from melting, smelting and refining, mainly lead (SEPP AQM Class 1 indicator) and low levels of chromium, antimony (SEPP AQM Class 2 indicators), cadmium and arsenic (Class 3 indicators).
- Stack emissions of typical combustion gases sulfur dioxide and nitrogen oxides plus particulates (SEPP AQM Class 1 indicators).
- Stack emissions of sulfuric acid mist (SEPP AQM Class 2 indicator).
- Potential low-level emissions of dioxins and furans, a SEPP AQM Class 3 indicator.

Consequently an air emissions assessment is required for application for Works Approval. This assessment is made up of:

- Air emission sources and air quality impact assessment (8.3)
- Best practice air quality management assessment (8.4).

8.1 General Exemption from the air requirements of Works Approval

The *Environment Protection (Scheduled Premises) Regulations 2017* ('the Scheduled Premises Regulations'), Part 3, Regulation 10, contain mass emission rate criteria for various pollutants, below which a general exemption from Works Approval can be applied. The air emissions from the Chunxing plant are modelled to be extremely low, due mainly to its small scale, advanced chemistry and technology, and comprehensive approach to pollution control. After review of the general exemption requirements, we believe that the emission rates of the Hazelwood North proposed facility are likely to be below Regulation 10 exemption levels.

This means that the Works Approval application is not required to consider air emissions at all, because they are below the levels requiring regulation, and therefore EPA is not required to assess the air section of the application.

We are providing this section voluntarily, given the community's clear interest in air emissions above all other aspects.

Justification of our assessment regarding the Regulation 10 general exemption for air is provided in Section 8.5.

8.2 Pollutants of concern

The choice of pollutants to model was based on those of primary concern in secondary lead smelting, which are largely resultant from inputs to the process.

Somewhat obviously, lead is the main pollutant tested for in the secondary lead processing industry[29], followed by sulfur compounds and particulates. Lead and sulfur compounds, such as sulfur dioxide and sulfuric acid, are core pollutants that arise from the presence of these compounds in large quantities in the battery. Nitrogen oxides are a primary combustion-

[29] US EPA AP42 Section 12-11, Background report secondary lead processing, available at: https://www3.epa.gov/ttn/chief/ap42/ch12/bgdocs/b12s11.pdf

based pollutant, as is particulate matter, but carbon monoxide has not been modelled because of the lead-reducing nature of smelting chemical reactions, which drive a high-level of oxidation efficiency (complete combustion) of CO to CO_2. Heavy metals other than lead are important due to their presence in the original battery alloy material – antimony is a major alloy metal component while cadmium, arsenic and tin are used as doping agents.

Dioxins and furans are targeted not because of their presence in the smelting feedstock but because of their ability to form in any thermal process, particularly if plastic battery components are not removed prior to smelting, and if these plastics include any PVC components. Other organic pollutants are not indicated to be relevant, given the absence of organic chemical materials in the feedstock and high (destructive) smelting temperatures.

Consequently, the pollutant emissions that this air quality assessment focuses on are collated in Table 15, beside their class 1, 2 or 3 indicator classification from SEPP(AQM).

Table 15: Air pollutants assessed for the proposed Hazelwood plant

Pollutant	SEPP (AQM) Class indicator
Lead, Pb	Class 1
Sulfur dioxide, SO_2	Class 1
Nitrogen oxides, NO_x	Class 1
Particulate matter (total, PM_{10}, $PM_{2.5}$)	Class 1
Sulfuric acid (H_2SO_4) mist	Class 2
Total chromium, Cr	Class 2
Arsenic, As	Class 3
Cadmium, Cd	Class 3
Tin, Sn	Not listed
Antimony, Sb	Class 2
Dioxins and Furans (as TCDD I-TEQs)	Class 3

8.3 Air emission sources and air quality impact assessment

Stack emission details, source process steps, relevant class 1, 2 and 3 indicators, emission rates, modelling method employed, background/ meteorological data used, modelled ground level concentrations (GLCs) and their assessment against SEPP (AQM) design criteria are all provided in the Air Quality Impact Assessment report at ***Appendix G***.

8.3.1 Emission estimates used as inputs into the model

The design of the Hazelwood plant is based directly on the reference plant in Jiangsu Province, China. The capacity of the reference plant in China is 800,000 tonnes of ULABs; the Hazelwood facility is designed to process 50,000 tonnes of ULABs – $1/16^{th}$ of the size. Quarterly monitoring required of this plant has been used to estimate emissions to air, based on an approximate scaling rate of Hazelwood being $1/16^{th}$ the current capacity (size) of the China plant. Applying this ratio is a simple mass balance, because lead is not introduced into the process from anywhere other than feedstock ULABs.

This approach is justified because the processing and emissions control technology are identical in both cases, designed to produce the same quantity of output lead products and lead emissions per tonne of input lead (ULABs).

The cornerstone of the US EPA's emissions estimation methodology (US EPA AP 42 program), when estimating emissions with no operating data available, is to use emission factors (kg pollutant per tonne of input material), which operate on the assumption that if a process remains of the same design, then the emissions will be the same per tonne of input feedstock.

Since the Hazelwood North facility has not been built yet, emissions must be estimated. Rather than using literature-based industry wide emission factors (which are often the only data available) Chunxing has the luxury of an operational reference plant which has independent stack testing carried out on a quarterly basis.

All China plant air quality monitoring data is provided in ***Appendix H***. It is noted that the plant is relatively new so this monitoring data covers only from (and including) 2017, and monitoring of some species such as non-lead heavy metals has only been required from Q1 2019.

While the technology employed is virtually identical, there are two key departures in process modification (from the China plant) that will be employed at the Hazelwood plant:

1. The Hazelwood facility will exclude of all battery plastic components from furnace feedstock – these are processed by the furnace in China.
2. One component of the China facility also processes anode sludge (from an electrolytic lead process, which uses silicofluoric acid). There will be no acid dissolution/ electrolytic component to the Hazelwood plant design at all, so fluoride emissions consideration is redundant and not considered for the Hazelwood plant.

This plastics management design improvement was arrived at through the process of air quality best practice development, described in Section 8.4.3.4, and deemed necessary to ensure dioxin emissions would meet the 0.1 ng/m^3 IED limit, required to demonstrate 'maximum extent achievable' emission reduction, and therefore best practice, dioxins emission management.

The China plant separates plastics from battery breaking (primarily from separators) and granulates those fractions suitable for recycling, while sending the remainder of this stream to the smelting furnace as an alternative fuel, to partially offset virgin fuel use and avoid a waste disposal cost. The China plant does not have a direct requirement to meet the European Union's Industrial Emissions Directive 2010/75/EU (IED), which stipulates a dioxins stack concentration limit of 0.1ng/m^3.

The China plant is a combination of two plants in one, with a separate stack serving each of the two plants. All China plant quarterly monitoring data contains fluoride results for the first plant, with its point source (stack) translated in lab reports as "Primary Exhaust Cylinder Phase 1 (Qy01)". There are no fluoride tests done on the second plant's stack (Primary Exhaust Cylinder Phase 2 (Qy02)).

This is because Plant 1 also feeds (lead-containing) anode sludge from a nearby electrolytic lead processing facility, which uses silicofluoric acid to dissolve lead input materials, and therefore contains significant amounts of fluoride. This sludge is processed through the smelting furnace. The electrolytic plant component can be as much as 4-5 tonnes (of anode sludge) per day, since electrolytic processing cannot deal with this lead-containing waste.

Since Plant 2 doesn't process anode sludge it is not required to test for fluoride.

Considering these modifications, as well as the 16-fold scale difference between the proposed plant and its reference plant, Table 16 outlines estimated air emissions from the proposed Hazelwood plant. These, in terms of emission rates in kg/hour, were used as inputs into the air quality dispersion model.

Table 16: Estimated emissions to air from the proposed Hazelwood plant

Pollutant	Emission rate		
	Min	Max	Average
	kg/hour	kg/hour	kg/hour
Sulfur dioxide	0.029	0.21	0.12
Nitrogen oxides	0.27	1.5	0.76
Total Dust	0.021	0.55	0.16
Lead	0.00016	0.0062	0.0019
Sulfuric Acid Mist	0.0019	0.100	0.037
Chromium	0.00008	0.00091	0.00049
Arsenic	0.00072	0.00074	0.00073
Cadmium	0.000032	0.000033	0.000033
Tin	0.000011	0.00011	0.00006
Antimony	0.00004	0.00024	0.00014
Dioxins and Furans (as TCDD I-TEQs)	0.0000000020	0.0000000020	0.0000000020

8.3.1.1 Exclusion of arsenic outlier replicate

Stack testing for arsenic, like other heavy metals, was conducted at the China plant in quarter 1 and quarter 2 of 2019, both using a triplicate sampling and testing method. These six replicate results for arsenic are shown in Table 17 and plotted in

.

Table 17: Arsenic stack testing results from the China plant

Arsenic emission (mg/hr) total China plant across 6 replicates						
Arsenic, total plant	Qtr. 1 (1)	Qtr. 1 (2)	Qtr. 1 (3)	Qtr. 2 (1)	Qtr. 2 (2)	Qtr. 2 (3)
	42,532	10,945	12,074	12,785	12,565	10,472
Excluding outlier		%				
Average	11,768					
SD	1,015	9%				
Including outlier		%				
Average	16,895					
SD	12,592	75%				
Outlier variance from average	30,764	261%				

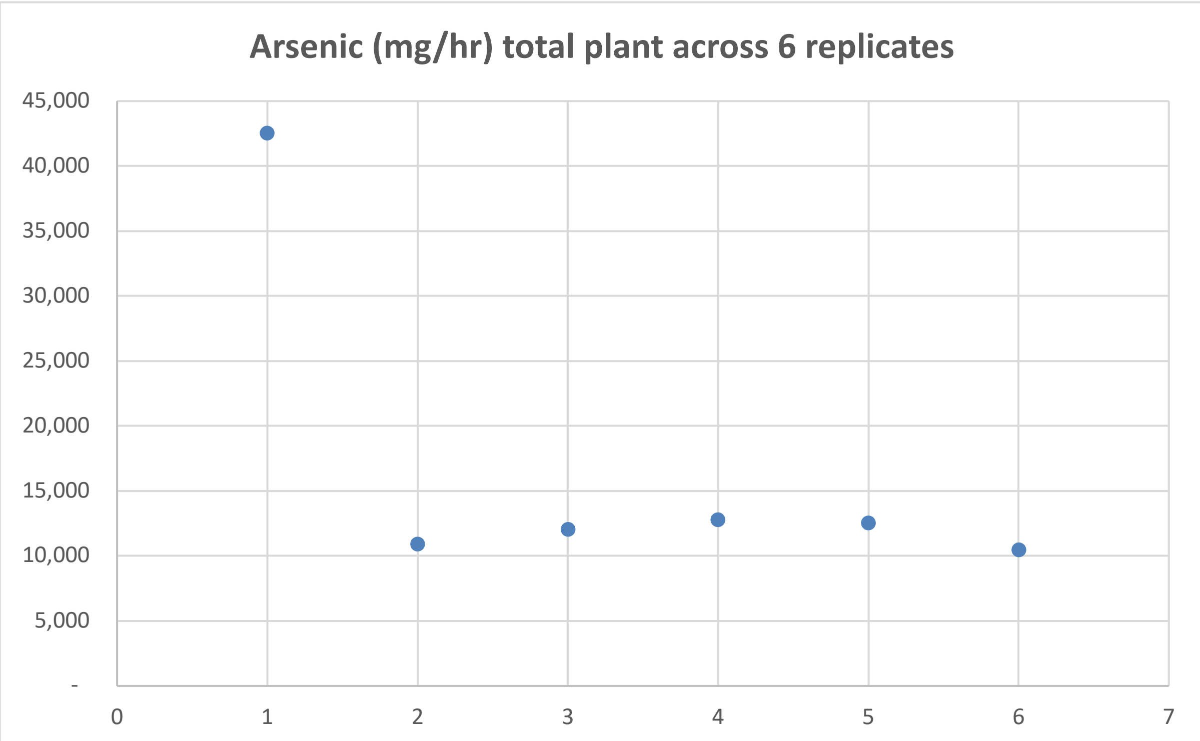

Figure 12: Variation in arsenic stack testing results from the China plant

Figure 12 shows clearly that the first replicate from quarter 1 is an outlier, since the other five replicates are quite tightly consistent. Table 17 indicates that when the outlier is included, the dataset has a standard deviation of 75% and the outlier's variance from the mean is 261%. This is in contrast to the dataset excluding the outlier, which exhibits a standard deviation of just 9% from the average of the five replicates.

For whatever reason, such as sampling, analysis or production anomalies/ errors, the quarter 1 (1) replicate is not indicative of the otherwise highly reproducible set of emission results for the plant. Consequently it has been ignored with the remaining five replicate results used as inputs into the model for arsenic.

8.3.2 Summary of air quality impact assessment (Appendix G)

An air quality modelling assessment was conducted in accordance with EPA Victoria guidelines, including:

- *State environment protection policy (air quality management)* ('SEPP(AQM)')
- *Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD)* – publication 1550
- *Guidance notes for using the regulatory air pollution model AERMOD in Victoria* – publication 1551.

The Hazelwood plant's emissions characteristics were based directly on those reported in routine monitoring data from the Chunxing China reference plant, and were taken as a 1/16th fraction of the China plant's emissions. The plume dispersion behaviour was modelled using AERMOD in accordance with the regulatory requirements, with site specific meteorological and terrain files, to predict the ground level impact (ground level concentrations or GLCs). Background data was used from the nearest ambient monitoring station that had been operating for the full duration of the assessment period (Morwell East).

The model was run using five consecutive years of site-specific meteorological data: 2012 to 2016 inclusive, which comprises 8,760 hours per year or 43,800 hours over five years. The total study area (called a domain) was 5km x 5km, broken up into 50m x 50m individual grid squares, with the plant's emission point at the centre of the square domain. Plume behaviour was predicted by the software for each of these hours to calculate a GLC for every individual grid square, over these 43,800 hours. This amounts to a GLC for each of 43,800 hours measured within each of 10,000 grid squares, or 438 million data points, for each pollutant modelled.

Appendix G's report describes modelled GLCs from a number of perspectives. Table 18 summarises the most critical information. It takes the lowest, highest and average stack emission results in kg/hour (model inputs scaled from the China reference plant), and identifies the single worst (highest) GLC, across all 438 million data points, which could be located anywhere in the 5km x 5km domain. As per EPA guidelines, the worst result is defined as the one located at the 99.9th percentile of all results listed lowest to highest – the highest result excluding statistical outliers.

These worst case GLCs for lowest, highest and average stack emissions are then expressed as a percentage of the Design Criteria for each pollutant – the concentration limits set by EPA for the protection of human health. All emissions modelled meet the Design Criteria with a large margin of comfort, with results ranging from 0.01% for antimony through to 3.99% for arsenic. Hydrogen fluoride emissions are compared to three types of Design Criteria (24 hour, 7 days and 90 days), as there is none available that is close to a one hour averaging time used in the model. The 24-hour figure of 0.0029 mg/m^3 is the most appropriate, which corresponds to a worst case GLC at 2.82% of this figure.

Lead is perhaps the most scrutinised emission for this type of plant, given that this metal is the target of recovery in secondary lead smelting. The worst case GLC identified at any hour in the five years, and within any part of the domain, based on the average stack emission, is just 0.31% of the Design Criteria.

The Appendix G report also looks directly at predicted levels at each of the closest identified sensitive receptor locations, which are typically houses in Hazelwood North but also a local school. GLCs at these locations are included for the final year (2016) as an example of the worst case predicted contributions to ambient levels at those locations, taking the worst hour across the dataset. This enables direct comparison with design criteria from the SEPP, which is shown in percentage terms in Table 19.

Since dilution of the plume occurs quickly within the first few hundred metres of the emission point, the levels predicted to be experienced at these locations are typically an order of magnitude lower than those maximum levels shown elsewhere in the study domain.

The summary of the air quality modelling assessment is that the highest (worst case) GLCs predicted to occur at any point in the domain, for all pollutants modelled, are significantly within Design Criteria limits, typically by a factor of 50-100 times. In the case of lead, the worst case GLC identified at any hour in the five years, and within any part of the domain, based on the average stack emission, is just 0.31% of the Design Criteria.

This worst case GLC event, when it occurs, is located in a radius approximately 250m from the stack emission point. From the site layout drawing (Appendix E) the distance from the stack emissions point can be deduced as approximately 400m to the southeast boundary of the site, which is the direction of the nearest sensitive receptor. Therefore, the worst case emission predicted by the model would occur within the site’s boundary.

These estimates reduce by an order of magnitude at nearest sensitive receptors.

Table 18: Summary of modelled GLC results (99.9th %ile) 2012 - 2016

Parameter	SUMMARY OF ANNUAL RESULTS (the highest min, max and ave found between 2012 and 2016) - NO BACKGROUND					
	SITE GLC (99.9th %ile) - ave as per SchA unless noted			Percentage of Design Criteria		
	Lowest Stack Result	Highest Stack Result	Ave Stack Result	Lowest Stack Result	Highest Stack Result	Ave Stack Result
	mg/m³	mg/m³	mg/m³	%	%	%
Sulfur dioxide	0.0001	0.0010	0.0006	0.03%	0.23%	0.13%
Nitrogen oxides	0.0013	0.0075	0.0037	0.70%	3.93%	1.96%
Total Dust - (criteria for nuisance TPM)	0.0002	0.0051	0.0015	0.06%	1.55%	0.44%
Lead	0.000001	0.000030	0.000009	0.03%	1.02%	0.31%
Sulfuric Acid Mist	0.00002	0.00093	0.0003	0.05%	2.82%	1.04%
Chromium and its compounds	0.00000074	0.00000841	0.0000046	0.004%	0.05%	0.03%
Arsenic and its compounds	0.00000667	0.00000690	0.0000068	3.93%	4.06%	3.99%
Cadmium and its compounds	0.00000030	0.00000031	0.0000003	0.91%	0.94%	0.92%
Tin and its compounds	0.00000010	0.00000103	0.0000006	-	-	-
Antimony and its compounds	0.00000041	0.00000221	0.0000013	0.002%	0.01%	0.01%
Dioxins and Furans (as TCDD I-TEQs)	0.000000000018	0.000000000019	0.000000000018	0.49%	0.50%	0.50%

Source: AUBIN Environmental (2019), Air Quality Impact Assessment for the Chunxing Corporation Pty Ltd (available at Appendix G)

Notes:
1. There is no design criteria set for tin.

Table 19: GLC$_{(99.9th\ \%ile)}$, 2016 MET file, no background, at specific sensitive receptor locations

Parameter	Design criteria	Nearest sensitive receptors								
	mg/m^3	SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8	SR9
Sulfur dioxide	0.45	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.01%	0.01%
Nitrogen oxides	0.19	0.43%	0.48%	0.47%	0.43%	0.38%	0.50%	0.42%	0.22%	0.19%
Total Dust (TPM) - (criteria for PM_{10} toxicity)	0.08	0.21%	0.23%	0.23%	0.21%	0.19%	0.24%	0.21%	0.11%	0.09%
Total Dust - (criteria for nuisance TPM)	0.33	0.05%	0.06%	0.06%	0.05%	0.05%	0.06%	0.05%	0.03%	0.02%
Lead	0.003	0.07%	0.07%	0.07%	0.07%	0.06%	0.08%	0.07%	0.03%	0.03%
Sulfuric Acid Mist	0.033	0.12%	0.13%	0.13%	0.12%	0.11%	0.14%	0.12%	0.06%	0.05%
Chromium and its compounds	0.017	0.003%	0.003%	0.003%	0.003%	0.003%	0.004%	0.003%	0.002%	0.001%
Arsenic and its compounds	0.00017	0.46%	0.51%	0.51%	0.46%	0.41%	0.54%	0.45%	0.24%	0.20%
Cadmium and its compounds	0.000033	0.11%	0.12%	0.12%	0.11%	0.10%	0.12%	0.10%	0.06%	0.05%
Tin and its compounds	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Antimony and its compounds	0.017	0.0009%	0.0010%	0.0010%	0.0009%	0.0008%	0.0010%	0.0009%	0.0005%	0.0004%
Dioxins and Furans (as TCDD I-TEQs)	0.0000000037	0.057%	0.064%	0.063%	0.057%	0.052%	0.067%	0.056%	0.030%	0.025%

Source: AUBIN Environmental (2019), Air Quality Impact Assessment for the Chunxing Corporation Pty Ltd (available at Appendix G)

8.4 Air quality management best practice

This assessment feeds directly into the overarching Environmental best practice section (5) but focuses on the detail of how the proposal meets air quality management best practice.

8.4.1 Scope

This assessment of whether Chunxing's proposal meets best practice in air quality management follows these steps:

1. distil the elements of best practice to consider, based on review of EPA guidance relevant to air quality management best practice assessment
2. describe and assess Chunxing's air quality management characteristics against these 'elements'
3. compare these characteristics against other similar plants, including ULAB recyclers and non-ULAB recycling emitters of lead in the Latrobe Valley
4. summarise the assessment's outcomes.

8.4.2 References relevant to air quality management best practice assessment

The following sections explore the most relevant reference publications for determining best practice air quality management.

8.4.2.1 EPA guidance

The following statutory policies and EPA guidelines are most relevant in demonstrating best practice in approval applications:

1. SEPP (AQM), Clauses 18 and 19
2. EPA Guideline 1517 Demonstrating Best Practice
3. EPA publication 1658 *Works approval application*, June 2017
4. The 'old' WAA Guideline (publication 1307.10 April 2015) Appendix C "examples of best practice for pollution controls of key impacts" (C-35 I02 Metal Melting)

SEPP (AQM) Clause 18(3)(c) says that generators of emissions "*must apply best practice to the management of their emissions or, if they emit Class 3 indicators, reduce those emissions to the maximum extent achievable*." Further, 'management of emissions' is described in the SEPP to mean:

> *"(a) avoiding and minimising emissions in accordance with the preference established in the principle of the wastes hierarchy; and*
>
> *(b) the assessment, monitoring, control, reduction or prohibition of emissions for air quality management purposes."*

EPA Guideline 1517 Demonstrating Best Practice and publication 1658 are not specifically applicable to an air quality assessment. They have been used for general process guidance both in sectoral assessments such as this one and in the general best practice assessment of Section 5.

EPA publication 1307's Appendix C provides examples of best practice for pollution controls of key impacts by scheduled premises category, including I02 Metal Melting, which includes "recycling used lead acid batteries by lead smelting, refining and casting". These identified examples of best practice air pollution controls (relevant to ULAB recycling) are:

- capturing fugitive emissions from electric melting furnaces
- removing particulates, smoke and odours from air emissions with scrubbers
- enclosing furnace houses and casting areas
- capturing particulates in air discharge with baghouse (fabric filter).

The potential for emission of dioxins (a class 3 indicator) is, as is the case with any thermal process, likely, but expected to be at a very low level. EPA's Energy from Waste Guideline (publication 1559) is probably the most authoritative EPA publication on thermal plant releases of dioxins, which says (at least with respect to EfW plants):

"In the case of air emissions, EPA currently considers thermal treatment technology as best practice if: …

- *Emission discharges, under both steady and non-steady state operating conditions, meet all the emissions standards set in the European Union's Waste Incineration Directive 2000/76/EC (WID), which was recast into the Industrial Emissions Directive 2010/75/EU (IED). The IED sets stringent emission limits and monitoring requirements which include:*
    - *Continuous emissions monitoring of total particulate matter (TPM); sulfur dioxide (SO2); oxides of nitrogen (NOx); hydrogen chloride (HCl); carbon monoxide (CO); total organic carbon (TOC); hydrogen fluoride (HF)). In addition, there must be at least non-continuous air emission monitoring of other pollutants such as heavy metals, dioxins and furans, a minimum of two measurements per year, which should be more frequent during the initial operation of the plant. This monitoring should capture seasonal variability in waste feedstock and characteristics.*
- *Additionally, in order to guarantee complete combustion, the IED requires all plants to keep the combustion or co-combustion gases at a temperature of at least 850°C for at least two seconds after the last injection of air. If waste with a content of more than 1 per cent of halogenated organic substances, expressed as chlorine, is combusted, the temperature must be raised to 1,100 °C for at least two seconds after the last injection of air."*

8.4.2.2 International references (in addition to the IED)

As a further resource to identify what 'maximum extent achievable' could mean, with respect to dioxin emissions specifically in secondary lead smelting, UNEP provides guidance in its advance draft *Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants*[30]. The UNEP guidance (Section VI.B. p.173) identifies the

[30] UNEP (2004) *Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants,* an

following 'best available techniques' for dioxin and other POP control in secondary lead smelting:

- Pre-sorting of feed material (to exclude plastics and oils)
- Effective process control
- Fume and gas collection
- High-efficiency dust removal
- Afterburners and quenching
- Adsorption on activated carbon
- The achievable performance level for emissions of PCDD/PCDF from secondary lead smelters is < 0.1 ng I-TEQ/Nm^3.

In addition, the World Health Organisation (WHO 2017)[31] provides recommended control measures for health protection from secondary lead smelting. In addition to those mentioned by UNEP 2004, these are:

- the use of fully automated and enclosed operations for the dismantling and separation of lead-acid batteries and the smelting and refining of lead
- the use of negative pressure enclosures, i.e. a sealed area where adequate ventilation is in place to create a negative pressure that is exhausted through an emission control device
- effluent treatment to treat all water used in the recycling process, as well as rainwater run-off from roofs and other surfaces, which are likely to be contaminated with lead
- batteries and slag are safely stored under cover.

8.4.2.3 Elements of best practice considered in this assessment

Collating all of the relevant references above, the air quality-specific elements we have determined to be applied to this best practice assessment are:

1. avoiding and minimising emissions
2. best practice process controls (including pre-sorting, fume and gas collection, automation, process enclosure, negative pressure environments)
3. best practice air pollution controls (including adsorption media)
    a. removing particulates, smoke and odours from air emissions with scrubbers
    b. capturing particulates in air discharge with baghouse (fabric filter)
    c. activated carbon injection

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advance draft prepared by the Expert Group on Best Available Techniques (BAT) and Best Environmental Practices (BEP), available at: http://www.dioksyny.pl/wp-content/uploads/Draft-BAT-BEP-Dec-2004.pdf

[31] World Health Organization 2017, *Recycling used lead-acid batteries: health considerations*, available at: https://apps.who.int/iris/bitstream/handle/10665/259447/9789241512855-eng.pdf;jsessionid=55BF2AF42FB395A7AB91BDE9EDB275E7?sequence=1

4. For class 3 indicators, as part of demonstrating 'maximum extent achievable' emission reduction, meeting the emissions standards set in the European Union's Industrial Emissions Directive 2010/75/EU (IED).

8.4.3 Assessment of the Chunxing option

EPA guidance sources 1, 4, the EU's IED, UNEP's POPs BAT/BEP guidance (for secondary lead smelting) and the WHO health considerations document have all been directly used to compile the list of best practice elements to be assessed, while EPA guidance source 2 has been referred to in developing the scope and method of this assessment.

An assessment of the Chunxing proposal against each key air quality-specific element is provided in the subsections below.

8.4.3.1 Avoiding and minimising emissions

Smelting and related activities undertaken in ULAB recycling are thermal processes that require combustion heat to drive them, which then produce unavoidable emissions of combustion gases. However, Chunxing's plant design minimises these emissions, specifically through technology innovations as compared to other secondary smelting approaches:

- Lead and NO_x emissions are significantly lower than other forms of secondary lead smelting (of ULABs) because the modified Isasmelt process (Vertical Smelt Furnace) used by Chunxing is very efficient in maximising lead recovery:
    - All handling, feeding and smelting systems in the plant are fully enclosed and electronically operated.
    - Lead grid is simply melted rather than smelted along with lead paste, as is standard in other types of ULAB smelting. The lower temperature of melting results in lower Pb emissions.
    - The dual smelting furnace uses process gases from the first furnace to pre-heat the second; enabling more rapid and efficient smelting reaction times.
    - Fuel and oxygen is injected into the smelting furnace through a lance, causing constant heating and, mostly importantly, continuous agitation of the molten material via the in-built stirrers facilitates rapid chemical reaction in smelting.
    - Lead paste charged to the furnace is already lower in sulfur than alternatives, due to the first desulfurisation step (with ammonium bicarbonate), which reduces the formation of PbS in the smelting furnace, and therefore the amount of charge iron required to reduce it. Traditional rotary furnace smelting is fed lead paste that is much higher in $PbSO_4$.
    - All process stage gas emissions are exhausted, collected and pass through pollution control equipment to the main stack.
- Sulfuric acid and SO_2 emissions are significantly lower than other forms of secondary lead smelting (of ULABs), because of the multiple stages of sulfur removal: the pre-desulfurisation step, which takes an initial proportion of sulfur out of the system as ammonium sulfate, before the smelting stage; clever controls of reductive and oxidative conditions in the smelting furnace, which first maximise the reduction of $PbSO_4$ to PbS and FeS then, once smelted Pb is maximised, oxygenated conditions

force as much of these sulfides into SO_2, which is sent to the wet scrubber for highly efficient removal as gypsum.

- Potential dioxin emissions are minimised through segregation of separators and other plastic battery components, which are excluded from smelting via collection and either recycling or, for those components contaminated in lead, disposal to landfill.

8.4.3.2 Best practice process controls

Best practice process controls as detailed in the best practice assessment references are described in Table 20, along with an assessment of the Chungxing Hazelwood plant design's performance against each.

Table 20: Best practice process controls

Process control: elements of best practice	Reference	Chunxing assessment against best practice element
Pre-sorting of feed material (to exclude plastics and oils)	UNEP POPs BAT/BEP guidance (2004)	Automatic battery breaker (hammermill and moving mesh conveyors) separates battery component material with a high degree of precision. Separation of plastics is by gravity in water (hydraulic separation). Since this plant processes batteries only (and not other Pb-containing feedstock) oils are not present to any significant degree but would be separated hydraulically.
Effective process control: • process control systems • maintaining furnace temperature above 850 °C		• Entire plant operates with a high level of automation. Processes are automatically controlled and monitored. • Clever process control of reductive/ oxidative furnace conditions is at the heart of Chunxing's ability to produce lower emissions and lower slag volumes • Smelting furnace operates at very high temperature (up to 1,300 ^{0}C) and temperature is maintained through process controls.
Fume and off-gas collection		All gas phase emissions are collected and ducted to pollution control equipment prior to discharge through main stack.
Afterburners and quenching		No afterburner is required since smelting furnace operates at temperatures that will destroy organics such as dioxins.

Process control: elements of best practice	Reference	Chunxing assessment against best practice element
Capturing fugitive emissions from electric melting furnaces	EPA publication 1307 (App C)	Entire plant is enclosed and sealed and maintained under negative pressure (including furnaces), containing fugitive sources, with off-gases collected and exhausted via relevant pollution control equipment.
Enclosing furnace houses and casting areas		
The use of fully automated and enclosed operations for the dismantling and separation of lead-acid batteries and the smelting and refining of lead.	WHO 2017 recommended control measures	
The use of negative pressure enclosures, i.e. a sealed area where adequate ventilation is in place to create a negative pressure that is exhausted through an emission control device		

8.4.3.3 Best practice air pollution controls

Best practice air pollution controls as detailed in the best practice assessment references are described in Table 21, along with an assessment of the Chungxing Hazelwood plant design's performance against each.

Table 21: Best practice air pollution controls

Pollution control: elements of best practice	Reference	Chunxing assessment against best practice element
Removing particulates, smoke and odours from air emissions with scrubbers	EPA publication 1307 (App C)	After the first baghouse cleans the flue gas of particulates, Chunxing then employ a wet scrubber, where lime is sprayed in to react with the SO_2 in the flue gas to form gypsum. The scrubber operates at high efficiency: SO_2 removal is 99.95%.
Capturing particulates in air discharge with baghouse (fabric filter)	UNEP POPs BAT/BEP guidance (2004)	The baghouse is designed to clean the air stream of particulates, which includes Pb. Removing dust first allows the subsequent scrubbing reactions to occur efficiently, without blocking the surface area of the lime and contaminating the resultant gypsum.
Adsorption on activated carbon		Activated carbon adsorption for dioxins is not carried out, as described in the assessment of MEA for dioxins (see Section 8.4.3.4).

8.4.3.4 Reduction of Class 3 indicators to maximum extent achievable (MEA)

SEPP (AQM) Clause 19(2) requires new sources of Class 3 indicator emissions to be reduced to the maximum Extent Achievable (MEA). MEA is defined in SEPP (AQM) as:

> *"a degree of reduction in the emission of wastes from a particular source that uses the most effective, practicable means to minimise the risk to human health from those emissions and is at least equivalent to or greater than that which can be achieved through the application of best practice."*

Class 3 indicators subject to this assessment are:

- arsenic, As
- cadmium, Cd
- dioxins and furans.

EPA's Energy from Waste Guideline (publication 1559) clearly identifies the meeting of the EU's IED requirements as the basis for best practice demonstration in thermal treatment technology, specifically for energy from waste plants. Given the SEPP(AQM) requirement to reduce Class 3 indicator emissions to MEA, IED compliance has been adopted as the measure of MEA demonstration for the Hazelwood ULAB plant, despite the fact that it is not an EfW facility. Relevant aspects of the IED, and the status of the Hazelwood plant's estimated compliance with these aspects, are detailed in Table 22.

Table 22: MEA demonstration through compliance with EU IED requirements

Class 3 indicators: elements of MEA	Reference	Chunxing assessment against best practice element
Emission discharges meet IED with respect to stack emission limits for Class 3 indicators	EU IED	Stack testing data from Chunxing's China reference plant meets the IED limits, as shown in Table 23. The Hazelwood plant will adopt an additional control – exclusion of feedstock plastics, which will reduce the risk of dioxins emissions further again.
Installation of continuous emissions monitoring (CEMS) for major combustion pollutants		The Chunxing China plant includes a continuous emissions monitoring system (CEMS). The Chunxing Hazelwood proposal will provide real time public access to stack monitoring data, taken from their Continuous Emission Monitoring System (CEMS). Chunxing are also exploring the possibility of further monitoring infrastructure to be located beyond the site, to enable real time access to air quality monitoring (ground level concentrations) from nearby areas.
Emission discharges meet IED with respect to: - at least non-continuous air emission monitoring of other pollutants such as heavy metals, dioxins and furans, a minimum of two measurements per year, which should be more frequent		As is the case with the plant in China, Chunxing intend to conduct quarterly monitoring for heavy metals. Dioxins are measured on an annual basis in China. The IED is for energy from waste plants, not ULAB recycling, and notes that a minimum of two measurements per year (or more) "should capture seasonal variability in waste feedstock and characteristics." ULABs are a highly uniform feedstock, unlike EfW feedstocks, so an annual

Class 3 indicators: elements of MEA	Reference	Chunxing assessment against best practice element
during the initial operation of the plant.		dioxins measurement should be sufficient to demonstrate such variability.
Emission discharges meet IED with respect to: - keeping combustion or co-combustion gases at a temperature of at least 850°C for at least two seconds after the last injection of air. If waste with a content of more than 1 per cent of halogenated organic substances, expressed as chlorine, is combusted, the temperature must be raised to 1,100 °C for at least two seconds after the last injection of air.		Approx. 8% of a ULAB is made up of plastics, mostly HDPP and HDPE, neither of which are halogenated and both of which have recycling value. Since there is some risk that a small proportion of this could contain PVC, the non-recycled plastic components separated out will be sent to landfill, rather than fired in the furnace. This will ensure this element of MEA is met. Note that the China reference plant sends these non-recycled plastics to their furnace as virgin fuel replacement. Smelting temperatures are well over 1,000 ^{0}C, up to a maximum of 1,250 ^{0}C, which ensures this temperature/ time condition is met.

Table 23 takes the measurements from the China reference plant's stack monitoring data (Appendix G), for the relevant class 3 indicators, and compares these against the IED's limit values for waste incineration installations.

Table 23: China plant and IED emission limits for class 3 indicators

Class 3 indicator	Unit	Stack emission concentration	
		Maximum (China reference plant)	IED limit
Sum of Sb, As, Pb, Cr	mg/m^3	0.22	0.5
Cadmium	mg/m^3	0.002	0.05
Dioxins and Furans (as TCDD I-TEQs)	ng/m^3	0.07	0.1

Notes:
1. All figures quoted are directly from stack emission testing of China reference plant, unadjusted for additional controls planned for Hazelwood facility

The China plant's stack emission concentration for the class 3 indicators of interest meet IED limits.

Dioxins and activated carbon adsorption

As part of the best practice assessment, consideration has been given to whether activated carbon addition (prior to the baghouse) is required to demonstrate best practice/ MEA reduction for dioxins. UNEP POPs BAT/BEP guidance (2004) suggests this as a means of controlling dioxin emissions.

EPA Guideline 1517 *Demonstrating Best Practice* makes it clear that that "practicability" and "cost-effectiveness" are important considerations for best practice, for example:

> *"The term 'best practice' implies a degree of pragmatism and cost effectiveness"*

> *"EPA does not expect best practice to be pursued 'at any cost'. It is important that the proposed approach be cost effective in the context of the relevant industry sector within which the site operates…, as well as within the context of the total project cost"*

Moreover, best practice considers the 11 principles of environment protection in the EP Act, such as principle 1B, the *Integration of economic, social and environmental considerations* which, according to Guideline 1517 "makes it clear that best practice measures need to be cost-effective and in proportion to the significance of the environmental problems being addressed".

Section 8.3.1.1 demonstrates that modelled levels of ground level concentrations for all pollutants, including dioxins (0.5% of design criteria) are very low. Table 23 shows that the IED (with respect to dioxins at stack) is also met. Both of these estimates are based on scaled emissions from the China reference plant, which burns separator plastics in the furnace. An improvement identified by this best practice assessment is that the Hazelwood plant <u>will not</u> do this, which would be expected to lower dioxins emissions further, to be well below the IED limit.

Clearly the addition of activated carbon as an adsorbent media would reduce the potential for dioxins emissions even further again. However, this has major implications for plant design because:

1. It would necessitate a second baghouse. Activated carbon would not operate with very high removal efficiency if added prior to the current baghouse, because its active sites would be 'clogged' by particulate emissions. One approach could be to reverse the order of the baghouse and the scrubber, but this would jeopardise the efficiency of the scrubber for SO_2 removal, due to the same particulate clogging effect on the lime. The scrubber's operation in SO_2 removal is critical to the low emissions, low slag and low-Pb-in-slag credentials of the technology, so this sequence change would be highly counter-productive. Therefore the only scenario where activated carbon removal of dioxins would be effective would be to do so after the scrubber, immediately prior to a second baghouse, installed essentially for dioxin removal alone.
2. The second baghouse would need the addition of hot dilution air for the carbon step to be effective, because flue gas coming out of the scrubber will be 'wet' and will need to be rapidly dried out. Moist flue gas would result in water adsorption on activated carbon active sites, negating the effectiveness of the step for removing dioxins.

Such changes would appear to be a case of over-engineering, creating a solution for a problem that the emissions evidence suggests does not exist. In terms of balancing the "practicability" and "cost-effectiveness" aspects of best practice, it would seem excessive to add significant additional plant and engineering costs to lower an emission that is already meeting the IED limit, even without removal of feed plastics, a design change that the Hazelwood plant will actually implement.

Consequently we have determined best practice and MEA reduction for dioxins to be satisfactorily addressed through existing designs and measures, without the need for addition of activated carbon.

8.4.4 Comparison with emissions from other plants

The outcome of applying these design aspects is best demonstrated by reference to emissions reports from the Chunxing China reference plant, scaling them to be equivalent to the smaller Hazelwood plant (1/16th of the size), and then comparing these emissions to other ULAB plants or primary lead smelting in Australia, other lead emitters in the Latrobe Valley region and literature data for secondary lead smelting.

The most relevant emissions comparison is against the only other ULAB smelter in Australia, a 46kt per year plant in Wagga Wagga, NSW. There is also a similar smelter in Laverton Vic which is currently not operational, but does have an EPA licence and corresponding emission limits for lead and other primary pollutants. At an extreme end of the scale is the Nyrstar Port Pirie (SA) primary lead smelter, which is very large and has a notable history of impacts from lead pollution. Lastly there is the contribution to the Latrobe Valley airshed from other major industrial emitters in the local area, that is worthy of comparison.

These emissions estimates, in kg per year, are tabulated and charted for comparison in ***Appendix I***. This comparison, using lead as one of the primary pollutants of interest, is shown in Table 24. Excluding those facilities that are higher by two or more orders of magnitude (Nyrstar Port Pirie primary lead smelter and the currently closed Hydromet Laverton secondary lead smelter's maximum licence limit), since the scale of their emissions would swamp the other facilities, Chunxing Hazelwood and comparison facilities' emissions are charted against each other in Figure 13.

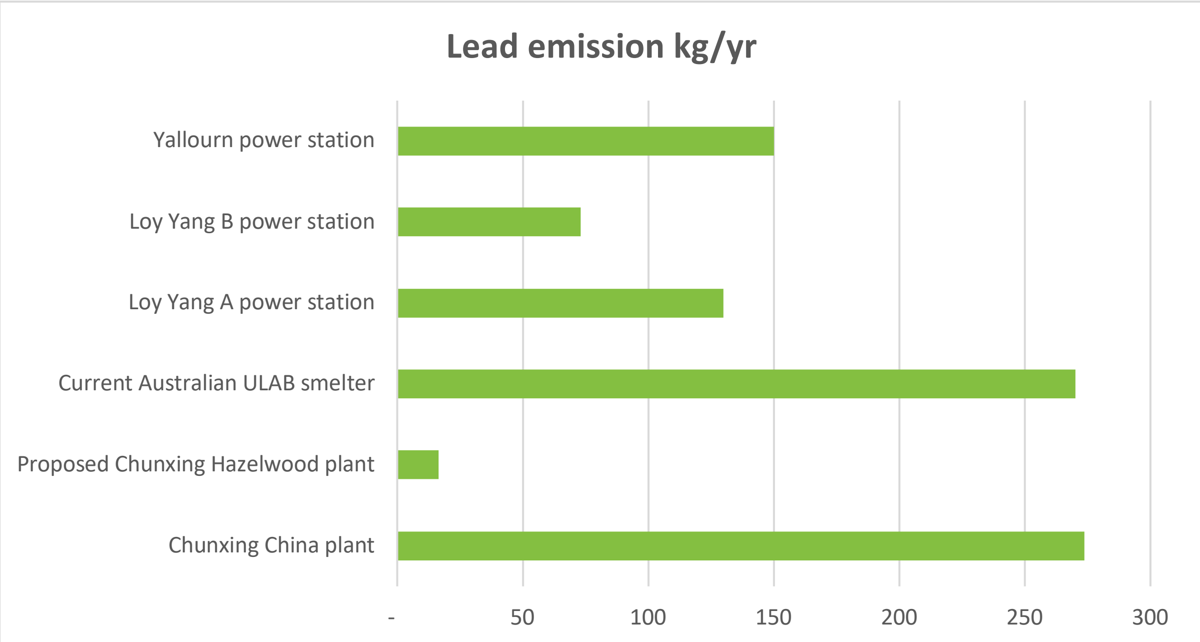

Figure 13 Comparison of lead emissions per facility, kg/ year

Table 24: Comparison of Chunxing lead emissions to similar plants

Lead emission unit of measure	Lead emission facility								
	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Hydromet Laverton licence limit	Loy Yang A power station	Loy Yang B power station	Yallourn power station	NPI secondary lead emission factor (controlled)
Grams per minute	0.52	0.031	0.52	110	5	0.25	0.14	0.29	-
Ratio of emission per year	17	1	17	3,515	159	8	4	9	-
Gram per tonne of ULABs processed	0.34	0.33	6.0	N/A	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	0.61	0.59	11	94	N/A	N/A	N/A	N/A	150

Notes and assumptions for Table 24:
1. kg/yr figures for all facilities except Chunxing plants and the current Australian ULAB smelter are taken from the National Pollutant Inventory, 2017-18 data
2. Chunxing China plant kg/yr is taken from its 2019 Quarterly report stack test, using supplied Pb results in mg/m^3 and supplied air flows for each stack
3. The current Australian ULAB smelter's emissions are calculated from quarterly monitoring data[32] reports and indicative stack flow estimates (per monitoring point) provided by Enirgi as part of their current EIS process for a plant expansion[33].
4. The current Australian ULAB smelter is assumed to produce 24,000 t/yr lead and alloys from 46,000 t/yr ULAB feedstock (supplied by Engitec Technologies: http://www.engitec.com/en/rmt__pty/)
5. Although not currently in operation, Hydromet Laverton's annual emission is estimated as a theoretical maximum permitted, based on the maximum their licence allows.

[32] EPSR monitoring reports dated July 2018, September 2018, February 2019 and May 2019, available from: http://www.enirgipower.com.au/recycling/recycling-facility/environmental-data/

[33] GHD 2018, *Report for Enirgi Power Storage Recycling - Enirgi Power Storage Recycling Consolidation Project EIS, Response to Submissions*, available at: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-6619%2120190307T062507.816%20GMT

Reference to Figure 13 and the ratioing in Table 24 (using the Chunxing Hazelwood plant as a base) shows that the other major ULAB smelter in Australia, itself a modern plant with a similar (or slightly lower capacity), is around 17 times higher in lead emissions that what is estimated for Hazelwood. The Chunxing proposal's lead estimate is also significantly lower than the smallest of the coal-fired Latrobe Valley power stations, which are not renowned lead emitters since their input brown coal is very low in lead.

For context, the large primary lead smelter Port Pirie SA, operated by Nyrstar, discharges more than 3,000 times the lead volume of Hazelwood, although recent media reports indicate that the plant's surrounding ambient monitoring is tracking very close to the 0.0005 mg/m^3 Ambient Air Quality NEPM standard for lead.

It is noted that a blanket comparison of raw emissions does not explain what the actual ground level pollutant impacts would be in any given situation, because stack heights, discharge velocities, topography, meteorology and other receiving environment characteristics differ with each situation. This is what modelling is for, and Section 8.3.1.1 summarises the air quality modelling assessment. But emission load, expressed per tonne of ULABs processed (or tonne of lead produced) as illustrated by Table 24, is the best way to demonstrate this element of best practice. On a per tonne of ULAB processed basis, Chunxing's Hazelwood facility is estimated to emit 18 times less lead than the only other current Australian operating ULAB smelter.

Annual emission load estimates for pollutants other than lead are included in ***Appendix I***. A direct comparison of the proposed Hazelwood plant's estimated emissions with those from the Wagga Wagga ULAB smelter is provided in Table 25.

Table 25: Comparison of Chunxing emissions to the Wagga Wagga ULAB smelter

Pollutant	Hazelwood plant, kg/year	Wagga plant, kg/year	Comparison	Wagga plant data source
Sulfur dioxide	1,054	40,298	(green)	Monitoring
Nitrogen oxides	6,655	31,000	(green)	NPI
Total Dust	1,378	2,423	(green)	Monitoring
Lead	16	275	(green)	Monitoring
Sulfuric Acid Mist	325	793	(green)	Monitoring
Chromium	4.3	23*	(green)	Monitoring (max total metals)
Arsenic	6.4	23*	(green)	
Cadmium	0.3	23*	(green)	
Antimony	1.2	23*	(green)	
Dioxins and Furans (as TCDD I-TEQs)	0.0000174	0.0000011	(red)	Monitoring

■ *Hazelwood plant is estimated to have lower emissions than Wagga plant* (green)

■ *Hazelwood plant is estimated to have higher emissions than Wagga plant* (red)

* *Maximum value possible*

Monitoring = 2018-19 licence monitoring data available from EPSR's website

Monitoring (max total metals) = Sum of 2018-19 licence monitoring data for Sb, As, Cd, Hg, Be, Cr, Co, Mn, Ni, Se, Sn and V, as reported by EPSR on its website

NPI = 2017-18 air emissions data supplied to the National Pollutant Inventory by EPSR.

Table 25 shows that Chunxing's Hazelwood plant is expected to have lower emissions than the Wagga Wagga ULAB smelter for all emissions except dioxins, based on scaled monitoring data from the Chunxing China reference plant (for the former) and (primarily) 2017-18 quarterly monitoring data[34] (for the latter).

The Wagga NO_2 result of 31,000 kg/yr (NPI result) was chosen because testing for NOx is not carried out on the main stack, which would be a significant source. It has been assumed in this case only that NPI data is a more accurate result.

The Wagga plant licence monitoring data provides only a total result for the metals Sb, As, Cd, Hg, Be, Cr, Co, Mn, Ni, Se, Sn and V. NPI data for these metals is more than 3 times lower than that reported by monitoring. While this could be explained by the presence of non-NPI metals in the monitoring analysis suite (such as Sn and V) this is only speculation. The maximum metal suite result from stack monitoring has been assumed for each metal in Table 25, since any individual species could make up this total.

The order of magnitude higher dioxin result is, like all Hazelwood estimates, based on a scaled version of the Chunxing China plant's measured emissions. This is expected to be significantly reduced by the removal of input plastics from the furnace feed, which is a design change to be adopted at the Hazelwood plant.

A detailed comparison with all other industrial emitters in the Latrobe Valley, based on 2017-18 data reported to the National Pollutant Inventory (NPI), is provided in Table 26. This comparison shows the contribution the Chunxing plant is expected to make to the Latrobe Valley airshed, for each pollutant, and also shows the three largest emitters per pollutant for reference. Note that the projected emissions from the yet-to-be built Paper Australia energy from waste plant are also included, taken from their EPA Works Approval Application's air quality assessment.

In terms of percentage of the emissions to the Latrobe Valley airshed, including those estimated to come from the proposed Paper Australia energy from waste plant, the Chunxing ULAB smelter will contribute an extremely small proportion of total emissions, ranging from 0.001% of sulfur dioxide up to 2% of arsenic.

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[34] http://www.enirgipower.com.au/recycling/recycling-facility/environmental-data/

Table 26: Chunxing emissions in the context of the Latrobe Valley airshed

Pollutant	Hazelwood plant		Jeeralang power station	CHH Sawmill	Loy Yang A power station	Loy Yang B power station	Yallourn power station	New Paper Aust EfW plant
	kg/year	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed
Sulfur dioxide	1,054	0.001%	0.001%	0.001%	56%	26%	17%	0.2%
Nitrogen oxides	6,655	0.01%	0.3%	0.01%	43%	27%	26%	1%
PM_{10}	1,378[1]	0.02%	0.06%	0.01%	64%	7%	26%	0.5%
$PM_{2.5}$	1,378[1]	0.06%	0.2%	0.04%	36%	16%	36%	3%[2]
Lead	16	1.19%	0.0001%	0.1%	9%	5%	11%	73%
Sulfuric Acid Mist	325	0.36%	-	-	36%	18%	33%	13%[2]
Chromium	4.3	0.26%	0.00004%	0.02%	32%	20%	17%	27%
Arsenic	6.4	2.3%	0.0002%	0.06%	40%	21%	20%	16%
Cadmium	0.3	0.05%	0.0001%	0.01%	47%	7%	8%	37%
Antimony	1.2	0.53%	-	-	24%	-	-	75%
Dioxins and Furans (as TCDD I-TEQs)	0.000017	0.51%	-	0.2%	9%	28%	47%	12%

Notes:

1. Emission is total dust. For theoretically worse case comparison purposes, total dust has been assumed to be made up entirely of $PM_{2.5}$, and therefore also PM_{10}.

2. No figure was modelled for Paper Australia EfW plant. Figures represent current emission from Paper Australia's pulp and paper operations.

8.4.5 Summary of the best practice air quality management assessment

Chunxing's facility is assessed as *meeting best practice in air quality management* because it satisfies a best practice evaluation in each of the following elements:

1. It exhibits very low emissions in comparison to the other operational ULAB smelter in Australia, itself deemed best practice technology when installed in approximately 2012. This is due to a combination of unique chemistry and process technologies:
    a) multiple desulfurisation steps, such as using NH_4HCO3 instead of $NaHCO_3$, which results in low sodium inputs to the furnace and consequently lower slag volumes
    b) manipulating O_2 concentration in the furnace to first reduce SO_4^{2-} and then subsequently oxidise S^{2-} to SO_2; and final treatment with lime in high efficiency scrubbers
    c) dual Vertical Smelt Furnaces, with pre-heating and continuous stirring, to ensure fast reaction times and efficient stoichiometry, lowering residual (unreacted) lead oxides in the flue gas (the source of lead emission)
    d) and advanced air pollution controls (as described below).
2. It incorporates best practice process controls including fully automated, enclosed and negative pressurised environments throughout battery breaking and pre-sorting, melting, smelting, refining, acid neutralisation and by-product purification; fume and off-gas collection, temperature control and high smelting temperatures.
3. It incorporates best practice air pollution controls by:
    a) removing SO_2 and other pollutants from air emissions with scrubbers, dosed with lime
    b) capturing particulates in air discharge with baghouse (fabric filter)
4. For class 3 indicators, as part of demonstrating 'maximum extent achievable' emission reduction, the plant meets the emissions standards set in the European Union's Industrial Emissions Directive 2010/75/EU (IED), namely:
    a) <0.5 mg/m^3 for the sum of Sb, As, Pb, Cr
    b) <0.05 mg/m^3 for Cd
    c) <0.1 ng/m^3 for dioxins and furans
5. The plant also meets the IED's requirements for:
    a) installation of continuous emissions monitoring system (CEMS) for major combustion pollutants
    b) at least non-continuous air emission monitoring of other pollutants such as heavy metals, dioxins and furans
    c) keeping combustion or co-combustion gases at a temperature of at least 850°C for at least two seconds after the last injection of air
    d) Eliminating plastics from furnace feedstock to ensure less than 1 per cent of halogenated organic substances, expressed as chlorine, is combusted.

6. The Chunxing plant's emissions comparison to the only operational ULAB smelter in Australia (the Wagga Wagga facility), shows it to be substantially lower in emissions of all pollutants except dioxins; which will be reduced substantially by the design change (compared to the China reference plant) of excluding plastics from the furnace.
7. All plant emissions are substantially lower than what is currently contributed to the Latrobe Valley airshed (including the projected emissions from the recently approved energy from waste plant at Paper Australia). The major pollutant emissions of concern for secondary lead smelting (Pb, SO_2, H_2SO_4 mist and PM_{10}) contribute only 1.2%, 0.001%, 0.4% and 0.02% respectively of airshed emissions, despite the fact that power generators are relatively low lead emitters due to its low incidence in Latrobe Valley brown coal.

8.5 Investigation of the applicability of exemption from works approval

As discussed in Section 8.1, the Scheduled Premises Regulations, Part 3, Regulation 10, contain mass emission rate criteria for various pollutants, below which a general exemption from Works Approval can be applied. These exemption levels exist to limit EPA's approval licensing processes to only those facilities with the potential for significant impact on the environment. It is noted, however, that exemption from the air requirements of Works Approval does not change EPA's statutory requirement to pursue continuous improvement and apply best practice in environment and emission management practices.

The air emissions estimated for the Hazelwood North facility, converted as individual quarterly measurement points from the Chunxing China plant, and expressed in the units of the exemption levels (kg/day or g/min), are shown in Table 27. These quarterly data points (as Hazelwood North-equivalent conversions) are charted for each pollutant with reference to the exemption levels in Figure 14, where the red line is drawn at the exemption level for each pollutant.

All results available for 2019 (Q1, Q2 and Q3 monitoring events) are identified in each chart by reference to a green dotted line, inserted as a reference point for the beginning of 2019. This delineation is useful in supporting the discussion of continuous improvement in Section 8.5.1 where, in most cases, emissions have been demonstrated to be significantly lower in 2019 due to iterative plant improvements carried out at the China facility.

Table 27: Hazelwood North facility emissions estimates (taken from individual quarterly China monitoring data)

Substance	AUSTRALIAN PLANT (1/16 assumption in 2018 & 2019, 1/6 assumption in 2017)														Scheduled Premises Regs	
	2017 QY01 (only phase 1 was tested)				2018 QY01+QY02 (Phases 1 & 2 combined)				2019 QY01+QY02 (Phases 1 and 2 combined)			Summarised emissions			Reg 10 exemptions	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Min	Max	Ave	Max	
	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	g/min
Sulfur dioxide	ND	ND	ND	ND	5.0	3.9	3.2	2.7	0.7	1.9	4.9	0.7	5	3	10	
Nitrogen oxides	77	38	97	17	31	25	13	8	8	12	10	6	36	17	100	
Total Dust (TPM)	9.5	1.8	1.5	1.4	13	<30	<30	<30	6.4	1.5	1.8	0.5	13	3.5	10	
Lead	0.01	0.02	0.02	0.01	0.15	0.05	0.13	0.05	0.02	0.03	0.0035	0.004	0.15	0.04	0.144	0.1
Sulfuric Acid Mist	NR	NR	NR	NR	0.05	0.20	ND	2.4	1.7	0.08	3.35	0.05	3.35	1.30	0.144	0.1
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	0.022	0.0019	0.0006	0.001	0.022	0.01	0.144	0.1
Arsenic	NR	NR	NR	NR	NR	NR	NR	NR	0.017	0.018	0.013	0.013	0.018	0.02	0.144	0.1
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	0.00080	0.00078	0.00008	0.0001	0.0008	0.001	0.144	0.1
Antimony	NR	NR	NR	NR	NR	NR	NR	NR	0.0057	0.0011	0.0032	0.001	0.006	0.003	0.144	0.1
Dioxins and Furans (as TCDD i-TEQs)									4.8E-08	4.7E-08	-	4.7E-08	4.8E-08	4.8E-08	0.144	0.1

ND: Not detected

NR: Not reported

In 2017 the China plant's capacity was 300,000 tonnes ULAB/yr and was running using one plant onsite

From 2018 onwards this capacity increased to 800,000 tonnes ULAB/yr, with two plant 'phases'; running on the same site. These differences have been applied to scaling each year's emissions from the China plant to the proposed Hazelwood North facility.

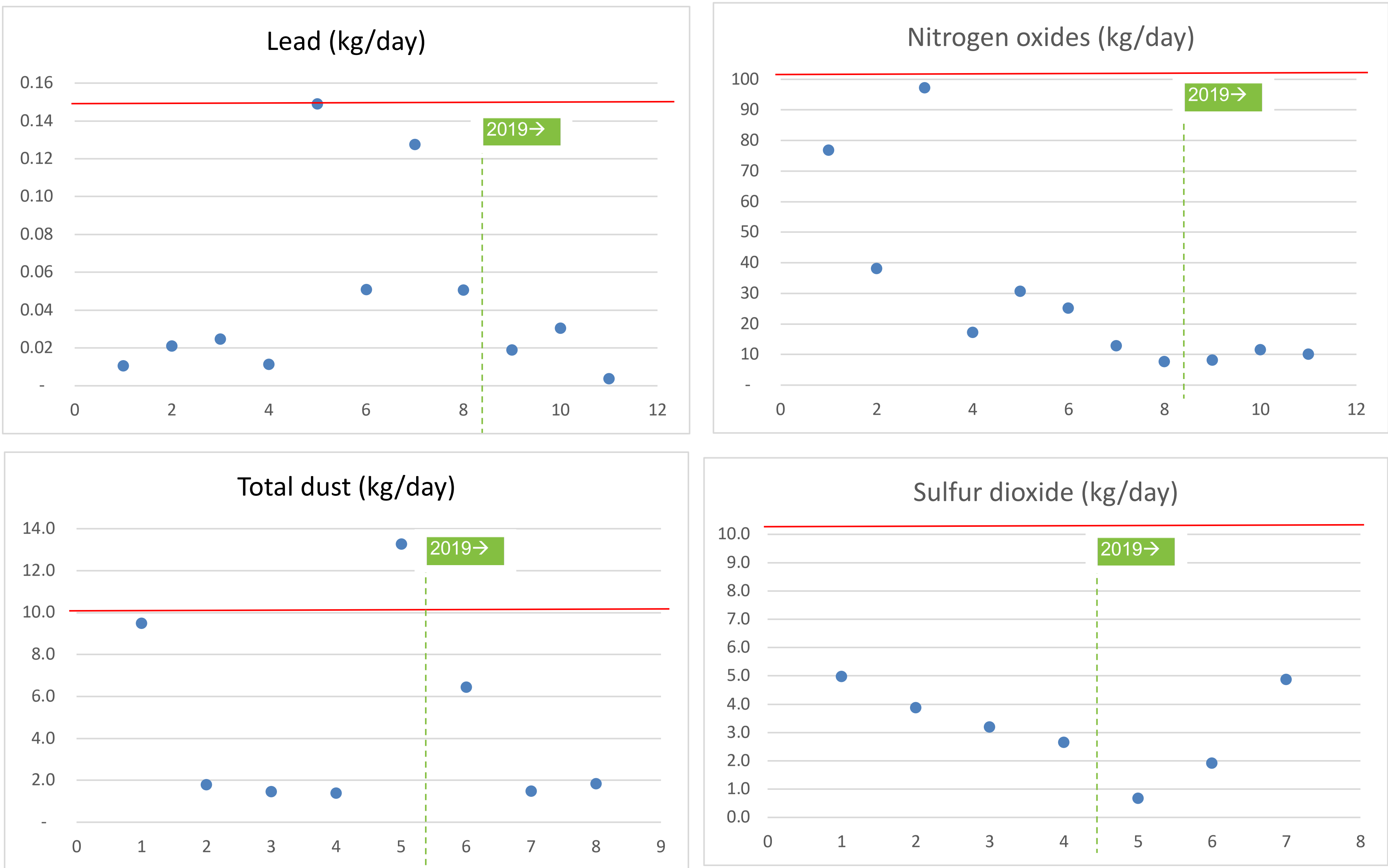
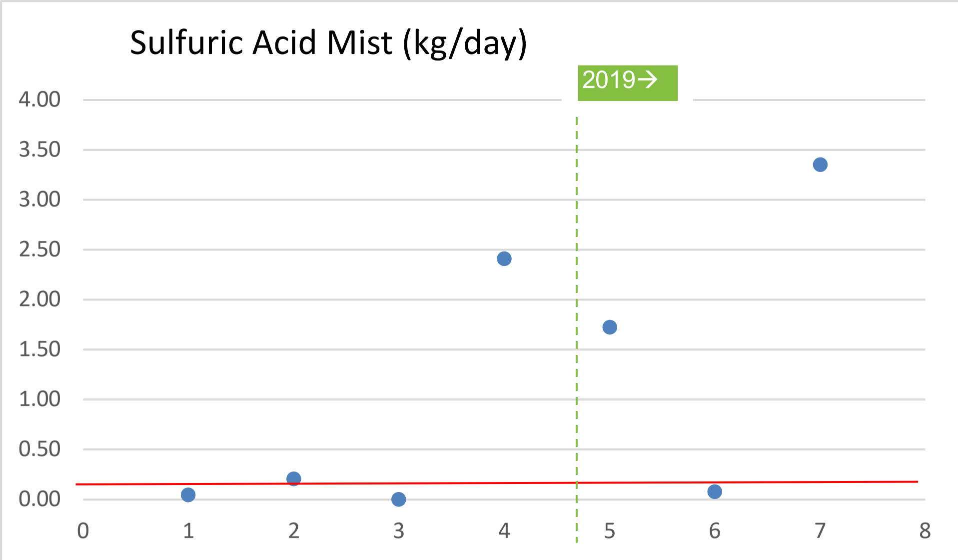


Figure 14a: Hazelwood North facility emissions estimates (against Exemption levels ——)



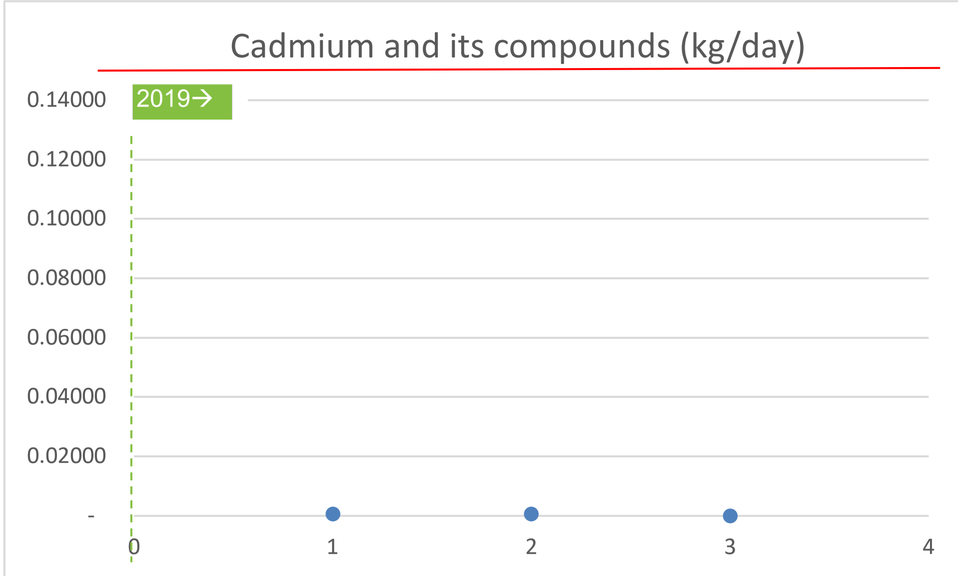


Figure 14b: Hazelwood North facility emissions estimates (against Exemption levels ——)

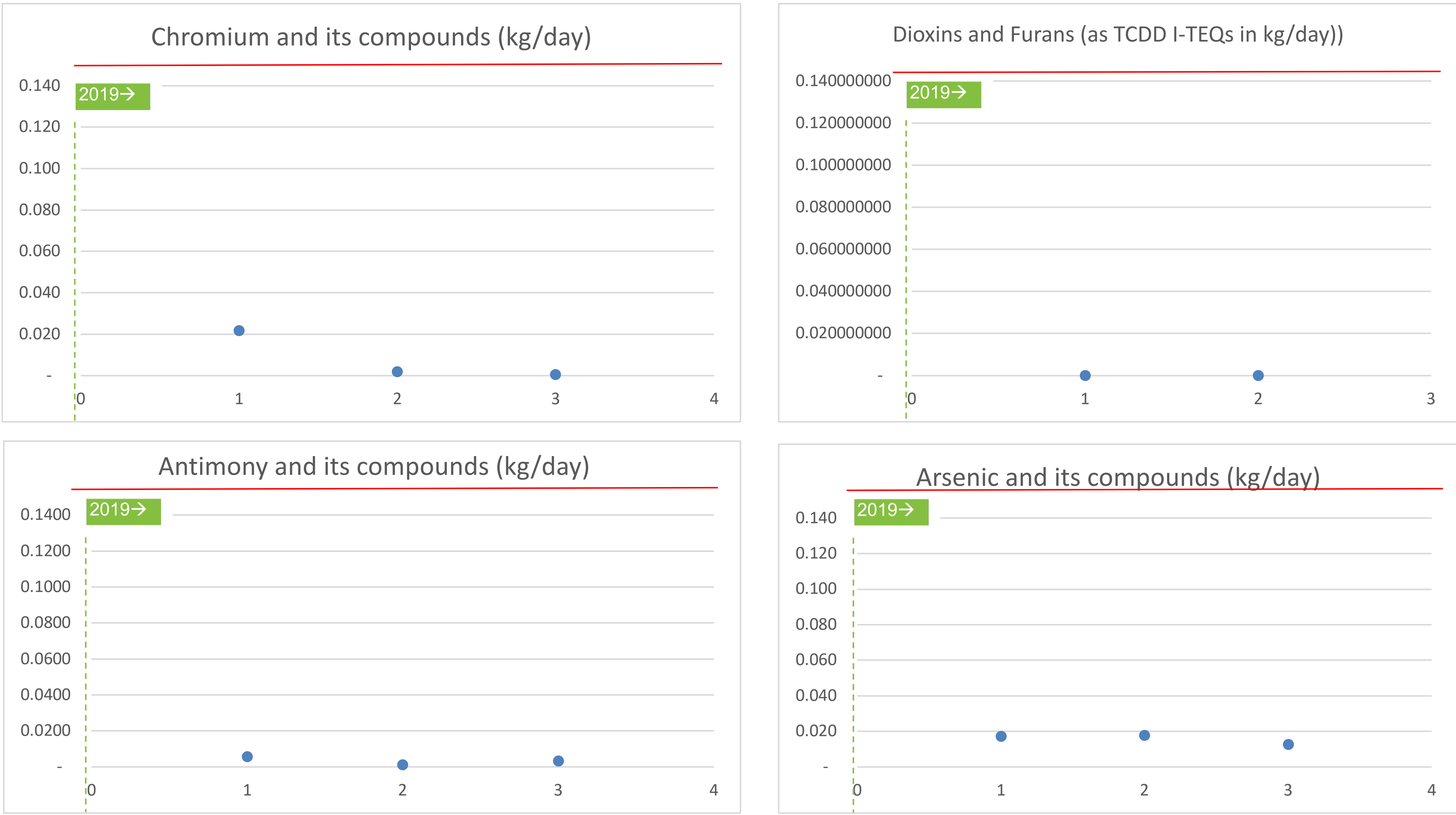


Figure 14c: Hazelwood North facility emissions estimates (against Exemption levels ——)

Individual quarterly emission results, scaled to the size of the Hazelwood North facility, are typically below Exemption levels, for all pollutants except for sulfuric acid mist, which has three occurrences below the Exemption threshold and four above it.

Using the 1/16 scaling factor, Exemption levels are demonstrated to be met, typically comfortably, by all quarterly monitoring occasions tested, for the following pollutants:

- nitrogen oxides
- sulfur dioxide
- cadmium
- chromium
- antimony
- arsenic
- dioxins and furans.

Particulate emissions (total dust) was exceeded once out of 9 measurements (Q1 2018). Lead levels were met on 11 out of 12 occasions, with one result right on the Exemption limit, which also occurred at the Q1 2018 measurement point.

8.5.1 Continuous improvement in emissions performance

The China plant has been on a program of continuous engineering improvements to its plant's environmental performance since its inception from late 2016. The establishment of the current-day plant was in the context of demonstrating exceptional environmental performance, as part of the credentials of the broader business park within which it operates, and the company has subsequentially received a number of awards within China for its environmental achievements. Low environmental impacts are fundamental to the New Chunxing Resource Recycling Group's competitive advantage within the market in China.

This historical focus on emissions improvement shows in the results over the three years of quarterly monitoring. Of the three quarterly monitoring occasions so far in 2019, only two results out of 35 (from all pollutants) have been above EPA Exemption levels: both were sulfuric acid mist, in Q1 and Q3 2019.

Neither of these results breached the China site's licence limits so they had not been a cause of great interest to the plant's engineers. However, since the issue of EPA's Exemption levels has been put on the table, followed by Dr Jayaweera's September 2019 visit to the plant to discuss the possibilities for a further lowering of emissions, the China plant's engineers have been making operational alterations aimed at a design that can perform consistently below these Exemption levels.

Specific changes made to the China plant during Dr Jayaweera's visit in September were to:

- Increase the filter area of the baghouse and reduce the flue gas flow rate entering the baghouse from (the velocity was reduced from 0.35 m/min to 0.20 m/min, a reduction of 43%). This increases dust contact with the pores of the dust collection bag, making the removal task more efficient. A CEMS monitoring point was installed directly at the baghouse exit to monitor the result of these changes in real time.

- Expand the area of the cooling tower by 9m^2 to enable 2-stages of flushing, increasing the efficiency of dust and sulfur dioxide capture from the flue gas.
- Upgrade the scrubbers to allow 3 stages of flushing and increase their cross-sectional area by 3m^2 to reduce the flow rate, extending the contact reaction time between flue gas and the lime slurry, which improves desulfurisation efficiency.
- As outlined in Figure 15, add a water-spray dust collecting device in the base of the stack to further reduce dust and collect resultant water mist through the mist removal plate.
- Increase the cross-sectional area of the stack by 40%, which reduces flow rate and reduces water mist emission.

Note that scheduled Q3 stack monitoring was conducted on 12 September 2019, which was immediately before Dr Jayaweera's visit. Consequently these most recent design changes were implemented post the Q3 data point, so Q4 monitoring (scheduled for late November) will demonstrate the results of these modifications.

However, in keeping with the conservative approach taken for the assessment of air emission impacts, modelled data used in Section 8.3 and the air quality impact assessment report at Appendix G cover the full range of China plant results, without adjustment for any of the design improvements above.

Consequently lead emissions for example, based on the 3-year dataset, are estimated to be in the order of 16kg per year from the Hazelwood North plant. However, if only the average of the three data points of 2019 are considered, this drops to 6.5kg/ year.

Specific attention has been given to design changes that could assist in the further reduction of sulfuric acid mist, in Section 8.5.2 below. This is the only pollutant potentially above the Exemption levels.

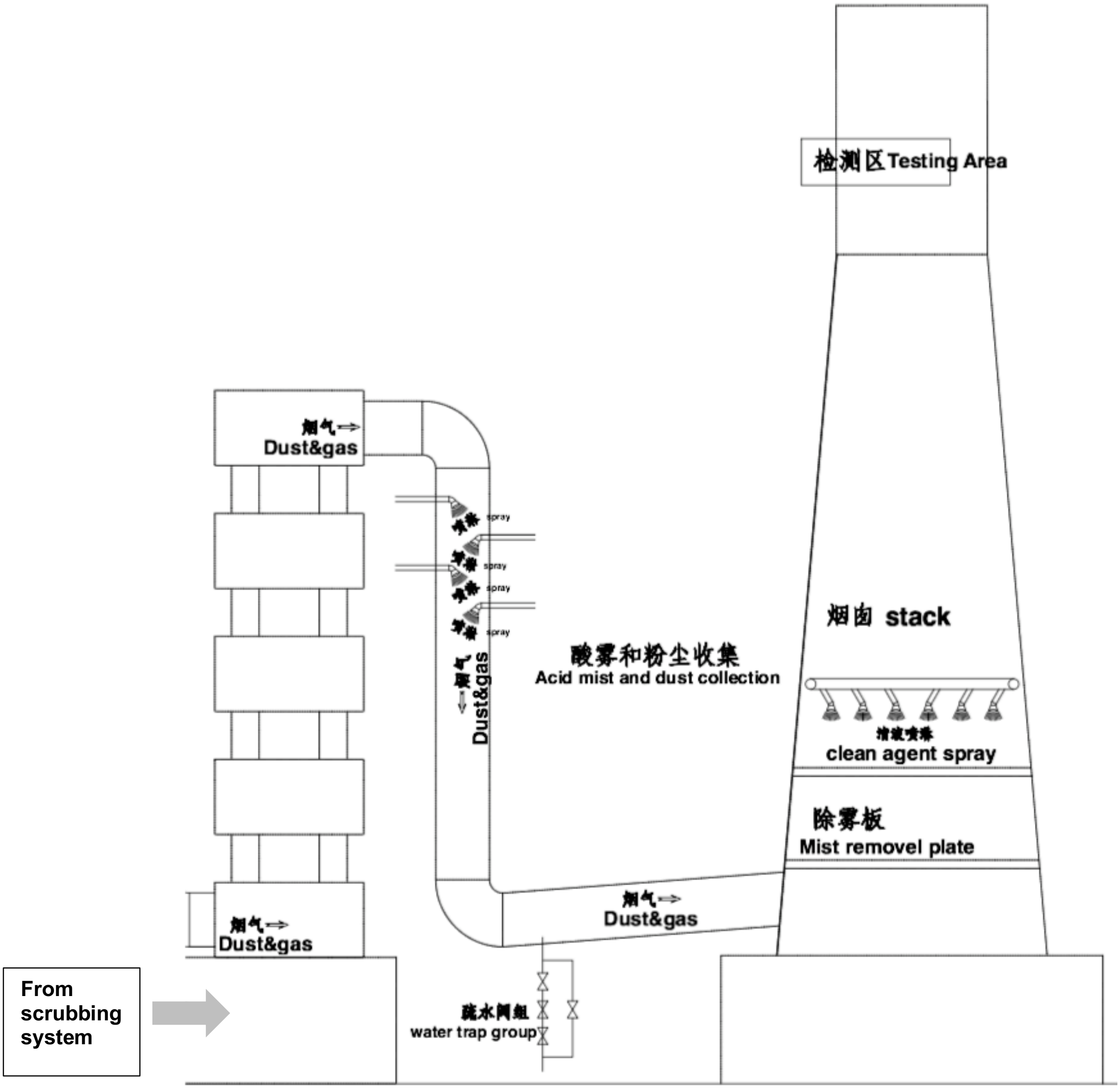


Figure 15: Further dust and acid mist collection improvements

8.5.2 Sulfuric acid mist – further improvements to design

Since the completion of Q3 testing, as a means of improving sulfuric acid mist emissions, the China plant has purchased a mist eliminator for installation in the base of the stack. A photo of the device is provided in Figure 16.

This type of mist eliminator is used in petrochemical and acid production plant applications, and is the mesh pad style eliminator. Mesh pad eliminators are made of layered knitted mesh, which has a high open area for gas flow to reduce pressure drop and fine wire surface area to increase droplet collection efficiency. Mist droplets collide on wire surfaces (impaction and interception collection mechanisms), and/or coalesce together to form larger droplets, which then drain to the bottom of the pad through the force of gravity.

Figure 16: Mist elimination mesh pad to be installed in the China facility

Mesh eliminator designs achieve removal efficiencies ranging from 95% to 100%, depending on droplet size and the concentration in the flue gas[35]. Assuming a 95% removal efficiency, and the 1/16 Hazelwood plant scaling factor, the maximum and average sulfuric acid mist results are shown against the Exemption levels in Table 28.

[35] CECO Filters technical brochure, *Sulfuric acid mist elimination*, available at: https://www.cecoenviro.com/hubfs/CECO%20Filters/SULFURIC%20ACID%20BROCHURE_CECO%20Filters.pdf?hsCtaTracking=5c038633-4e0d-48ed-87bf-37b6150a86da%7C2b57df04-7af8-48de-b193-1192da713239

Table 28: Hazelwood North facility sulfuric acid mist emissions estimates (with and without mist elimination control)

Substance	AUSTRALIAN PLANT (1/16 assumption in 2018 & 2019, 1/6 assumption in 2017)			Scheduled Premises Regs
	Summarised emissions			Reg 10 exemptions
	Min	Max	Ave	Max
	kg/day	kg/day	kg/day	kg/day
Sulfuric Acid Mist (as measured)	0.05	3.35	1.30	0.144
Estimated Sulfuric Acid Mist (with mist elimination)	0.003	0.168	0.065	0.144

Table 28 shows that the average sulfuric acid emission result from the China plant, scaled to the size of the Hazelwood North facility (1.30 kg/day), would potentially be reduced to 0.065 kg/day with the installation of the mist eliminator, which is below the EPA Exemption level of 0.144 kg/day. The maximum result obtained across the three years of plant operation is the most recent one (Q3), which is estimated to reduce to 0.168 kg/day with mist elimination, is still above but very close to the Exemption level.

The Hazelwood North facility design will incorporate all of the improvements identified in Section 8.5 and implemented in the China plant, including the mist elimination device in the base of the stack. Improvements to emissions from these design modifications are yet to be demonstrated through stack testing. However, Q4 monitoring (in late November) is expected to provide further evidence (specifically for sulfuric acid mist) to support our expectation that the Hazelwood North plant can operate with all emissions to air beneath the EPA Exemption levels.

9 Noise emissions

Noise modelling would be the most reliable method of determining noise emissions at the nearest sensitive receptors but this is unnecessarily expensive approach if noise emissions are expected to be low. The WAA guideline distinguishes between requiring a general noise impact assessment (WAA guideline 9.1, which does not require noise modelling) and requiring a detailed noise impact assessment (WAA guideline 9.2, which requires noise modelling), to tailor the assessment effort to the risk. Since the buffer distance to the nearest sensitive receptor is more than twice that required for this type of industry, and the major noise emitting activities occur inside fully enclosed structures, the noise impact is likely to be low, and we believe that using modelling to demonstrate this is excessive.

Our method to estimate noise impacts at the nearest sensitive receptor, or *noise sensitive area*, involves taking noise measurement data from the China plant and using a simplistic extrapolation to estimate how much of this sound would be expected to be experienced at the closest noise sensitive area. For completeness, these extrapolated noise emissions (at sensitive receptors) are compared against *recommended maximum noise levels* as prescribed in the *Noise from Industry in Regional Victoria* (NIRV) guideline[36].

9.1 Noise emission estimation using China plant site boundary noise data

The China reference plant undertakes noise monitoring onsite, on a quarterly basis, at four sampling points located on the north, south, east and west perimeter of the facility. Although this plant is 16-fold larger than that proposed for Hazelwood North, the latter has been assumed to produce an equivalent level of noise to simplify this assessment and in recognition that noise is not neatly relative to plant scale. Quarterly noise data from the China plant is provided in Table 29. An indicative site map showing noise sampling point as black triangles is shown in Figure 17.

[36] EPA publication 1411 (October 2011), *Noise from Industry in Regional Victoria*, available at: https://www.epa.vic.gov.au/~/media/Publications/1411.pdf

Table 29: China plant quarterly noise testing (dB(A))

No.	Location	Day/ night	2017 Noise test results				2018 Noise test results				Average
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
			Results 01/03/2017	Results 17/04/2017	Results 25/07/2017	Results 04/12/2017	Results 05/03/2018	Results 7/06/2018	Results 24/08/2018	Results 29/10/2018	
1	East side	Day time	54	58.8	59.5	57.1	61.7	56.6	61.1	60.3	59
		Night time	53.7	50.9	47.9	49.6	51.4	50.3	51.7	52.2	51
2	South side	Day time	52.5	57.9	60.0	58.8	63.5	57.4	59.5	59.3	59
		Night time	44.5	52.0	47.3	47.5	51.3	50.9	51.4	52.0	50
3	West side	Day time	53.4	57.7	61.3	57.8	61.6	59.3	61.5	62.2	59
		Night time	48.4	48.8	47.3	47.9	50.5	52.7	52.1	51.1	50
4	North side	Day time	53.6	59.3	60.8	58.2	61.4	52.7	60.1	60.2	58
		Night time	49.8	49.9	47.7	49.7	51.1	54.0	50.9	52.5	51
Average day time noise (points 1 - 4)											**59**
Average night time noise (points 1 - 4)											**50**

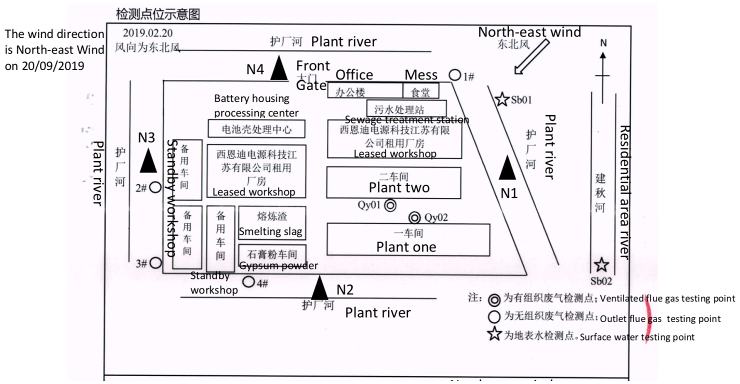


Figure 17: China plant site map showing noise sampling points (N1 – N4)

The China reference plant's noise emissions provide reference points for what (an overestimated) Hazelwood plant might emit. Using the sensitive receptor (or *noise sensitive area*) locations and information of Figure 2 and Table 1, the closest noise sensitive areas in directional terms is shown in Table 30.

Table 30: Nearest noise sensitive areas

Approx. direction from plant	Description	Approx. distance from plant
South-south east	SR1 Residential address	1.1km
East	SR6 Residential address	1.55km
Northeast	SR7 Residential address	1.7km
Northwest	SR8 Residential address	1.75km
North-northwest	SR9 Residential address	2.1km

Note:
Nearest noise sensitive areas to the south and west are >3km and >10km away, respectively.

To estimate the sound levels resulting from these plant emissions, experienced at the nearest sensitive receptor (1.1 km away), the *invoice square law* from basic wave physics is applied. The invoice square law says that sound propagates from its source as an essentially spherical wave uniformly in all directions, assuming there are no reflective surfaces or barriers between the source and the location at which the sound level is being determined. The intensity of the sound wave energy at any given point away from the source is diminished as a function of the total surface area of the sphere coincident with that point.

According to the inverse square law, it can be shown that for each doubling of the distance from a point source, the sound pressure level decreases by approximately 6 dB. The formula to calculate sound attenuation over a distance from a point source is:

$Lp(R2) = Lp(R1) – 20Log_{10}(R2/R1)$, where:

Lp(R1) = sound pressure level at initial location

Lp(R2) = sound pressure level at the new location

R1 = distance from the noise source to initial location

R2 = distance from noise source to the new location.

The inverse square law is depicted in Figure 18.

In the real world, the inverse square law is an idealisation because it assumes exactly equal sound propagation in all directions. If there are reflective surfaces in the sound field, then reflected sounds will add to the directed sound and you will get more sound at a field location than the inverse square law predicts. If there are barriers between the source and the point of measurement, you may get less than the inverse square law predicts. Nevertheless, the inverse square law is a reasonable estimation technique for sound you would get at a distant point in a reasonably open area, such as the surrounding farmland to the east and south east of the Hazelwood plant.

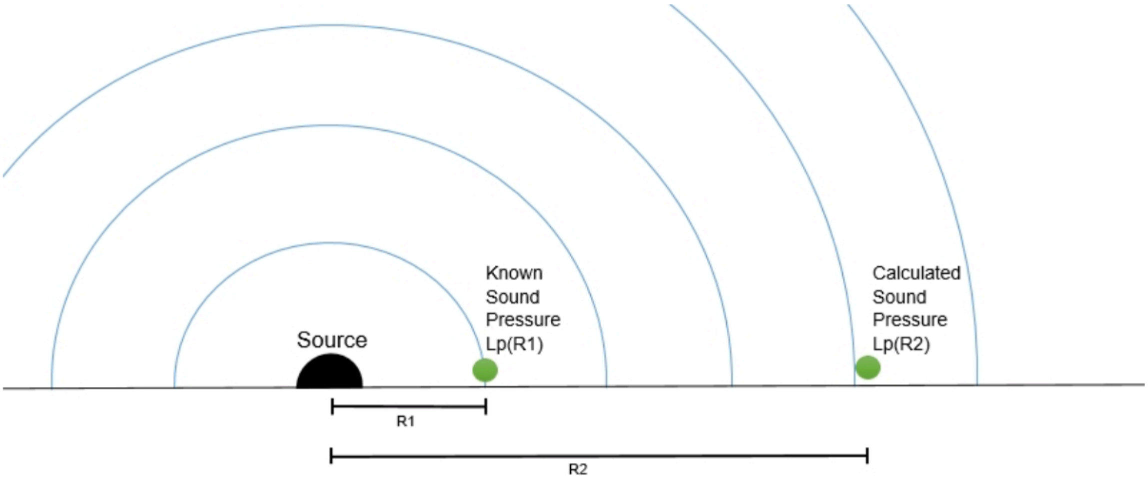


Figure 18: Sound propagation via the inverse square law

Source: https://www.wkcgroup.com/tools-room/inverse-square-law-sound-calculator/

For simplicity, it is assumed that the compass-point sides of the manufacturing building represent a large point source, and for each sampling point the distance has been measured from each compass-point wall of the main building. For example, the east side sampling point is located 40m from the eastern wall of the main plant building.

For the purpose of this assessment, the China plant is assumed to be located at the Hazelwood plant site, and its noise measurements have been overlayed as if they were collected there. The inverse square law has been applied to the average day time and night time sound readings from the China plant, based on the distance of the sampling points from the closest plant building wall, and the distance to a point in any direction equivalent to the closest noise sensitive area around the Hazelwood site (SR1 1.1km away). Table 31 applies the inverse square law to give estimates of residual noise 1.1km away at the nearest noise sensitive area, both during the day and at night.

In reality, the China plant has 16 times larger capacity than the Hazelwood plant, and is situated next to other facilities in a technology park. On the actual site just within its northern boundary there is a large co-located battery manufacturing plant, which is directly linked to the outputs of the ULAB plant. The northern noise sampling point is located Immediately outside the northern plant boundary and on a busy main road. Consequently noise measurements taken from the northern sampling point have been excluded, since they do not represent the ULAB facility alone and are subject to significant interference from these other sources.

Using this China plant overlay approach, the noise at a distance of 1.1km away, assuming no structural retarding or reflecting effects, is estimated to be ***30 dB(A) during the day and 21 dB(A) at night***.

Table 31: Estimated noise at closest noise sensitive area (SR1)

No.	Sampling point (at China plant)	Day/ night	Average noise at sampling point, dB(A)	Distance from source to sampling point, m	Distance (m) to nearest noise sensitive area (SR1)	Average residual noise, dB(A), estimated at SR1
1	East side	Day time	59	40	1,100	30
		Night time	51	40		22
2	South side	Day time	59	45		31
		Night time	50	45		22
3	West side	Day time	59	30		28
		Night time	50	30		19
4	North side[2]	Day time	58[2]	105		38[2]
		Night time	51[2]	105		31[2]
Average day time noise (points 1 - 3)[2]			**59**	30 – 45		**30[2]**
Average night time noise (points 1 - 3)[2]			**50**	30 – 45		**21[2]**

Notes:

1. Residual noise calculated using the inverse square law from: http://hyperphysics.phy-astr.gsu.edu/hbase/Acoustic/isprob2.html

2. In addition to ULAB recycling the China plant also includes a large scale battery manufacturing plant in the northern part of the site. The north side sampling point is at the main facility gate, positioned on a busy main road. Results from this point have been excluded as they are not a good reflection of ULAB plant noise.

9.2 Noise emission estimation using China plant internal noise test data

In addition to quarterly noise monitoring undertaken at property boundary points, the China reference plant undertook a noise testing program on 27 March 2018, which involved portable noise sampling equipment deployed throughout the inside of the plant, next to key plant equipment areas at a nominal distance from each source of 1m.

For completeness, a list of equipment used by plant in these areas is provided in the greenhouse gas emissions section, Table 10. The site is predicted to operate 24 hours 7 days per week, with allowance for 30-40 days of maintenance per year. The China plant noise monitoring data (Table 29) typically shows a reduction in noise at night time compared to day time, so it is assumed that the Hazelwood site would operate in a similar way.

The results from the noise testing program are shown in Table 32, which also calculates each dB(A) measurement as an individual sound pressure in Pa, thus allowing them to be summed. Then the total pressure is converted back to decibels. This then enables a total plant noise ‘emission’ to be estimated, which calculates to 88.82 dB(A). No adjustment for equipment-varying frequency (of noise) has been made, although there are no turbines or similar high-frequency equipment used in the Chunxing process.

Table 32: Within-plant noise testing (Chunxing China facility, 27/03/2018)

Noise source area		Rating dB(A)	Sound pressure (Pa)
Battery breaker	Crane section	64.3	26,915,348
	Breaking & selection section	86.7	4,677,351,413
	Breaking conveyor belt section	81.0	1,258,925,412
	Lead paste treatment section	70.0	100,000,000
	Waste collection section	70.4	109,647,820
	Breaking system operating room	65.0	31,622,777
Melting/ smelting area	Crane Section	65.0	31,622,777
	Furnace feeding section 1	68.2	66,069,345
	Furnace feeding section 2	68.0	63,095,734
	Furnace slag section 1	65.2	33,113,112
	Furnace slag section 2	64.9	30,902,954
	Furnace surrounding 1	67.4	54,954,087
	Furnace surrounding 2	67.4	54,954,087
	Dust collector section 1	72.2	165,958,691
	Dust collector section 2	72.0	158,489,319
	Casting section 1	73.0	199,526,231
	Casting section 2	73.4	218,776,162
	De-sulfurisation section	64.2	26,302,680
Refining area	Refining furnace feeding section 1	71.4	138,038,426
	Refining furnace feeding section 2	72.6	181,970,086
		Total sound pressure (Pa)	**7,628,236,462**
	Total sound 'emission' (converted to dB(A))	**88.82**	

All noise emitting equipment is housed in plant-area enclosures which are in turn contained within buildings. The exact materials to be used in wall construction are not yet specified, which makes estimation of the noise attenuation achieved from enclosure, or sound transmission loss (STL), difficult. If no STL was accounted for at all, a point source of 88.82 dB(A) at a nominal 1m distance, using the inverse square law, calculates to be 28 dB(A) at a distance of 1.1km.

The Engineering Toolbox website[37] provides guidance for STL achieved various common building structures, from 230mm brick work/ plastered both sides (-55 dB) to one-layer plasterboard (-25 dB). Although one-layer plasterboard would never be chosen for the walls of an industrial building, assuming this level of STL on a point source of 88.82 dB(A) would reduce it to 63.82 dB(A). Applying the inverse square law based on a theoretical point of 1m outside the wall (at 63.82 dB(A)) and a point 1.1km away, noise at the latter calculates to just 3 dB(A).

Internal plant noise measurements are designed primarily for assessing worker exposures, and their extrapolation for the purpose of estimating residual noise over 1km away, without any account of sound transmission loss from building enclosures is obviously over-

[37] The Engineering Toolbox, *Sound Transmission through Massive Walls or Floors*, available at: https://www.engineeringtoolbox.com/sound-transmission-massive-walls-d_1409.html

estimating reality, possibly by some magnitude. However, it provides some context to the (more credible) method in Section 9.1.

9.3 Recommended maximum noise levels at noise sensitive areas

Part 3 of *Noise from Industry in Regional Victoria* (NIRV, Publication 1411, October 2011) outlines how to set recommended maximum noise levels (RMNLs) specific to the location of noise sensitive areas near the proposed Hazelwood site.

The first step requires both noise generating and noise receiving land use zones to be identified. The proposed site is in an Industrial 2 zone (IN2Z), while the nearest noise sensitive area (Church Road Hazelwood North) is located in a farming zone (FZ). Table 1 from NIRV determines this combination's zone noise levels to be: day = 53 dB(A); evening = 48 dB(A); night = 43 dB(A).

Step 2's distance adjustment provides for the maximum 9db subtraction, since the distance between the noise sensitive area and the closest edge of the IN2Z zone is more than 900m. This lowers the noise levels to: day = 44 dB(A); evening = 39 dB(A); night = 34 dB(A).

The base noise levels described in step 3 of Part 3 are: day = 45 dB(A); evening = 37 dB(A); night = 32 dB(A). For each period, the greater of these numbers and the distance-adjusted levels should be used, which corresponds to: day = 45 dB(A); evening = 39 dB(A); night = 34 dB(A).

The final step (Step 4) that is relevant from NIRV requires a background check and adjustment, which could have the effect of increasing the limit levels to account for any significant background. We have no background noise levels to apply to the Church Road area anyway, so the final NIRV-derived RMNLs at the noise sensitive area 1.1km from the plant are:

- Day = 45 dB(A)
- Evening = 39 dB(A)
- Night = 34 dB(A).

Table 33 compares the highest estimates of residual noise from the proposed Hazelwood plant with these RMNLs, taking no account for noise reduction commensurate with the scale reduction from the 800,000 tonne per year China reference plant to the 50,000 tonne per year Hazelwood proposal, nor other accommodation for the China plant's co-location with other major (noise generating) industry on its site.

Table 33: Hazelwood plant noise estimates compared to recommended maximum noise levels (RMNLs)

Period of day	RMNL (dB(A)	Estimated residual noise level at nearest noise sensitive area, SR 1 (dB(A))
Day	45	30
Evening	39	21 - 30
Night	34	21

9.4 Summary of the noise assessment

Using noise measurements taken at the site boundary of the China reference plant as an indication of noise emissions from the proposed Hazelwood plant, without adjustment for relative size or subtraction of noise from adjoining industrial sources within the China plant's boundaries, noise levels estimated to be experienced at the nearest noise sensitive area (SR 1 on Church Road Hazelwood North, 1.1 km away) are significantly below day, evening and night recommended maximum noise levels.

10 Water

The proposed plant will not discharge to waterways. All battery drop-off, unloading, storage and processing areas are bunded and within-building under roof, to prevent any contaminated runoff. All spills and washings are collected into the waste water treatment system, where water is recovered for recycling to various plant uses, as described in Section 7.

Rainwater and stormwater are collected and channelled into onsite waste water treatment so as to ensure that no untreated stormwater leaves the site. In the case of high-rainfall 'emergency' events, there is capacity to release collected, tested and quality-assured stormwater at a rate of up to $40m^3$ per day to trade waste, as described in 7's Figure 11.

Any losses of process water are either discharged to air as waste heat or steam, or collected and sent to the onsite wastewater treatment plant for reuse within the process, or discharged to sewer via a trade waste agreement.

10.1 Onsite wastewater treatment plant

The China plant includes an extensive wastewater treatment system which will be replicated at Hazelwood North. The purpose of this system is to treat:

- harvested rainwater/stormwater
- plant process water
- water from workers' showering and laundry in-plant (potentially lead-containing), as well as workers' sanitary effluent.

Since there is an avenue to discharge to trade waste, particularly where circumstances of high rainfall put capacity pressure on the site's water storages, the wastewater treatment system also ensures any such discharges will be within acceptable trade waste limits.

The site plan of ***Appendix E*** shows the wastewater treatment plant (see Stormwater and Wastewater Treatment Area).

The wastewater treatment plant consists of a physical treatment system, a chemical treatment system and a small-scale biological treatment system, as outlined in Section 7, Figure 11. These are described below.

10.1.1 Physical treatment plant

Rainwater and stormwater collected onsite are an important source of water to be used for tasks within the plant. This water, as well as post-use plant process water must undergo physical treatment before further use, treatment or storage. Physical treatment involves grid separation of coarse solids, flocculation, primary sedimentation and filtration.

Physical treatment removes solids collected from rooves and plant surfaces, but also removes the vast majority of any lead from process waters, since lead species in the process are virtually all contained in the solid phase, being extremely insoluble in water.

10.1.2 Chemical treatment plant

Rainwater and stormwater may at times require pH adjustment in the chemical treatment plant, to ensure downstream plant uses are not unnecessarily impacted by corrosion from slightly acidic water. This is likely to be the only treatment required for harvested supplies.

Chemical dosing with lime or sodium hydroxide will also assist with any further removal of process water lead, as can addition of sodium sulfide, precipitating out any remaining soluble component of lead. Lead is not a direct issue for process water quality, but its removal is good practice, to ensure any emergency event discharge of storages (to trade waste) is either within specification for lead or close to it, requiring minimal further treatment.

Wastewater from employee showering and laundering of work uniforms has the potential to contain small concentrations of lead. Consequently, this stream will undergo ion exchange within the chemical treatment plant. Ion exchange columns are effective at removing low levels of heavy metals through replacement of functional groups in the ion exchange resin.

10.1.3 Small-scale biological treatment plant

As part of collecting wastewater from employee showers and daily laundering of work uniforms, the same floor-level employees will generate effluent from toilets and hand-washing activities. Although small in scale compared to plant water treatment, this will require simple onsite biological treatment, prior to on-sending to the physical and chemical treatment plants, the latter specifically for ion exchange removal of lead, which can only be effective on otherwise 'clean' water.

The biological treatment process will include: anaerobic digestion, activated sludge, aeration, and final filtration prior to disinfection in the chemical treatment plant. From there it is feed back into plant recirculation.

10.1.4 Treated water quality

No water will be discharged directly to waterways.

Treated plant water (including treated wastewater from laundering), or excess treated and stored rain/storm water have the potential to be discharged to sewer via trade waste. Such discharges must meet trade waste discharge water quality, which will be determined under a future trade waste agreement with the water authority.

Table 34 provides an exhaustive list of indicative concentration limits for pollutants in trade waste discharge, taken from a sample trade waste agreement provided by South East Water[38].

It is noted that only a small proportion of these potential contaminants would be relevant to a future Chunxing trade waste agreement. Those most likely to be of interest would be many of the listed macro-parameters plus a number of the metals, including lead, cadmium and arsenic. The maximum allowable concentration for limits for these heavy metals respectively are 10mg/L, 2 mg/L and 1 mg/L.

[38] South East Water, *Sample Trade Waste Agreement*, available at: https://southeastwater.com.au/SiteCollectionDocuments/Business/Trade-Waste/Sample_Trade_Waste_Agreement.pdf

The China plant does not dispose any water at all offsite. Data from routine monitoring of their treated water ("clear water pool"), which they use for onsite landscape watering, is shown in Table 35. The highest results obtained for each heavy metal are: lead 0.092 mg/L, cadmium 0.0076 mg/L and arsenic 0.083 mg/L. The upper limit specification the plant's treatment system operates to, for these heavy metals, is: lead 0.1 mg/L, cadmium 0.01 mg/L and arsenic 0.1 mg/L. Applying these to potential trade waste limits demonstrates compliance by one to two orders of magnitude.

The clear water pool at the China plant is used as a decorative fish pond, as shown in Figure 19.

Figure 19: Final treated water pond (clear water pool) at the China plant

Sewage from office and kitchen amenities will be identical to domestic sewage, so will be sent directly to sewer without treatment. Consequently this stream has no particular water quality considerations.

Table 34: List of possible 'chemical characteristics' considered by a sample Trade Waste Agreement from South East Water, Victoria

Parameter	Max. allowable concentration (mg/L*)
VARIOUS MACRO-PARAMETERS	
pH	6.0 – 10.0
Biochemical oxygen demand (BOD)	1,000 kg/day
Total Kjeldahl Nitrogen	500
Ammonia (as N)	50
Oxidised sulfur (as S)	100
Sulphide	1
Cyanide	10
Total phenoxyacetic acids and chemical derivatives (expressed as phenoxyacetic acid)	1,000
METALS	
Arsenic	1
Barium	150
Beryllium	30
Boron	25
Cadmium	2
Chromium	10
Cobalt	10
Copper	10
Iron	100
Lead	10
Manganese	10
Mercury	1
Molybdenum	10
Nickel	10
Selenium	10
Silver	5
Thallium	20
Tin	10
Uranium (238)	30
Zinc	10
HALOGENS AND HALIDES	
Bromine (as Br_2)	5
Chlorine (as Cl_2)	5
Fluoride	30
Iodine (as I_2)	5
PHENOLICS, ALDEHYDES, KETONES & NITRILES	
Sum of phenol, monochlorophenol, dichlorophenol and their isomers	300
Trichlorophenol	50
Tetrachlorophenols	5
Pentachlorophenol	5
Acetone	50
Acrolein	0.1

Parameter	Max. allowable concentration (mg/L*)
Formaldehyde (as HCHO)	200
Acrylonitrile	1.0
MONONUCLEAR AROMATIC HYDROCARBONS	
Benzene	1.0
Cumene	3.0
2,4 Dinitrotoluene	10
2, 6 Dinitrotoluene	10
Ethylbenzene	2.0
Nitrotoluene	5.0
Styrene	2.0
Toluene	2.0
Total Xylenes	2.0
HALOGENATED ALIPHATIC HYDROCARBONS	
1,2 Dichloroethane	5.0
1,1,1 Trichloroethane	3.0
1,1,2 Trichloroethane	3.0
1,1,2,2 Tetrachloroethane	2.0
Hexachloroethane	1.0
Chloromethane (Vinyl Chloride Monomer)	0.5
1,2 Dichloroethylene	5.0
Trichloroethylene	1.0
Tetrachloroethylene	1.0
Carbon Tetrachloride	1.0
Methylene Chloride	5.0
Methyl Chloride	1.0
Methyl Bromide	1.0
Trichloromethane (Chloroform)	1.0
Bromodichloromethane	1.0
Trichlorofluoromethane	1.0
Dichlorodifluoromethane	1.0
Chlorodibromomethane	5.0
1,1 Dichloropropane	5.0
1,2 Dichloropropane	5.0
1,3 Dicloropropane	1.0
Hexachlorobutadiene	1.0
ALIPHATIC HYDROCARBONS (C6 – C9)	1.0
ESTERS, ETHERS & OTHER ORGANICS	
Ethyl Acrylate	1.5
Methyl Methacrylate	30.0
Diethylene glycol monobutyl ether (butyl carbitol)	2,000
Glyphosate	10
Trifluralin	10
Epichlorohydrin	0.3
PERSISTENT ORGANOCHLORINE PESTICIDES	

Parameter	Max. allowable concentration (mg/L*)
Aldrin	0.001
Chlordane	0.006
DDT	0.003
Dieldrin	0.001
Heptachlor	0.003
Lindane	0.1
OTHER HALOGENATED AROMATIC HYDROCARBONS	
Polychlorinated Biphenyls (PCB's)	0.002
Polybrominated Biphenyls (PBB's)	0.002
Chlorodibenzo-p-dioxins and Chlorodibenzo-furans (TEQ)	20.0ng/l
Any substance not otherwise mentioned in this Schedule (where the discharge or release of which to any element of the environment is restricted or prohibited by any legislation applying in Victoria)	1µg/L

** Unless other units are stated*

Table 35: 2019 China plant monthly monitoring of treated water quality for heavy metals

Date	Sample	Heavy metal concentration		
		Pb (mg/L)	As (mg/L)	Cd (mg/L)
16 Jan 2019	Clear water pool	0.05	0.062	0.0048
30 Jan 2019	Clear water pool	0.04	0,013	0.0012
7 March 2019	Clear water pool	0.09	0.047	0.004
11 March 2019	Clear water pool	0.07	0.037	0.0033
15 March 2019	Clear water pool	0.04	0.058	0.0012
24 April 2019	Clear water pool	0.059	0.083	0.0076
27 April 2019	Clear water pool	0.092	0.029	0.0027
13 May 2019	Clear water pool	0.028	0.022	0.0025
22 May 2019	Clear water pool	0.011	0.076	0.00613
12 June 2019	Clear water pool	0.09	0.026	0.00619
18 June 2019	Clear water pool	0.08	0.08	0.0012
25 June 2019	Clear water pool	0.08	0.081	0.0017

11 Land and groundwater

The Chunxing facility will not involve storage of petroleum products underground, pipeline transfer of petroleum products, groundwater extraction or injection of waste or other materials to groundwater.

All raw materials, such as zinc oxide, ammonium bicarbonate, smelting iron, reductant coal, fluxes and additive metals will be stored in above ground tanks located in bunded areas.

There will be no discharges to land, and risk of accidental discharge will be controlled through bunding, and drainage of all surfaces into the waste water treatment circuit.

11.1 Statement of Environmental Audit on the site

The Hazelwood North land parcel is on part of the former Lurgi Coal Gasification Plant site and, as part of its redevelopment within the Government's Gippsland Heavy Industry Park Infrastructure Project, an Environmental Audit was carried out on it in 2008.

From this work a Statement of Environmental Audit was issued, dated 29 September 2008, which contains conditions that apply to the use of the land for Industrial purposes. The Audit Statement reads as follows:

"The site is suitable for the beneficial uses associated with Commercial and Industrial land uses, subject to the following conditions attached thereto:

a. *Groundwater shall not be extracted (withdrawn) from the site for uses other than clean up or monitoring without testing of its suitability for the proposed use.*
b. *Site development protocols must take into account the requirements of the Environmental Management Plan (EMP) attached to this Statement of Environmental Audit and the presence of aesthetically-impacted material at the site.*
c. *The site owner / occupier shall notify the responsible authority and EPA when construction of the capping layer across the "building restriction zone" shown in Figure S2 and as described in the EMP is completed.*
d. *No buildings with enclosed spaces shall be constructed within the boundaries of the "building restriction zone" as shown in Figure S2, unless a risk assessment including consideration of vapour risk is conducted that indicates it is safe to do so.*
e. *If the owner / occupier undertakes the redevelopment of the part of the audit site that includes the "building restriction zone" (other than construction of the capping layer referred to above), the owner / occupier must review the suitability of the EMP for the proposed development.*
f. *The owner / occupier shall notify EPA and the responsible authority of any significant revision to the EMP."*

The full Audit report, including the EMP and appendices, can be found at: https://portal.epa.vic.gov.au/irj/portal/anonymous?NavigationTarget=ROLES://portal_content/epa_content/epa_roles/epa.vic.gov.au.anonrole/epa.vic.gov.au.searchanon&trans_type=Z010, transaction number 8001659 (site name is Former Lurgi Gasworks, Tramway Road, Morwell).

The EMP describes the nature of soil contamination on the site:

> *"Soil assessment works revealed that the majority of soil contamination was present on the northern end of the site on Block B. This was known to be associated with the by-products processing facilities located in this portion of the site. Elevated concentrations of asbestos, TPH C10-C36, toluene, polychlorinated biphenyls (PCBs), metals (cadmium, cobalt, copper, lead, nickel, manganese, mercury, selenium and zinc), polycyclic aromatic hydrocarbons (PAHs), total cyanide, cresols and phenols were identified at select areas across the entire site."*

It then describes the extent of groundwater contamination:

> *"Final groundwater assessments conducted upon completion of all remedial works revealed elevated concentrations of TPH C_{10}-C_{36}, metals (copper, manganese and zinc), sodium, chloride, fluoride, ammonia and nitrate."*

After review of other background groundwater in the area auditor concluded that:

> *".. concentrations of TPH, metals, chloride, sodium and fluoride are typical of those encountered in the surrounding areas and that the site has not polluted groundwater with these contaminants."*

EPA determined on 26 September 2007 that groundwater Clean Up to the Extent Practicable had been achieved.

The audit identifies two primary areas of impacted groundwater on the site; both take up very small areas. These are the area of contamination at the northern boundary and the 45m by 45m square from the previously sited Effluent Oxidation Tank (EOT) on the southern boundary, identified by the auditor as the "building restriction zone." The EOT building restriction zone is shown in Figure 20, while the northern boundary contamination area is shown in Figure 21. Both areas of contamination are provided as coordinates and red-pen hand drawn hashed areas. Both figures are reproduced from the audit's Executive Summary.

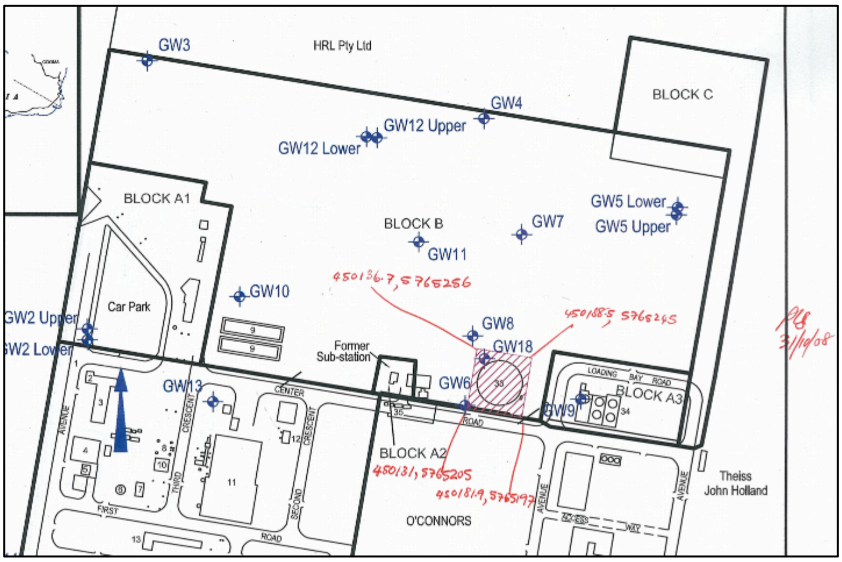


Figure 20: "*Figure S1 Site Location Plan and Audit Boundaries*" (extract from Audit Executive Summary)

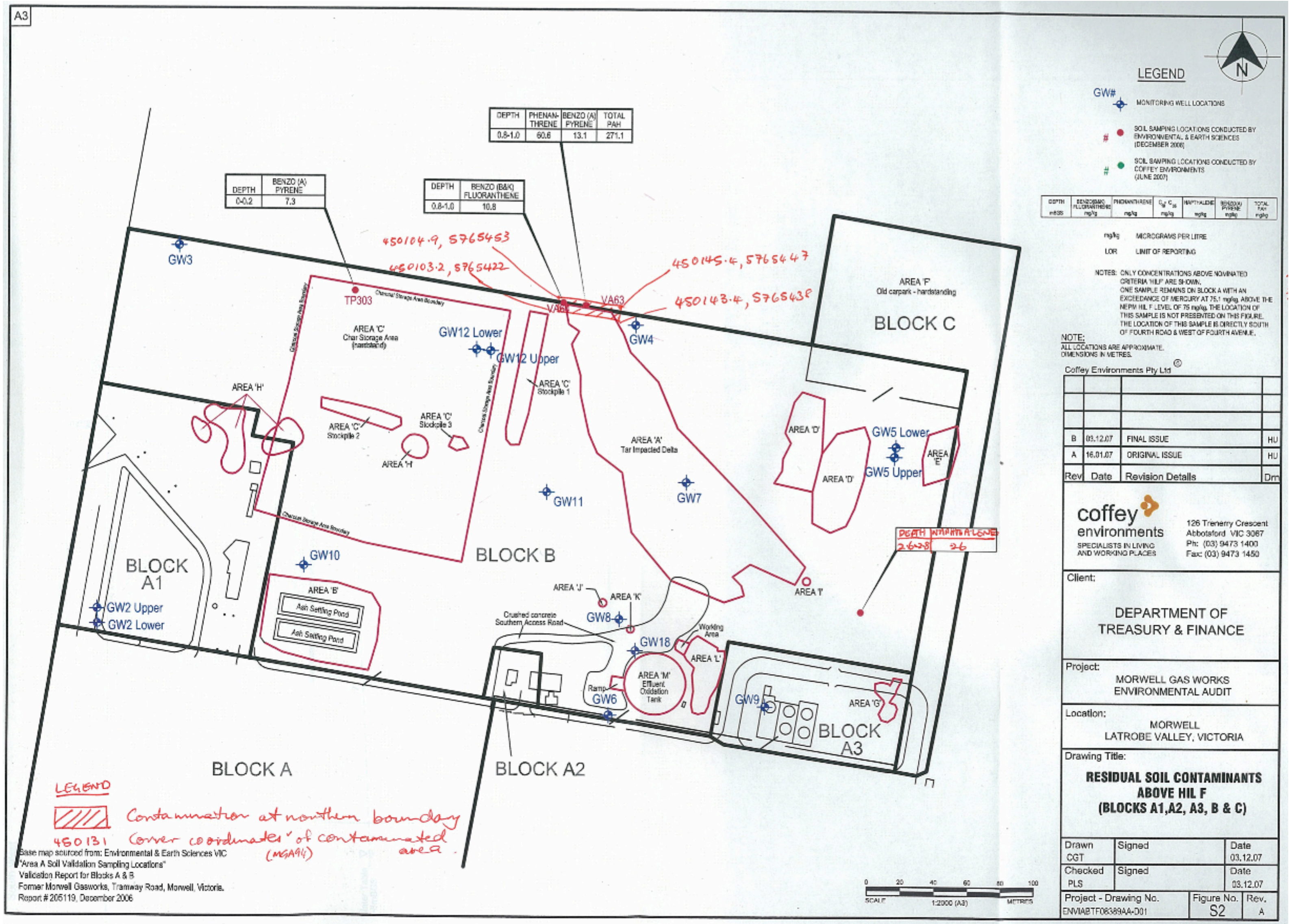


Figure 21: "***Figure S2 Site Plan Showing Areas of Contamination Remaining***" **(sourced from Audit Executive Summary)**

11.2 Management implications for Chunxing

The proposed development of the land by Chunxing to build and operate a ULAB recycling facility is in accordance with the audit and EMP conditions, since it will not extract groundwater for any uses, will not build over the nominated “building restriction zone” and will not build or operate its facility in any way that is contrary to the requirements of the EMP.

The EMP notes that its implementation rests with “future site owners/ occupiers” which will be Chunxing in this case. The EMP’s tasks and responsibilities are nominated as:

- Implementation of the Soil and Groundwater Management Plan (within the EMP).
- Instruction of site personnel on how to comply with the Soil and Groundwater Management Plan.
- Nomination of an Environmental Officer to co-ordinate site activities.
- Keeping records of soil movements and waste disposal.

Chunxing notes that, as part of excavation of the site upon construction, there may be areas of soil contaminated sufficiently that would warrant their management as prescribed industrial waste, dependent on levels of contaminants.

12 Waste

12.1 Waste generation

Waste, in the form of ULABs, is accepted into the plant to produce lead alloy, bullion and other by-products. This section explores the wastes that are generated by the process itself, onsite, and how they will be managed.

Both *industrial wastes* (IW) and *prescribed industrial wastes* (PIW) are produced onsite, as well as a range of by-product streams that have economic markets. These are all detailed in Table 36 along with their planned management fate.

Table 36: Wastes and by-products generated at Chunxing Hazelwood plant

Type of material	Detail	PIW or IW	Estimated production (t/yr)	Management fate
Waste				
Plastic separators	Porous sheets of polyethylene or potentially PVC plastic used to separate lead plates in the battery. Contaminated in lead and sometimes called 'partition'.	PIW	1,000	PIW landfill, dependent on Pb levels (either Cat B or Cat C)
Slag	Waste slag made up of iron oxides, sulfides and various silicates. Contaminated with lead at levels ~ 0.2 – 0.6%	PIW	4,500	Likely Cat B waste sent to Suez Lyndhurst Cat B PIW Landfill. If Cat A then immobilised first followed by Cat B PIW Landfill
General waste	General waste from office and plant activities	IW	5	Local collection for recyclables and landfill
Chemical containers & packaging	Drums, bags or other containers that may be contaminated with original chemicals	PIW	<1	Collection by EPA licensed transporter to EPA licensed treater (e.g. drum recycler)
By-product				
Case plastic	Polypropylene casing plastic (or sometimes ebonite rubber) is separated by colour, washed and chipped. White polypropylene attracts a higher price than other colours.	-	3,000	Collected in colour-specific hoppers after chipping and sent to plastics recycler destined for reuse in battery casings in battery manufacturing
Zinc sulfate	Resultant liquid by-product from ZnO addition to neutralize dilute battery acid (H_2SO_4)	-	6,580	High value liquid agricultural product used as a foliage spray, to promote leaf growth
Ammonium sulfate	Resultant liquid by-product from $(NH_4)_2HCO_3$ addition to convert $PbSO_4$ to $PbCO_3$ in pre-desulfurisation	-	1,280	High value liquid agricultural product used as liquid soil fertilizer
Gypsum		-	5870	Valuable soil amendment for Ca/ S nutrition, acid neutralization, water infiltration and P retention

Management fates in Table 36 have been chosen with the order of the wastes hierarchy in mind, balanced against regulatory requirements for safe and secure handling and disposal of hazardous wastes.

The one exception to this is plastic separator waste, which has designated for landfill, despite the fact that it has sufficient calorific value that could warrant its burning in the smelting furnace as a small scale fuel replacement. This is what occurs at the China plant and other ULAB smelters around the world. Because separators have the potential to be made from PVC, a halogenated plastic, its introduction to the smelting furnace could provide raw materials for subsequent dioxin formation, albeit dependent on other process conditions and at very low levels. This risk was rated as a more important one to control, compared to the benefit of energy recovery from the plastics. Further rationale behind this decision is discussed in the integrated environmental assessment (Section 4.6).

12.2 'Wastes' returned back into the process

The refining process uses fluxing agent additives to help impurities separate from the purified lead. This separation results in a layer of dross waste that contains antimony, tin and copper, as well as trace levels of other metals. Chunxing's approach of separately processing lead grid to produce lead alloy, and lead paste to produce high purity lead is unique in ULAB smelting and provides a pathway for reuse of the dross. The metallic elements in dross are important in the composition of the alloy product so the dross is returned to the smelting furnace for recovery and reuse in the alloying step.

Pulse-cleaned contents of baghouse bags, called baghouse dust, consists of residual particulates collected from incoming stack flue gas. There will be approximately 700 tonnes per year of this waste generated. Because of the lead content, this material will be returned to the smelter for lead recovery.

12.3 Waste received (ULABs)

While not generated by the facility, ULABs are received as the primary form of lead-rich material to be recycled, although it is possible that small proportions of other lead scrap could be received, such as the components from battery breaker-only facilities already in operation in other parts of Australia, who currently send these wastes overseas.

The plant has capacity to receive and recycle 50,000 tonnes per year of ULABs.

12.4 PIW hazard classification and categorisation

12.4.1 PIW hazard classification

Likely waste classification would be:

- ULABs received from interstate would be a *controlled waste*: *D220 Lead and lead compounds.*
- ULABs received from within Vic are deemed by the EPA not to be PIW, due to the enclosed nature of the hazard within an intact battery. Consequently their classification is industrial waste only.
- Slag: the NSW ULAB smelter records its slag as *D300 non-toxic salts*, with lead and other heavy metals listed as contaminants. The other, perhaps more obvious waste code that could be used is *D220 Lead and lead compounds*, although this suffers from the potential to be confused with ULABs (a very different type of D220 waste) or other lead-bearing wastes. D220 is used to classify waste jarosite from the Nyrstar Hobart zinc refinery. Another option is Victorian code *D400 Smelter waste containing prescribed industrial waste*, but as a code used only by Vic, this option would be

converted to either D220 or D300 in national collations anyway. Another detraction for D400 use is that it has almost exclusively been used to describe aluminium smelting waste (spent pot liner), which is an important waste in its own right that has much more unique management requirements than slag.

  - A definitive classification decision requires EPA advice, but slag would be PIW.

- Plastic separators: PIW as *D220 Lead and lead compounds*
- Chemical containers & packaging: PIW as *N100 Containers and drums that are contaminated with residues of substances referred to in this list*.

12.4.2 PIW hazard categorisation

Characterisation and categorisation of the hazard of a solid waste is done by following EPA's IWRG guidelines for solid waste[39]. Information about contaminant concentration and leachable levels is required to make a definitive assessment as to whether PIW is Category A, B, or C, where A is the most hazardous and C the least.

12.4.2.1 Slag

Testing of the slag emanating from the Chunxing China reference plant has been tested in China and also more recently in Australia, after a sample was brought back from a recent visit to the operating plant. The results of these analyses and their comparison against IWRG categorisation is shown in Table 37.

In terms of total Pb in slag the two results available range from 0.20% – 0.56%, which places this waste at the Category B level. Since the higher of the two results is close to the Cat B upper limit of 0.6%, it is possible that this slag could be Category A PIW, which could require treatment by immobilisation prior to landfill. There are no other contaminants with either total or leachable results that would categorise the waste beyond the lowest level of industrial waste (IW).

12.4.2.2 Plastic separators

A separator is a porous membrane placed between electrodes of opposite polarity, permeable to ionic flow but preventing electric contact of the electrodes. Therefore it is in direct contact with battery chemicals such as Pb species, so some lead is likely to remain after washing. There is no current testing to demonstrate its categorisation but it would be unlikely to be higher than Cat B and may be Cat C PIW.

12.4.2.3 Chemical containers & packaging

This waste is expected to be very small. Levels of contamination and therefore categorisation depend on the extent to which original contents will be residual in such containers, which could vary. Accurate categorisation is not possible at this time.

[39] EPA Victoria publication IWRG631 – June 2009, *Industrial waste resource guidelines, Solid Industrial waste hazard categorisation and management*, available at: https://www.epa.vic.gov.au/~/media/publications/iwrg631.pdf

Table 37: Laboratory test data of slag from the China reference plant

Parameter tested	Australian lab test on China slag		China lab test on China slag		EPA category B upper limit		Likely EPA Category
	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	
Aluminium	16,000	0.3	-	-	-	-	-
Antimony	<7	<0.15	-	-	300	8	IW only
Arsenic	8	<0.05	-	-	2,000	2.8	IW only
Barium	240	3.2	-	-	25,000	280	IW only
Beryllium	<1	<0.01	-	-	400	4	IW only
Boron	1,800	1	-	-	60,000	120	IW only
Cadmium	2	<0.01	-	0.01	400	0.8	IW only
Chromium	5	<0.01	-	-	2,000	20	IW only
Cobalt	<1	<0.02	-	-	-	-	-
Copper	8	<0.01	-	-	20,000	800	IW only
Iron	67,000	17	-	-	-	-	-
Lead	2,000	2.4	5,610	0.26	6,000	4	Cat B PIW
Manganese	1,000	0.4	-	-	-	-	-
Mercury	<0.1	<0.0005	-	-	300	0.4	IW only
Molybdenum	6	<0.03	-	-	4,000	20	IW only
Nickel	1	<0.02	-	-	12,000	8	IW only
Selenium	<2	<0.12	-	-	200	4	IW only
Silver	<1	<0.02	-	-	720	40	IW only
Thallium	<2	<0.05	-	-	-	-	-
Tin	390	<0.05	-	-	-	-	-
Vanadium	17	<0.02	-	-	-	-	-
Zinc	2,700	1.1	-	-	140,000	1,200	IW only

12.5 PIW handling, storage and final destination

12.5.1 PIW transport and receipt

While not classified as PIW, all ULAB transport must occur using EPA permitted vehicles.

If ULABs are arriving from interstate the Controlled Waste NEPM requirements apply, including:

- a consignment authorisation from the environmental protection agency in the destination state or territory
- a waste transport certificate from the agency in the originating state or territory must accompany the ULAB load in transit
- a permit/licence for the vehicle transporting the batteries.

Battery packaging for transport adheres to the Australian Battery Recycling Initiative's (ABRI's) packaging standard for used lead acid batteries[40]. In broad terms, batteries are

[40] ABRI 2017, *Packaging Guidelines for Used Lead Acid Batteries*, available at: https://batteryrecycling.org.au/wp-content/uploads/2018/12/170802-ABRI-Guidance-Packaging-for-Used-Lead-Acid-Batteries-ULAB-R4.pdf

packed to protect against damage and spills using Australian Standard wooden pallets packed, wrapped and strapped according to Figure 22.

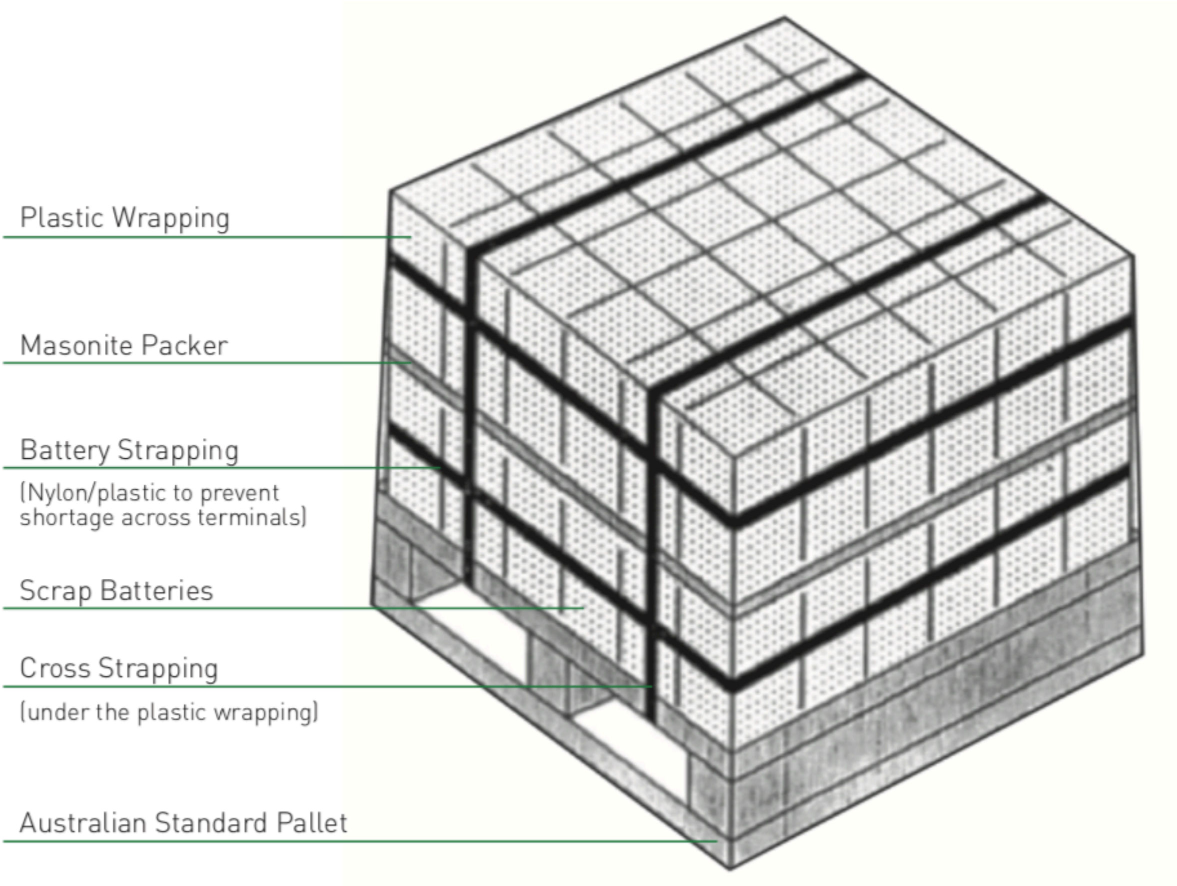


Figure 22: ULAB packaging compliant with ABRI packaging guidelines

Upon receipt the ULAB shipment must be managed according to an EPA licence that Chunxing must hold to operate. This licence will include waste handling conditions that require that only ULABs (or related D220 lead waste) can be received at the premises and the only options available for management of this will be either storage (up to a capacity indicated in licence) or recycling by secondary smelting.

Chunxing's operation will comply with these requirements and all ABRI guidance information, such as the Responsible *Recycling of Used Lead Acid Batteries*[41] and the Packaging Guidelines more specifically.

All unloading of batteries from trucks will occur within the covered and enclosed receipt building, which has an impermeable acid resistant concrete floor, drained to the onsite waste water treatment system. The area has only one entrance and one exit for trucks, and the enclosed area stays closed during drop-offs to avoid dust release. Every truck carrying ULABs is washed down after unloading, with washwaters drained to the waste water treatment system, before the vehicle can exit the building.

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[41] ABRI, *Recycling of Used Lead Acid Batteries*, available at: https://batteryrecycling.org.au/responsible-recycling-of-used-lead-acid-batteries/

12.5.1.1 Estimated number of truck movements

The main truck movements into and out of the plant will be EPA permitted vehicles carrying ULABs. Historical waste tracking data for ULAB transport shows that a typical ULAB load will be around 30 tonnes per truck. Consequently the 50,000 tonne per year Hazelwood plant is expected to receive 1,667 ULAB delivery truck loads per year, or 4.6 truck loads per day. These would typically be B-Double type trucks.

Table 38 summaries total estimated truck movements, including other types of truck deliveries and despatches.

Table 38: Estimated Hazelwood plant daily truck movements

Movement type	Quantity shipped (tonnes per year)	Estimated load per truck (tonnes)	Estimated number of trucks per year	Estimated number of trucks per day
Into plant (loaded)				
ULABs received	50,000	30	1,667	4.6
Consumables deliveries	9,142	20	457	1.3
Out of plant (loaded)				
Lead ingot despatch	16,500	20	825	2.3
Lead alloy despatch	11,270	20	564	1.5
By-product despatch	15,360	20	768	2.1
Slag waste to landfill	4,500	30	150	0.4
Other waste to landfill	1,000	30	33	0.1
			Total trucks per day	**12**

Notes:

1. Shipped quantities estimated from inputs and outputs of Table 4

2. All B-double trucks assume 30t payloads; all other trucks are assumed to be trailers at 20t payload

All trucks will be loaded or unloaded inside the building, and all deliveries and despatches will occur from 7.00am – 5.00pm Monday to Saturday.

For comparison purposes, Paper Australia's Energy from Waste Works Approval Application Health Impact Assessment[42] estimated an additional 100 vehicles per day from that project once operational. The assessment concluded that, at this rate of truck movements, ""… the number of vehicles added by (the energy from waste) development will have a minimal traffic impact upon the local road network" and that "… no significant reduction in travel times is

[42] Environmental Risk Sciences 2018, *Maryvale Energy from Waste Plant: Health Impact Assessment*, prepared for Paper Australia and Jacobs, available at: https://cvws.icloud-content.com/B/Aake9PWyiL1PJdqIDz75iLJErXtqAextOvMoXlzr2Q7AvOWYn4xdmJpq/Images.zip?o=ArNXCuMgT5ASfoNcOR8bL-bNZKOGMPNtBSpNdkdfVxqD&v=1&x=3&a=CAoguU0URZY8UgE6wgoON5vAN_zSfUZgU9q77p40faGc4CASJxC3hLfeui0Yt5SyssQtlgEAKggByAD_IfCUYVIERK17aloEXZiaag&e=1564547516&k=xWkbe0L5axdbN3FDcJeYXg&fl=&r=22CEF7E9-A909-4A02-A74F-C81A4A110595-1&ckc=com.apple.largeattachment&ckz=A78ECDBE-21B4-405F-B0A6-50AC63EBE1E4&p=44&s=KFHVQAuQMcBmzNXJDhItbWXYDXE&teh=1

expected". The estimate for Hazelwood is 10-fold below that estimated for Paper Australia's EfW plant.

12.5.2 ULAB unloading and storage

An exploded view (from the full plant layout drawing in Appendix E) of the building housing the loading/ unloading, washing area (denoted by the vertical bars) and the storage area is shown in Figure 23.

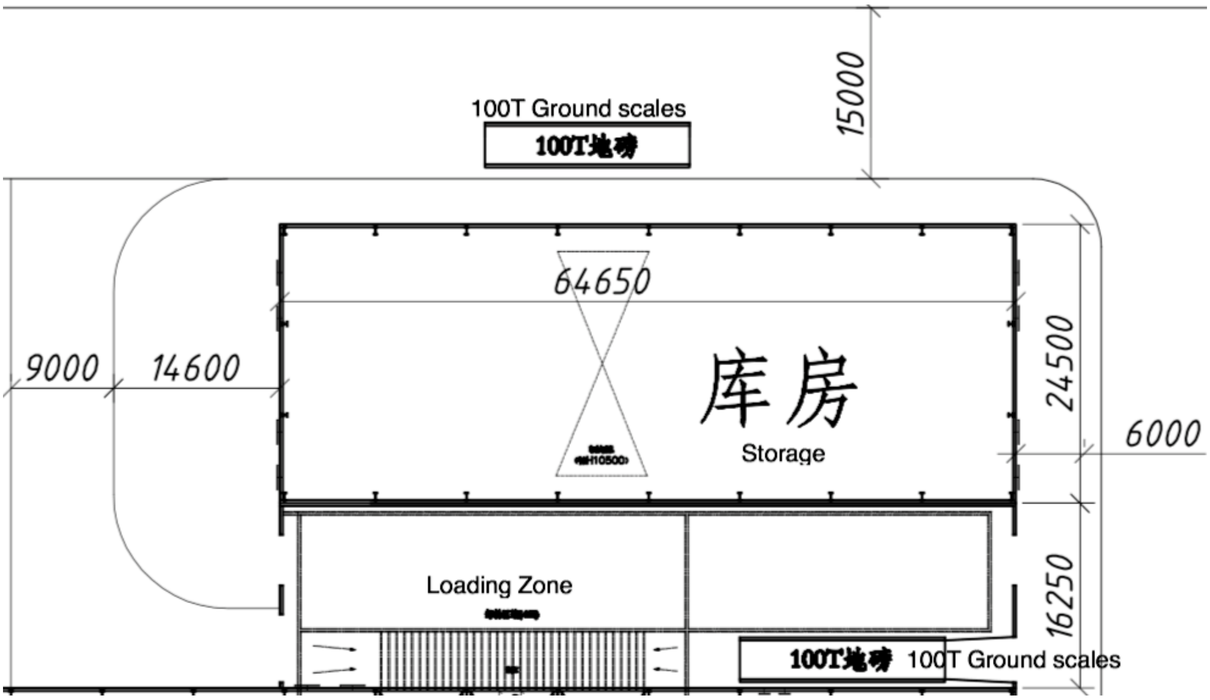

Figure 23: Unloading and storage site layout

Trucks enter from the top right of the above layout, pass over an entry weighbridge, turn left and left again into the loading zone, where unloading occurs. The vehicle then moves through the vehicle wash (the vertical bars show a grated floor section) and out again through the exit weighbridge (bottom right). Both weighbridges are called 'ground scales' in Figure 23.

The storage area is large (64,650mm x 24,500mm, or almost 1,600m^2) and is designed to be capable of storing 1-2 weeks' worth of ULABs, which is approximately 1,000 to 2,000 tonnes, or 100 m^3 to 200 m^3.

Batteries are taken from storage into the breaking section (immediately to the bottom boundary of Figure 23) via robotic crane to the breaker conveyor.

All undercover receipt and storage areas are fully bunded and comply with EPA publication 347.1[43]. ULABs are stored on wrapped and strapped pallets, as received in accordance with ABRI guidelines and Worksafe Dangerous Goods & Occupational Health & Safety requirements.

[43] EPA publication 347.1, October 2015, *Bunding*, available at: https://www.epa.vic.gov.au/our-work/publications/publication/2015/october/347-1

12.5.3 Final management for all PIW

ULABs are either stored onsite in the covered and bunded storage area for later processing or processed via recycling at the plant, as described in this application and to be sanctioned by EPA licence.

PIW removed from site will be transported on EPA permitted vehicles to Lyndhurst PIW landfill (in the case of Cat B waste such as what slag is likely to be), other potentially other Cat C landfill in the case of lower levels of contamination, such as separator plastics (should these be classified as Cat C PIW). If any wastes are demonstrated to be Cat A PIW they will first be treated via immobilisation/ encapsulation techniques, followed by landfill. All destinations will be EPA licensed to perform these respective forms of waste management and all vehicles will be permitted by EPA to transport these wastes. All PIW movements will be conducted within EPA Victoria's PIW tracking system.

12.5.4 Fire risk assessment and materials storage

This section adopts a risk management approach following the process outlined in the international risk management standard ISO 31000:2009 – Risk Management Principles and Guidelines, as summarised in Figure 24:

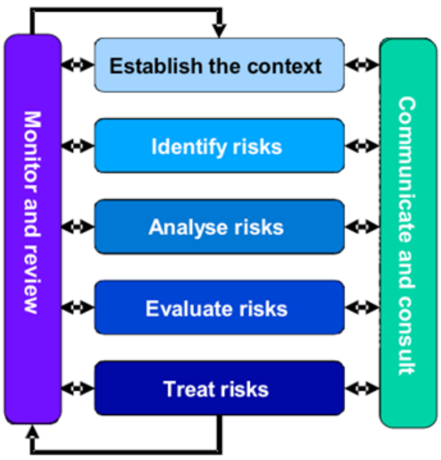

Figure 24: Risk management framework

The contents of the following subsections are based on an assessment of compliance with EPA Publication 1667.2 'Management and storage of combustible recyclable and waste materials – guidelines' and EPA Publication 1698 'Liquid and storage handling guidelines'.

12.5.4.1 Combustible recyclable materials and wastes

EPA Publication 1667.2 *Management and storage of combustible recyclable and waste materials – guidelines* is designed to guide the management and storage of combustible recyclable and waste materials in a manner that minimises the risk of harm to human health and the environment from fire. The guideline supports compliance with the Waste Management Policy (Combustible Recyclable and Waste Materials) (WMP CRWM).

The objective of the WMP CRWM is to ensure that combustible recyclable and waste materials at waste and resource recovery facilities are managed and stored in a manner that minimises risks of harm to human health and the environment from fire.

According to the guideline, ULABs, which are technically ‘specified electronic waste (e-waste)’ are combustible recyclable and waste materials. However, it is also clear that the focus of the guideline is on those wastes and recyclables with significant inherent risk of combustion, such as paper and cardboard, wood, plastic, rubber, tyres, textiles, organic materials and other combustible or flammable materials.

The primary materials present within the Chunxing facility that could have potential for fire risk are:

- Natural gas for combustion to heat furnaces.
- Smokeless coal (~3,000 tonnes per year) used as a reductant in the smelting process.
- Relatively small amounts of refining fluxes that contain sodium hydroxide (~650 tonnes per year) and sodium nitrate (~250 tonnes per year).
- Plastics from battery casings (~3,000 tonnes per year) and in-battery separators (~1,000 tonnes per year), mostly high density polypropylene (HDPP) and high density polyethylene (HDPE).
- The potential for small amounts of rubber (ebonite) in battery casings.
- The presence of liquid oxygen (2 x 20m^3 tanks), stored onsite.

Sulfuric acid is present within ULABs in a 10-15% dilute solution. Sulfuric acid is neither combustible or flammable, but fires could potentially result from the heat generated by contact of sulfuric acid with combustible materials. However, this is likely to only be an issue with concentrated sulfuric acid, which is not present on site.

Another risk mentioned in the literature with respect to lead acid batteries (as opposed to ULABs) is the generation of off-gas hydrogen (and oxygen), which can be explosive if present in confined spaces at high enough concentrations. However, this is only a risk <u>during the charging process</u> of a functional battery, and not a risk with ULABs, because the electrochemistry is ‘forced’ due to the application of a charge. ULABs in the battery breaker have no charge applied, so their electrochemistry is governed by the relative reduction potentials of the electrochemical series, and lead and H_2 are immediately adjacent to each other, which limits electron flow and therefore the generation of H_2.

Zinc oxide, used in the plant for sulfuric acid neutralisation to produce zinc sulfate, is neither combustible or flammable, but can react violently if mixed with chlorinated rubber, magnesium or linseed oil. None of these risk factors are present at the plant, but zinc oxide, like all process chemicals used onsite will be isolated, separately stored and bunded.

Liquid oxygen will be used onsite as lance feed into the smelting furnace, in place of air, to tightly control combustion conditions, enable alternation between oxidation/ reduction conditions, limit NO_x formation in the flue gas and keep gaseous volumes small (compared to what they would be with air). All management, maintenance, replacement and safety aspects of handling liquid oxygen is provided under contract by a gas supply company, such as BOC Gases.

Leaded components of ULABs, such as lead grid and wire, lead oxides and lead sulfate are neither flammable or combustible. Similarly, other key chemicals used onsite such as iron pellets, ammonium bicarbonate solution and by-products ammonium sulfate, gypsum and lime are benign from a fire risk point of view.

Fires at lead acid battery recycling facilities are extremely rare. We are unaware of any fire-related incidents at all in Australia in the last 30 plus years of battery recycling. This is possibly due to a couple of factors:

- Other than the fuel burnt onsite (natural gas), there is limited combustible material present in either the input batteries or chemicals used.
- Thermal processes like melting and smelting have inherent safety controls due to the temperatures these core processes are operating at – and these processes are the core technical business of the operation of these facilities.

A high level fire risk assessment has identified a list of hazards and risks relevant to ULAB recycling. The table below shows these risks, rates them, assigns mitigation controls and then rates the residual risk.

Table 39 will form the beginnings of an operational fire risk register, to be used during construction and operation of the plant, where it is likely that many more hazards and risks will be identified that require consideration and controls. This would likely be implemented as part of a more general onsite risk register, which would also incorporate those risks and controls identified in Table 42 'Potential plant upset risk identification'.

The guideline's requirements for storage of combustible recyclable materials and wastes are met by:

- having limited flammables/ combustibles on site
- all chemical, waste and material storage is highly segregated, like with like
- the site has a large storage area to allow this segregation
- all storage of chemicals and materials occurs within enclosed buildings
- all buildings will have a record of the fire items installed or constructed in the building (such as sprinklers, fire doors and paths of travel to exits).

An Emergency management plan (EmMP), which incorporates fire risk, will be developed as part of the development of procedures and systems for workplace health and safety once the site has been constructed. The EmMP would be developed from the assessment of a series of hazards such as those in Table 39 and Table 42, plus others identified by a hazard and operability study (HAZOP), to be conducted during detailed design and installation of the facility.

The EmMP will include:

- Key information about the site, its layout and an inventory and location of combustible recyclable and waste materials and dangerous goods
- Nearby infrastructure, businesses and residences
- Evacuation and fire/ bushfire procedures
- Fire protection systems, equipment, water access and fire-water runoff/ containment

- Details of site services and sewage/ drainage points
- Staff response actions, exit corridors and first aid stations.

Table 39: Preliminary fire risk register

Risk #	Hazard	Potential causes	Initial risk		Potential for offsite impact	Controls	Residual risk
			Consequence	Likelihood			
1	External fire (adjacent to site) impacts Chunxing facility	Fire or explosion from neighbouring business	High: asset damage; plant shut down; personal injury	Medium	None likely from Chunxing	Large buffer spaces to site boundaries, limited fuel in these spaces (other than landscaped grasses) Significant fire water, protection systems & fire-fighting resources on site Gas supply can be cut-off immediately, producing solid smelter contents within 15 minutes. Onsite procedures re fire drills and training	Low. Fire (onsite) should be contained quickly, minimising damage at site.
2	Natural gas leak and ignition or fire caused by other combustibles onsite	Fire or explosion	High: asset damage; plant shut down; personal injury	Low	Yes	Erected barriers around gas supply piping & material storage buildings Limited flammables/ combustibles on site Chemical storage highly segregated like with like Furnaces and other plant fully enclosed Small batch design: 15 minute cool-down response time from gas cut-off Highly automated furnace feeding mechanism eliminates risk of mis-feeding of material Housekeeping, maintenance, lead detection Onsite procedures re fire drills and training	Very low. Fire (onsite) should be contained quickly, minimising damage at site.
3	Smelting furnace explosion impacting community	Incorrect fuel/ oxidant mix	High: asset damage; plant shut down; personal injury	Low	Yes	AS3814 compliant gas fired system High levels of process control and automation Batch process allows rapid plant shutdown Small scale of smelting furnace – incidents can be rapidly controlled and confined	Very low – no known furnace explosions in 30+ year history of secondary lead smelting in Australia
4	Molten metal explosion	Addition of water to hot furnace	High: asset damage; plant shut down; personal injury	Medium	Unlikely	No water supply / pipes in proximity to furnace Fully enclosed furnaces – no access for projectile entry	Very low – no known furnace explosions in 30+ year history of

Risk #	Hazard	Potential causes	Initial risk		Potential for offsite impact	Controls	Residual risk
			Consequence	Likelihood			
						Furnace temperature has ramped start-up to boil off residual water rather than be hot enough for superheated steam conditions High levels of process control and automation Batch process allows rapid plant shutdown Small scale of smelting furnace – incidents can be rapidly controlled and confined	secondary lead smelting in Australia
5	Chemical fire	Co-mingling of non-compatible chemicals	Fire or explosion	Medium	Not likely	Limited flammables/ combustibles on site Chemical storage highly segregated like with like Large storage areas to allow segregation Large buffer spaces to site boundaries, limited fuel in these spaces (other than landscaped grasses) Significant fire water, protection systems & fire-fighting resources on site	Low
6	Breaker explosion	Lithium ion battery accidently mixed in with ULABs	Damage to breaker	Low	No	Li-ion battery totally different dimensions to ULAB – easily identified prior to breaker Li-ion battery unlikely to be collected by aggregators because it has limited $ value c/f ULABs Breaker – all wet process Breaker is fully enclosed	Very low

12.5.4.2 Storage and handling of liquids

The facility complies with EPA Publication 1698 'Liquid and storage handling guidelines'. There are limited liquids handled on site. Any losses of process water are either discharged to air as waste heat or steam, or collected and sent to the onsite wastewater treatment plant for reuse within the process, or discharged to sewer via a trade waste agreement, the latter an 'emergency' option in the event of water volumes excess to the entire system's capacity, at a maximum rate of 20m^3 per day.

The Chunxing facility receives liquids within sealed ULABs (in the form of dilute sulfuric acid), produces some liquid by-products that are on-sold for downstream industrial and commercial uses, uses some liquid raw materials and produces wastewater, which is almost entirely treated and recycled within the onsite waste water treatment plant. These liquids are:

- Acidic wastewater from any battery leakage from receipt and storage areas
- Waste sulfuric acid separated from ULABs is neutralised with zinc oxide (solid) within the process to produce liquid zinc sulfate (a 7% w/w solution by-product used as an leaf growth-enhancer in agriculture)
- Ammonium bicarbonate solution is used as a raw material in pre-desulfurisation of lead sulfate prior to smelting
- Ammonium sulfate solution (a liquid fertiliser) is produced as a by-product from this pre-desulfurisation step
- Waste water from the breaker and other plant sources as described in Section 7.

As is the case with solid wastes, dangerous goods, other raw materials and by-products, liquids are stored in fully enclosed buildings in segregated areas, and are contained with bunding and fully sealed flooring and drainage.

There are no uncontrolled liquids that leave the site, due to the onsite waste water treatment system introduced in Section 7 and further described in Section 10. There are no liquid prescribed wastes generated by the facility, part from small quantities of waste containers and drums, which may contain traces of liquid contents.

12.6 Best practice of managing PIW generation

Best practice has been addressed previously in this application in the following areas:

- Energy use and GHG emissions (Section 6.2)
- Air emissions (Section 8).

This section addresses Best Practice in PIW generation according to the waste hierarchy as follows:

- Waste generation implications of process/ technology options
- Options to avoid or minimise PIW generation
- Alignment with the State-wide Waste and Resource Recovery Infrastructure Plan, SWRRIP (June 2015)
- Summary of best practice assessment

12.6.1 Waste generation implications of process/ technology options

Section 4.5 lays out five technology choices for recycling ULABs. The waste generation implications of each option are described in Table 40.

Of the options considered, hydrometallurgical/ electrolytic options are not commercial scale or proven at this point – the most recent of these technologies has the potential to have the best waste outcomes due to the fact that it does not produce slag, but it is only lab scale at this point.

Of the others, battery breaking simply transfers the waste slag from an Australian problem to one at an overseas smelter, with higher transport emissions and other inefficiencies. The Chunxing technology produces around half of the slag quantity typical of rotary furnace smelting (such as the one in Wagga Wagga) and lead concentration in the Chunxing slag (the only relevant contaminant) is about one-tenth of that observed in rotary furnace slags.

Table 40: Waste aspects of each process/ technology option

Technology choice	Waste generation aspects	Comment
Battery breaking only	• No thermal process so no slag is produced • Breaker washings need to be managed • Acid waste needs to be neutralized and managed (liquids typically to sewer, solid salts to offtake markets or waste) • Plastic separators require landfill • Lead scrap sent overseas via export permit or to Wagga Wagga, for smelting	• Only partial recycling solution • Slag waste is not produced onsite but since all Pb scrap (waste) is either sent to Wagga Wagga or exported for smelting, slag is still produced elsewhere
Secondary smelting (rotary furnace)	• Produces approximately 300-350 kg slag per t of Pb product[44] • Slag at the Wagga Wagga facility is approximately 3.5% Pb; rotary furnace slags are typically 5% Pb[44] • Breaker washings need to be managed • Acid waste needs to be neutralized and managed (liquids typically to sewer, solid salts to offtake markets or waste) • Plastic separators require landfill	• Quantities of slag and lead levels in slag are higher than Chunxing technology
Hydrometallurgical (electrolytic) reduction	• No thermal process so no slag is produced • Safety and hazardous waste concerns through use of strong acid solvents (F-based)	• Fluorinated solvents a significant hazard to be managed, both in the workplace and as hazardous waste • Limited commercial reference plants (at scale) around the world – economics not proven at operational scales
New hydrometallurgical technologies	• No thermal process so no slag is produced • Advantage over 'conventional' electrolytic processes because deep eutectic solvents (DES) are used in place of more damaging F-based solvents	• Not proven beyond lab scale • No commercial reference plants around the world

Chunxing VSF	• Slag volume around 4,500 tonnes/ yr or 160 kg/ slag per t of Pb product; much lower than other smelting practices
	• Slag Pb levels around 0.20 – 0.56% Pb; much lower than other smelting practices
	• Overall process rates high against the waste hierarchy:
	  ◦ Business is a recycling operation
	  ◦ Avoids generating 50,000 tonnes of waste lead scrap (see export point below)
	  ◦ Four potential wastes are converted to saleable by-product streams: $ZnSO_4$, $(NH_4)_2SO_4$, HDPP chipped plastic and gypsum
	• Improves overall Australian environmental outcomes for ULABs by reducing the reliance on overseas export by as much as 50,000 tonnes/ yr
		• Of the commercially valid options, Chunxing's technology produces the lowest slag volume and lead content
		• Chunxing proposal increases Australian Pb recycling capacity so will divert large amounts of currently exported Pb scrap, saving money, efficiency and GHG emissions.

[44] From: Basel Convention 2003, *Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries,* available at: http://archive.basel.int/pub/techguid/tech-wasteacid.pdf

12.6.2 Options to avoid or minimise PIW generation

Slag, the most significant PIW stream, cannot be avoided in a ULAB smelting process. But Chunxing's intelligent choices of chemistry, process and pollution controls minimise both slag volumes and Pb levels.

Chunxing's intelligent approach to desulfurisation (removal of S) is the main explanation for low slag/ Pb, and this is achieved in multiple stages:

- pre-desulfurisation of the battery paste (with ammonium bicarbonate)
- neutralisation of battery sulfuric acid (with zinc oxide)
- furnace desulfurisation (with Fe filings followed by controlled air lance oxidation) and
- final desulfurisation through lime-addition in the scrubber, which captures the sulfur as sulfate in the form of gypsum ($CaSO_4.2H_2O$), thus keeping diverting most of it from the slag.

The first stage is the treatment of battery paste (the $PbSO_4$ is the target material) with ammonium bicarbonate (as opposed to sodium salts used in other processes), to produce ammonium sulfate. The solubility of ammonium sulfate is very high (70.6 g/100g water at 0^0C – 103.8 g/100g water at 100^0C), compared to the relatively moderate solubility of sodium sulfate (maximum of 49.7 g/100g water at 32^0C, decreasing as temperature increases beyond that). This means that the use of ammonium bicarbonate (over sodium carbonate or similar sodium salt) results in far greater removal of sulfate to the liquid fraction, leaving less as part of the solid for later smelting and final reduction through the wet scrubber.

Neutralisation has the effect of desulfurisation by converting H_2SO_4 to $ZnSO_4$.

The third stage of desulfurisation relies on a high degree of process control. Iron pellets are used in the reducing conditions of the smelter to react with PbS to produce FeS and Pb metal. Other smelters use this process to tackle their sulfur emission problem by dropping it out as high FeS-slag. But Chunxing don't do this. The furnace conditions are switched from reductive (to maximise Pb recovery) to oxidative later in the smelting cycle, through close control of the O_2 lance, to oxidise the FeS-bound sulfur back to SO_2 ($FeS + O_2 \rightarrow Fe + SO_2$ and $4Fe + 3O_2 \rightarrow 2Fe_2O_3$). This control of oxidative and reductive chemistry results in lower slag volume (because the S shifts from solid to gaseous phase for removal as SO_2 in the scrubber) and lower slag Pb content (because the excessive oxidation conditions further limits the formation of PbS that would have remained in the slag).

The last stage of desulfurisation is after smelting, where off gases are passed through the wet scrubber tower, dosed with lime. Because there was a reduced level of sulfur (converted to SO_2 in the smelting/ refining process) to begin with, due to pre-desulfurisation, the scrubber's removal efficiency of 99.95% results in lower stack exit concentration of SO_2 than alternatives, such as that employed in traditional ULAB smelting. From a waste perspective this is good because the desulfurisation done in a wet process beyond the slag formation zone of the process, and the resultant sulfur rich output (gypsum) has agricultural value as a product.

12.6.3 Alignment with the SWRRIP

The State-wide Waste and Resource Recovery Infrastructure Plan (SWRRIP) is the Victorian Government's 30-year plan for waste management and resource recovery, which provides a framework for a complementary set of regional waste and resource recovery implementation plans. Section 50C (1a) of the EP Act now requires applications for Works Approval, in relation to a waste management facility, to be assessed for consistency with the SWRRIP or a relevant Regional Waste and Resource Recovery Implementation Plan.

Table 4.1 of the SWRRIP lists types of resource recovery infrastructure. Chunxing's proposed ULAB recycling facility is not clearly identified, but we have assumed it be described under 'Other reprocessors', which sits under the broader heading of 'Reprocessing infrastructure: Infrastructure to recover materials and resources'.

Section 1.6.2 of the SWRRIP provides a decision making guide for regulatory processes such as Works Approvals, with five considerations (to be assessed in approvals as relevant). These considerations, and an assessment of Chunxing's compliance with them, is provided in Table 41.

Table 41: Consistency with SWRRIP assessment

SWRRIP consideration	Assessment of Chunxing proposal
Consistency with the SWRRIP vision, purpose, goals, long term directions and five year outcomes	Vision: Chunxing's proposal: • protects the community, environment and public health √ • recovers valuable resources from our waste √ • minimise long term costs to households, industry and governments √ Purpose: Chunxing's proposal: • reflects the principles of environmental justice √ • supports a viable resource recovery industry √ • reduces the amount of valuable materials going to landfill (or in this case valuable materials going offshore) √ Goals: Chunxing's proposal is consistent with Goals 2 and 3, while Goals 1 and 4 are not directly relevant to it. Long term strategic directions: Chunxing's proposal: • helps to maximize the diversion of recoverable materials from landfills √ • increases resource recovery √ • will access already consolidated quantities of ULABs for reprocessing √ • will manage ULABs in suitably located and zoned land √ • will maximise national ULAB economic outcomes, provide cost effective service delivery and reduce community, environment and public health impacts √ Five year outcomes: Chunxing's proposal assists in the achievement of the following 5-year outcome: • Material streams for recovery will be diverted from landfills (where appropriate) if it is economically viable and if it can improve community, environment and public health impacts. √ ***Meets SWRRIP consideration***
The capacity of existing infrastructure to manage the state's waste and materials streams and the impact of decisions on availability of suitably located and zoned land for this purpose.	• There is no operational ULAB management infrastructure in Vic and only one ULAB smelter in Australia - Australia sends around 60kt (almost half of the entire market) overseas as lead scrap for smelting • Chunxing is the second ULAB secondary lead smelter plant proposed in Victoria (the Hydromet facility in Laverton is licensed to operate) but the latter is not currently operational and does not appear to have plans to re-open • Chunxing is ideally located in Hazelwood North, Latrobe Valley IN2Z industrial zoning and well within the 500m buffer distance proposed for this type of plant in the EPA guideline, with 1.1km to the nearest sensitive receptor and over 2km to the nearest township

SWRRIP consideration	Assessment of Chunxing proposal
	Meets SWRRIP consideration
Consistency with the objectives of the hubs and spokes model for the provision of waste and resource recovery infrastructure.	Hub and spokes model not a consideration for ULAB collection and consolidation networks and management infrastructure as this waste stream operates in a national market with only three options for recycling management in Australia – only the Wagga Wagga facility conducting full recycling – and none of these facilities are in Vic. ***SWRRIP consideration not relevant***
The principles of environmental justice and evidence based decision making to maximise the positive and minimise the negative long term economic, community, environment and public health impacts of this infrastructure.	The process of best practice development and assessment in this application and the decision that the Authority will ultimately make in its assessment, are examples of environmental justice and evidence based decision making. ***Not a consideration unique to Chunxing***
The potential opportunities and inhibitors for recovering the waste streams.	ULABs already have very strong economic value and so collection and recovery is much less of a problem than the quality and recovery credentials of battery breaking-only plants, which conduct only one step of the recovery and recycling process. ***SWRRIP consideration not relevant***

12.6.4 Summary of best practice assessment for PIW generation

Noting that the Chunxing VSF technology option of ULAB (secondary lead) smelting can only realistically be compared with either battery breaking or rotary furnace ULAB (secondary lead) smelting, because other options are not sufficiently viable commercially, the best practice assessment for PIW generation clearly favours the Chunxing option. This is due to:

- Significantly lower slag volumes per tonne of Pb produced, relative to other smelting options
- Significantly lower Pb levels in this slag relative to other smelting options
- Increasing the Australian ULAB circular economy, by avoiding the export overseas of 50,000 tonnes of waste lead scrap
- The Chunxing technology rates high against the waste hierarchy because:
  - The business is a recycling operation
  - Four potential wastes are converted to saleable by-product streams: $ZnSO_4$, $(NH_4)_2SO_4$, HDPP chipped plastic and gypsum
  - Improves overall Australian environmental outcomes for ULABs by reducing the reliance on overseas export by as much as 50,000 tonnes/ yr
- It aligns with the State-wide Waste and Resource Recovery Infrastructure Plan, (SWRRIP) to the extent this policy applies to ULABs management.

13 Environmental management

The WAA Guideline requires relevant information to be provided if there is an environmental management system in place. Since the facility has not been built yet this question cannot be answered at this point.

The WAA Guideline requires relevant information to be provided if construction activities can potentially cause significant environmental impacts (dust and noise emissions, or discharging contaminated stormwater).

13.1 Non-routine operations

Table 42 outlines a high-level risk assessment of potential plant upset situations. This includes the various emergency situations or non-standard operating conditions that could potentially occur (identified risks), environmental impacts that could conceivably result from them, a high-level rating of the risk, proposed mitigation measures and finally a rating of residual risk post the implementation of these mitigation controls.

Table 42: Potential plant upset risk identification

#	Type of process upset risk	Likelihood of process upset occurring	Potential environmental impact	Measures to mitigate or reduce risk	Rating of risk to environment
1	Transport accident results in spill of ULABs enroute to site	Low	Pollution of water way from leaked battery acid/ lead compounds	All ULAB transport must occur using vehicles that hold EPA permits for transport of ULABs or other lead-containing waste. Extensive requirements exist for permitted vehicles, including tracking system recording. Battery packaging for transport adheres to the ABRI packaging standard for ULABs.	Low
2	Spillage or leakage from ULABs during unloading or storage	Medium	Pollution of water way from leaked battery acid/ lead compounds	All unloading and storage occurs in undercover building dedicated area which is fully bunded and drains to the waste water collection and treatment system. Spill can occur but environmental impact risk is negligible.	Low
3	Trucks leave site contaminated with lead from ULABs	Low	Pollution of water way from leaked battery acid/ lead compounds	All trucks are washed in the vehicle wash bay prior to departure from the site. This area is undercover, fully bunded and drains to the waste water collection and treatment system.	Low
4	External power failure	Medium	Discharge of untreated emissions	Thermal processes (melting, smelting and refining) operate on a batch basis so there is no more than 75 tonnes of lead paste material charged at any one time (equivalent to ~ $7m^3$). In the event of any system failure these thermal processes can be shut down within 15 minutes, limiting any potential for uncontrolled emission.	Low
5	Gas supply cut-off or burner failure	Medium	Incomplete chemistry in smelting process produces higher lead oxide emissions	Thermal processes (melting, smelting and refining) operate on a batch basis so there is no more than 75 tonnes of lead paste material charged at any one time (equivalent to ~ $7m^3$). In the event of any system failure these thermal processes can be shut down within 15 minutes, limiting any potential for uncontrolled emission. Pollution control equipment (electrically powered) would continue to operate regardless, further controlling emissions during smelting cooldown.	Low
6	High emission event due to unexpected process anomalies	Low	Higher emissions of various air pollutants	Entire plant is highly process-controlled, including CEMS. Warning signs of higher than expected pollutants in flue gas would trigger mitigation action responses quickly, including shutdown if necessary.	Low

#	Type of process upset risk	Likelihood of process upset occurring	Potential environmental impact	Measures to mitigate or reduce risk	Rating of risk to environment
7	Combustion oxygen failure in lance	Low	Incomplete chemistry in smelting process produces higher lead oxide emissions	Thermal processes (melting, smelting and refining) operate on a batch basis so there is no more than 75 tonnes of lead paste material charged at any one time (equivalent to ~ 7m^3). In the event of any system failure these thermal processes can be shut down within 15 minutes, limiting any potential for uncontrolled emission. Pollution control equipment (electrically powered) would continue to operate regardless, further controlling emissions during smelting cooldown. Entire plant is highly process-controlled, including CEMS. Warning signs of higher than expected pollutants in flue gas would trigger mitigation action responses quickly, including shutdown if necessary.	Low
8	Heat exchanger (cooling tower) fan failure	Low	Release of particulates to atmosphere due to damage to bag filters	Fan and baghouse temperature interlocked to shut down process. In the event of any system failure these thermal processes can be shut down within 15 minutes, limiting any potential for uncontrolled emission. Dual scrubbers would provide some reduction efficiency for particulates during short-term shutdown period.	Low
9	Lime dosing failure or blockage	Medium	Release of higher SO_2 levels to atmosphere	Process control would detect higher SO_2 and/or lime concentration anomalies and consequently shut down the smelting process. Scrubbers continue to operate during short-term shutdown periods with reliance on second scrubber in series. Further to these two scrubbers, as is the case for the China plant, additional scrubbing capacity is also available as backup pollution control, which is used to enable normal operations during planned shutdown and routine maintenance of mainline scrubbers, which must be cleaned from time to time.	Low
10	Baghouse over-temperature or failure	Medium	Release of untreated emissions to atmosphere	Interlocked to stop process and initiate further water cooling in chamber if necessary. In the event of any system failure these thermal processes can be shut down within 15 minutes, limiting any potential for uncontrolled emission. Dual scrubbers would provide some reduction efficiency for particulates during short-term shutdown period.	Low

#	Type of process upset risk	Likelihood of process upset occurring	Potential environmental impact	Measures to mitigate or reduce risk	Rating of risk to environment
11	Wastewater treatment plant failure or high rainfall event	Low	Additional releases to trade waste or potentially stormwater	There is a combined capacity of 640m^3 per day in the wastewater treatment/ recycling circuit, plus roof rainwater collection tanks totalling 150m^3 and 400m^3 stormwater storage pond. The system is designed to allow discharge of wastewater to sewer (within trade waste agreement parameter limits) in the event of an emergency, but this would only occur in a wastewater treatment plant overload or failure scenario. The site will have a trade waste agreement which will be redundant under normal operating conditions but could be called upon in emergency events.	Low
12	Onsite chemical spillages	Medium	Contamination of stormwater	All unloading, storage and chemical handling areas are within covered and enclosed buildings, with impermeable acid resistant concrete floors, drained to the onsite waste water treatment system. Storage, spill control, bunding and operation will be in accordance with relevant regulations and standards.	Low
13	Explosion/ fire	Low	Air pollution, spread of fire to nearby buildings	All Chunxing facilities and vehicles are provided with adequate fire and safety equipment. Full training will be given to all staff on induction and at regular intervals throughout the year. An automatic fire alarm and protection system will be in operation 24 hours a day.	Low
14	Lead exposure to workers beyond safe limits	Low	Short and long-term impacts on worker health	The potential for lead exposure to workers is common to mining, mine processing, smelting, casting, foundry and abrasives blasting industries. Consequently, strict health and safety requirements exist in Australia to minimise exposure in the work place: https://www.safeworkaustralia.gov.au/topic/lead. The China standards are identical to those in Australia (males must be <30 µg/dL and, if tested above, must be moved to a non-process-floor role until such time as their level drops below 20 ug/dL). The China plant tests staff routinely every 3 months and focuses on staff whose results are >20ug/dL. Actual recent blood testing results from 'on-floor' workers at the China plant show the lowest of 154 staff measured was 8.4 and the highest was	Low

#	Type of process upset risk	Likelihood of process upset occurring	Potential environmental impact	Measures to mitigate or reduce risk	Rating of risk to environment
				29.9, with the average at 23.7. All results were below the 30 µg/dL regulatory level, which was recently lowered from 50 ug/dL in Australia. Chunxing staff begin their shift by changing into new uniforms, which are then removed at the end of the shift, where showering and laundering occur onsite. Similar procedures apply for hygiene for breaks and meals during work hours. The plant is heavily automated. Key work areas are controlled by enclosure and negative pressure to minimise worker exposures. In addition, strict PPE requirements apply during work tasks. Lead blood tests are carried out before employees commence the work, one month after starting and at regular intervals thereafter. Chunxing's China plant's 'on-floor' workforce is all male, so they adopt the 30 µg/dL safe level. Workers with blood lead levels above this will be removed from lead-risk work until such time as these levels drop well below them, with regular monitoring to determine this. There are strict rules under company policy on smoking, alcohol and drug using which will also be monitored in the premises.	

In addition to fire risks, which are discussed in Section 12.5.4, Table 42 indicates some risks that have the potential for impacts offsite. Two of these, both plant failure emission scenarios are considered below.

13.1.1 Baghouse failure (high lead emission scenario)

The baghouse is a component of the pollution control system whose primary function is to filter dust particles from the air stream exhausted by the smelting furnace. Lead, like most of the other heavy metals that may be present from smelting, will be there in solid form as part of those particles. So the baghouse plays the most significant role in the pollution control system in maintaining extremely low lead emissions.

One plant upset scenario is that the baghouse fails, allowing uncontrolled emissions to pass through the baghouse into the scrubbers, which will act as secondary pollution control, followed by elevated emissions escaping to the atmosphere from the stack. The likelihood of this event is extremely low because the CEMS system monitors for particles in the exhaust stream constantly, in real time, and anomalous results are linked to actions that would initiate closer inspection and maintenance procedures. Very high results from the CEMS system would result in automatic controls such as gas cut-off and plant shutdown.

In the scenario of complete baghouse failure, the plant would automatically shut down via gas cut-off. It takes approximately 15 minutes for molten material in any of the furnaces to cool to solid, eliminating further emissions. The calculations below estimate and model what could occur in those 15 minutes, in the case of lead, since this is the major particulate species of concern and particulates themselves (without speciation of the chemicals within them) do not have workplace exposure limit concentrations to compare to.

- Figure 9 shows that the baghouse inlet concentration of exhaust gas is approximately 5,000 mg/m^3 in lead. This would pass straight through to the scrubbing system.
- While designed primarily for gaseous pollutants such as SO_2, wet scrubbing systems are also reasonably effective particulate removal controls[45], with removal efficiency estimated by US EPA to be 90% for particulate matter greater than 5µm, and 60-80% for particulate matter between 3-5µm. Since dust from the furnace would be a mixture of particle sizes, we have assumed the poorest removal efficiency would apply (60%).
- Assuming no further control occurs, the emission from stack during this 15 minute upset window would be:
    - Stack flow rate (664 m^3/min) x emission of Pb (5,000 mg/m^3) x 0.4 (post-scrubber control) x 60 (min in an hour)) ÷ 1,000,000 (mg in a kg) = 80 kg/hr
    - Plugging this emission into the model gives a worst case ground level concentration of lead of 0.38 mg/m^3 during these 15 minutes
- Since this is a short-term exposure event, the most appropriate standards to apply are workplace exposure standards. The 8-hour Time-weighted average (TWA) is

[45] US EPA (2002), *EPA/452/B-02-001 Section 6 Particulate Matter Controls, Chapter 2 Wet Scrubbers for Particulate Matter*, available at: https://www3.epa.gov/ttn/catc/dir1/cs6ch2.pdf

used by Safe Work Australia as a chemicals exposure standard for workers, and is defined as:

- "the maximum average airborne concentration of a substance when calculated over an eight-hour working day, for a five-day working week."[46]

- The 8-hr TWA for lead is 0.15mg/m^3
- Converting the 15 minute window into an 8 hour equivalent exposure period for this event: 0.38 mg/m^3 (15 minutes) ÷ 32 (8 hr ÷ 0.25 hr) = 0.012 mg/m^3, which is just 8% of the TWA.

Consequently, a baghouse failure scenario (with respect to lead emissions) would have negligible impact on plant workers or adjoining businesses, since it would be so far below the workplace exposure limits set assuming exposure was occurring across a 5-day working week, and would occur for such a short duration. The impact would also be negligible to nearby residents, located at least 1.5km away, since the resulting ground level concentrations in that 15-minute window would be an order of magnitude lower again.

13.1.2 Total scrubber system failure (high sulfur dioxide emission scenario)

The scrubber system is a component of the overall pollution control system whose primary function is to adsorb and trap gaseous pollutants such as SO_2 and sulfuric acid mist from the air stream exhausted by furnaces and previously passed through the baghouse.

One plant upset scenario is that the scrubber system fails, allowing un-scrubbed emissions to pass directly to the stack, resulting in elevated emissions escaping to the atmosphere. The likelihood of this event is extremely low because the CEMS system monitors for SO_2 in the exhaust stream constantly, in real time, and anomalous results are linked to actions that would initiate closer inspection and maintenance procedures. Very high results from the CEMS system would result in automatic controls such as gas cut-off and plant shutdown.

In the scenario of complete baghouse failure, the plant would automatically shut down via gas cut-off. It takes approximately 15 minutes for molten material in any of the furnaces to cool to solid, eliminating further emissions. The calculations below estimate and model what could occur in those 15 minutes, in the case of SO_2, since this is the major gaseous species of concern.

- Figure 9 shows that the scrubber inlet concentration of exhaust gas is approximately 12,000 mg/m^3 in SO_2. This would pass straight through and out of the stack.
- Assuming complete failure of the entire scrubbing system, and therefore no control whatsoever, the emission from stack during this 15 minute upset window would be:
  - Stack flow rate (664 m^3/min) x emission of SO_2 (12,000 mg/m^3) x 60 (min in an hour)) ÷ 1,000,000 (mg in a kg) = 478 kg/hr
  - Plugging this emission into the model gives a worst case ground level concentration of SO_2 of 2.4 mg/m^3 during these 15 minutes

[46] Safe Work Australia (2013), *Workplace exposure standards for airborne contaminants*, available at: https://www.safeworkaustralia.gov.au/system/files/documents/1705/workplace-exposure-standards-airborne-contaminants-v2.pdf

- Since this is a short-term exposure event, the most appropriate standards to apply are workplace exposure standards.
  - The 8-hour Time-weighted average (TWA) is used by Safe Work Australia as a chemicals exposure standard for workers, and is 5.2 mg/m^3 for SO_2 [46]
  - The short-term exposure limit (STEL) is another measure used by Safe Work Australia, which is defined as the "time-weighted average maximum airborne concentration of a substance calculated over a 15 minute period." The STEL for SO_2 is 13 mg/m^3 (note there is no STEL set for lead).
- Direct comparison shows the upset emission of SO_2 (2.4 mg/m^3) to be comfortably below the 15-minute STEL (13 mg/m^3)
- Converting the 15 minute window into an 8 hour equivalent exposure period for TWA comparison: 2.4 mg/m^3 (15 minutes) ÷ 32 (8 hr ÷ 0.25 hr) = 0.075 mg/m^3, which is just 1% of the TWA.

Consequently, a complete scrubbing system failure scenario (with respect to SO_2 emissions) would have negligible impact on plant workers or adjoining businesses, since it would be well below relevant short-term exposure limits. The impact would also be negligible to nearby residents, located at least 1.5km away, since the resulting ground level concentrations in that 15-minute window would be an order of magnitude lower again.

13.1.3 Plant monitoring and maintenance

The scheduled shutdown for general plant maintenance will be approximately 30 days per year, or near one day per fortnight inclusive of a longer full maintenance shutdown once per year. The plant's online monitoring and process control software manages performance checks during plant operation.

13.2 Construction impact management

Construction of the proposed facility will be undertaken in accordance with the Construction Environmental Management Plan (CEMP), and the conditions of the Council planning permit.

Given the >1km buffer zone in all directions it is unlikely that there will be significant environmental impacts from construction, such as from road and construction dust, noise of machinery or discharge of contaminated stormwater. Regardless, since dust and noise accompany all construction activity to some extent, a CEMP will be developed to control, manage and monitor for these impacts. The CEMP will summarise all construction activities, potential environmental risks and controls that will be applied to manage those risks.

The CEMP will be developed in accordance with relevant aspects of EPA's Environmental Guidelines for Major Construction Sites (1996)[47], noting that this publication is aimed at large scale infrastructure projects, and will follow specific guidance about managing any sediment run-off from EPA publication 275[48].

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[47] EPA Victoria (1996), *Environmental Guidelines for Major Construction Sites*, available at: https://www.epa.vic.gov.au/~/media/Publications/480.pdf

[48] EPA Victoria (1991), *Construction techniques for sediment pollution control*, available at: https://www.epa.vic.gov.au/our-work/publications/publication/1991/may/275

Construction activities will be confined to between 7.00am and 6.00pm Monday to Friday and 8.00am to 1.00pm Saturdays. No work will be undertaken on Sundays or public holidays.

Management of any contaminated soil will be in accordance with the CEMP, and will involve full compliance with EPA Victoria's prescribed industrial waste (soil) classification procedures, including laboratory contaminant testing, categorisation within the prescribed industrial waste (A,B,C) framework and waste transport via permitted vehicles to licensed receivers under waste transport certificates.

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SECTION 3 – OTHER APPROVALS

14 Seeking other EPA approvals

Chunxing does not seek to apply for Commissioning Approval as part of this Works Approval application, since this is a greenfields project with a number of planning, pre-construction and construction stages to work through prior to the need for such approval.

Upon receipt of EPA approval for the works, construction planning and preparation will commence. Once construction has begun Chunxing will contact EPA again to discuss the elements of a Commissioning Plan that will need to be developed. From this an application for Commissioning Approval will be sought.

Chunxing will apply for an operational licence after completing site construction and plant installation, prior to commencement of operations.

15 Post decision – operational requirements

Since Chunxing's secondary lead (ULAB) smelting operation is EPA schedule category *I02 Metal Melting Works*, and it is not A01, A05, G04, L02 or L04, financial assurance is not required.

Chunxing will not store, handle, use or transport PCBs so is not required to prepare a PCB EIP.

A subsequent operational licence will require a monitoring program to be developed, which will allow assessment of environmental management at the site. Monitoring will focus on air pollutant emissions. This monitoring program will be developed as part of the future licence application process, and will be informed by the Commissioning Plan and the monitoring results that come out of its implementation.

Once an operating licence is successfully obtained, Chunxing will have a requirement to prepare an annual performance statement (APS). The APS will allow demonstration of compliance with each licence condition or how any non-compliance incidents have been handled.

Appendix A

ASIC company search – certificate of incorporation

ASIC
Australian Securities & Investments Commission

Australian Company

CHUNXING CORPORATION PTY LTD
ACN 632 456 538

Extracted from ASIC's database at AEST 15:07:03 on 07/11/2019

Company Summary	
Name:	CHUNXING CORPORATION PTY LTD
ACN:	632 456 538
ABN:	50 632 456 538
Registration Date:	25/03/2019
Next Review Date:	25/03/2020
Status:	Registered
Type:	Australian Proprietary Company, Limited By Shares
Locality of Registered Office:	CHATSWOOD NSW 2067
Regulator:	Australian Securities & Investments Commission

Further information relating to this organisation may be purchased from ASIC.

07/11/2019 AEST 15:07:03 1

Appendix B

Siting information

B1 Locality plan

B2 Land zoning report

Proposed site: CA 2047 Fourth Rd, Hazelwood North
(part of the previous Lurgi Coal Gasification Plant site, redeveloped as part of the Gippsland Heavy Industry Park Infrastructure Project)

Department of
Environment, Land,
Water and Planning

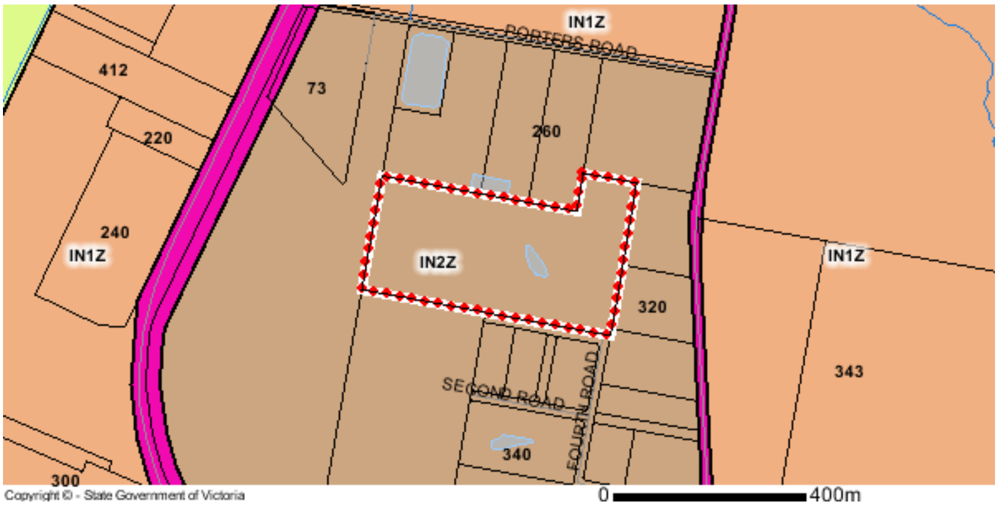
Planning Property Report

from **www.planning.vic.gov.au** on 24 October 2018 04:26 PM

Address: FOURTH ROAD HAZELWOOD NORTH 3840
Crown Description: Allot. 2047 PARISH OF HAZELWOOD
Local Government (Council): LATROBE **Council Property Number:** 55744
Directory Reference: VicRoads 97 H6

Planning Zone

INDUSTRIAL 2 ZONE (IN2Z)
SCHEDULE TO THE INDUSTRIAL 2 ZONE (IN2Z)



Note: labels for zones may appear outside the actual zone - please compare the labels with the legend.

Zones Legend

- ACZ - Activity Centre
- B1Z - Commercial 1
- B2Z - Commercial 1
- B3Z - Commercial 2
- B4Z - Commercial 2
- B5Z - Commercial 1
- C1Z - Commercial 1
- C2Z - Commercial 2
- CA - Commonwealth Land
- CCZ - Capital City
- CDZ - Comprehensive Development
- DZ - Dockland
- ERZ - Environmental Rural
- FZ - Farming
- GRZ - General Residential
- GWAZ - Green Wedge A
- GWZ - Green Wedge
- IN1Z - Industrial 1
- IN2Z - Industrial 2
- IN3Z - Industrial 3
- LDRZ - Low Density Residential
- MUZ - Mixed Use
- NRZ - Neighbourhood Residential
- PCRZ - Public Conservation & Resource
- PDZ - Priority Development
- PPRZ - Public Park & Recreation
- PUZ1 - Public Use - Service & Utility
- PUZ2 - Public Use - Education
- PUZ3 - Public Use - Health Community
- PUZ4 - Public Use - Transport
- PUZ5 - Public Use - Cemetery/Crematorium
- PUZ6 - Public Use - Local Government
- PUZ7 - Public Use - Other Public Use
- PZ - Port
- R1Z - General Residential
- R2Z - General Residential
- R3Z - General Residential
- RAZ - Rural Activity
- RCZ - Rural Conservation
- RDZ1 - Road - Category 1
- RDZ2 - Road - Category 2
- RGZ - Residential Growth
- RLZ - Rural Living
- RUZ - Rural
- SUZ - Special Use
- TZ - Township
- UFZ - Urban Floodway
- UGZ - Urban Growth
- Urban Growth Boundary

Railway | Tram | River, stream | Lake, waterbody

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Appendix C

Responses to issues and concern raised by stakeholders

The following issues and concerns (noted in bold) have been raised by community stakeholders during consultation meetings and discussions. Responses are provided below each issue.

The issues are divided into two categories:

- those raised by concerned residents and other stakeholders that have interacted with Chunxing via community forums, meetings, emails or other conversations
- those raised directly by the Action Group, formed in opposition to the proposal, through their information campaigns in the media, their distributed documentation or at the community meetings (where Chunxing was asked not to attend).

C1 Responses to issues raised by the broader community

1. Concerns raised (from cautious to serious) about lead emissions and their impact on health

Lead exposure can occur via ingestion (food and water), adsorption (due to the direct handling of lead or lead products) or inhalation from lead in the air. Lead is perhaps the most scrutinised emission for this type of plant, given that this metal is the target of recovery in secondary lead smelting, and is long-understood to result in serious health effects at high enough levels of exposure.

It is for these reasons that both regulatory controls and the design of the Chunxing plant (for the protection of workers, nearby people and ecological values) place heavy scrutiny on lead emissions.

The emissions data (at the stack's point of release) presented in the EPA Works Approval application show that the Chunxing plant, once operational, would make up only 1.2% of emissions of lead contributed by large industrial sources in the Latrobe Valley. The vast majority is emitted from coal-fired power generation. This is despite the fact that the Chunxing facility is focused entirely on lead recovery.

Emissions tell only one side of the story, because this occurs at a height and air flow rate; what matters more is the net result of that emission – the predicted ground level concentrations that arise due to the plant's emission. Air quality modelling takes emission inputs and simulates what happens to an emission plume, under a range of meteorological, terrain, environmental and chemistry factors, to ultimately predict what ground level concentrations would result.

The summary of the air quality modelling assessment is that the highest (worst case) ground level concentrations predicted to occur at any point in the domain, for all pollutants modelled, are significantly within Design Criteria limits, typically by a factor of 50 to >100 times. In the case of lead, the worst case ground level concentration identified at any hour in the five years, and within any part of the study domain is 0.000009 mg/m^3 or just 0.31% of the Design Criteria.

These estimates reduce by an order of magnitude at the nearest residence, since dilution of the plume occurs quickly within the first few hundred metres of the emission point. The worst case ground level concentration at the closest sensitive receptor (1.5km away from stack) is 0.000002 mg/m^3 or 0.07% of the Design Criteria.

These results are extremely low, to the point of being beneath the levels of detection of field monitoring instruments. To put it in perspective, the plant's emissions at this 1.5km distance could be 1,500 times higher (in lead) before the EPA limit to protect human health would be breached. Put another way, in theory at least, 1,500 identical (50,000 tonne) Chunxing plants could be placed at that particular location before lead Design Criteria levels were exceeded at the nearest residence or school.

Victoria, like other states, phased out lead in petrol - the regulatory ban was from the end of 2001, but emissions had been progressively lowering since the introduction of the catalytic convertor in 1986. By 2002, according to the Victorian Auditor General "levels of lead in the

Latrobe Valley are so low that it is no longer monitored on an ongoing basis."[49] Prior to the phase out they were as high as 0.001 mg/m^3 in ambient air in Melbourne and Adelaide in the 1980s, or anywhere where car traffic densities were high. By the early 2000s these ambient levels had dropped to as low as 0.00002 mg/m^3 [50], which prompted all states and territories to discard the requirement for ambient air quality monitoring of lead.

Current day monitoring data for lead in the Latrobe Valley is not available, but data exists for the cities. The worst-case emission-hour predicted to occur at the closest sensitive receptor point 1.1km away from the Chunxing Hazelwood North plant (0.000002 mg/m^3) would still be 10-fold lower than 2003 ambient levels in Melbourne, Adelaide and likely any other Australian capital, levels deemed too low to continue regulatory monitoring.

As a final means of comparison, levels of emission of lead at the nearest sensitive receptor can be compared to other exposure routes, such as simply eating or drinking.

Potential lead intake via breathing ambient air at the closest residence

The worst case ground level concentration at the closest sensitive receptor (1.1km away) is 0.000002 mg/m^3.

The average adult, when resting, inhales and exhales about 7 or 8 litres of air per minute[51]. That totals about 11,000 litres of air per day, or 11m^3. At 0.000002 mg/m^3 lead, this equates to a theoretical maximum of 0.00002 mg of lead inhaled from breathing per day at the closest residence.

Chunxing lead intake at closest residence v potential intake via drinking water

Gippsland Water advises that lead can be present in drinking water as a result of dissolution from natural sources or from household plumbing. Based on health considerations in the Australian Drinking Water Guidelines, concentrations of lead in drinking water should not exceed 0.01 mg/L. Gippsland Water sites achieved this 100% of the time in 2015-16 for all customer tap sites. Gippsland Water's 2015-16 Annual Report on Drinking Water Quality[52] did however report instances of measurable lead levels in drinking water supplies in 2015-16. A maximum level of 0.002 mg/L was measured for a town supply very close to the plant location.

Health authorities commonly recommend drinking about eight 8-ounce glasses of water a day, which equals about 2 litres. If this was from a supply at 0.002 mg/L lead, this would equate to 0.004 mg of lead ingested per day from drinking tap water at this level. Comparing this to breathing air at the closest residence (a maximum of 0.00002 mg of lead inhaled per day)

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[49] Auditor General Victoria (2002), *Managing Victoria's air quality*, available at: https://www.parliament.vic.gov.au/papers/govpub/VPARL1999-2002No155.pdf

[50] Environment Protection Authority Government of South Australia (2003), *Future Air Quality Monitoring for Lead in Metropolitan Adelaide - a report to the National Environment Protection Council*, available at: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwiuoZmm_8_jAhVB7XMBHYhxAVoQFjAAegQIARAC&url=https%3A%2F%2Fwww.epa.sa.gov.au%2Ffiles%2F477255_lead_aq_report.pdf&usg=AOvVaw3Y0hIDlkQA9qaxGjMRxnKl

[51] Sharecare medical health website, available at: https://www.sharecare.com/health/air-quality/oxygen-person-consume-a-day

[52] Gippsland Water 2015-16 Annual Report on Drinking Water Quality, available at: https://www.gippswater.com.au/application/files/7114/7752/4332/SDWA_Annual_Report_on_Drinking_Water_Quality_2015-2016_.pdf

suggests that the impact 1.1km from the Chunxing plant is potentially greater from drinking town water at the recommended daily rate, potentially by as much as 200 times.

It is important to stress that drinking water in the Latrobe Valley, like most places in Australia, is very safe, is not contaminated in lead and was measured to contain levels of lead well below health standards 100% of the time during 2015-16. This example illustrates how low the Chunxing-derived air lead ground level concentration is at these locations, not how high drinking water is contaminated.

Chunxing lead intake at closest residence v potential intake via food

Diets vary widely but, since our lifestyle and environment is not utopian, some levels of heavy metals such as lead can be present in foods we eat, albeit at exceedingly low levels. The US Agency for Toxic Substances and Disease Registry (ATSDR), via the Food and Drug Administration (FDA), has set an action level of 0.5 µg/dL (5 µg/L) for lead in food products intended for use by infants and children and has banned the use of lead-soldered food cans. These levels are based on FDA calculations of the amount of lead a person can consume without ill affect.

American Dietary Reference Intake (DRI) suggests a protein intake for the average sedentary man of 56 grams per day, and 46 grams per day for the average sedentary woman[53]. Obviously there are many other components of diet than proteins, but lead has been reported as present in raw protein rich foods such as milk, eggs, neat and fish[54], at least in decades past.

Given that the ATSDR/ FDA level for foods for infants and children is very stringent, this figure is assumed as the maximum that can be legally present in food. If only the protein component of food intake is considered and assuming food density of 1kg/L, then a legal maximum of lead that could be consumed in this part of an average diet would be:

0.051 kg (protein) x 5 µg (lead)/kg (protein) = 0.255 µg lead = 0.000255 mg lead per day (legal maximum). This is 13 times higher than amount taken in from breathing (0.00002 mg) at the nearest residence (1.1km from the plant).

In other words, fully safe and legal consumption of food could result in ingesting lead at a daily rate more than 10 times that from breathing air at the nearest residence. As with the example of ingesting lead from drinking, this comparison is not to infer there is anything whatsoever wrong or unsafe with eating food (in terms of lead impacts), rather to illustrate how low the risk is from the maximum level of lead modelled in the air 1.1 km from the Chunxing operation.

2. Disbelief in the modelling data/ meteorological data

All air quality modelling has followed strict EPA protocols, including the use of the EPA approved model (AERMOD), the use of five years of local meteorological data (often one year is deemed sufficient), terrain files and the inclusion of background data from the nearest ambient monitoring station that had been operating for the full duration of the assessment period (Morwell East).

[53] Healthline.com website, available at: https://www.healthline.com/nutrition/how-much-protein-per-day
[54] Jelinek CF, *Levels of lead in the United States food supply*, J Assoc Off Anal Chem. 1982 Jul;65(4):942-6, available at: https://www.ncbi.nlm.nih.gov/pubmed/7118801

The process of air quality modeling is incredibly conservative. Regulatory comparisons are made using the worst-modelled ground level concentration – a single hour's result out of 43,800 discrete hours of data across the five year period, spread across a 5km x 5km geographical study area (438 million data points, for each pollutant modelled). This is rarely reached, but the assessment practice is to take this worst-case figure and assume it was occurring 24 hours a day every day, and compare it against the Design Criteria level of the SEPP(AQM) (the regulatory limit).

All emissions modelled meet the Design Criteria with a large margin of comfort, with results ranging from 0.01% (of the Design Criteria) for antimony through to 3.99% for arsenic.

3. Impacts on students of the Hazelwood North Primary School (located 1.6km away)

See response to '1', in particular the analysis of ground level concentrations at the nearest sensitive receptor (1.5km away). The Hazelwood North Primary School is 2km away (from the stack emission point), and the worst-case emission-hour predicted to occur at the school is 0.000002 mg/m^3 for lead, which is equivalent to other sensitive receptors discussed under '1'.

This level, like all other worst case ground level concentrations predicted near sensitive receptors, are indistinguishable from background levels and therefore negligible. For comparison purposes, the Australian Government Department of Energy and the Environment notes that:

> *"the natural concentration of lead in the air is less than 0.1 microgram per cubic metre."*

At 0.002 microgram per cubic metre, worst case lead levels in the surrounds of the school are not only negligible with respect to health standards and existing background, but orders of magnitude below what the Australian Government's chemicals management section deems to be "natural" levels of lead in the air.

4. How can we trust your emissions estimates – where is the accountability to ensure they are right?

The Hazelwood facility's emissions are modelled to be orders of magnitude below EPA standards (Design Criteria). Should EPA provide Works Approval, it will be for the facility to perform to the actual emission levels modelled by this application, not the higher levels of the Design Criteria.

Once the plant is built it must go through a second EPA process – the Commissioning Approval process. This is where actual emissions performance must be demonstrated to meet the levels that the Works Approval predicted. If the plant cannot perform to this level then is simply cannot operate, and no licence to operate will be given by EPA. This commissioning stage is the built-in regulatory accountability to the Works Approval. In addition, there will also be licence limits set to ensure ongoing emissions performance, which require monitoring against and reporting back to EPA on a routine basis.

As further levels of accountability, Chunxing has committed to provide its in-stack monitoring data live online, as well as set a network of independent air monitoring stations in the community to also be made available online in real time.

5. How can we trust emission monitoring data from China – "the Chinese have been known to disregard the environment"

Air emission regulations in China are similar to those in Victoria. These have become substantially more stringent since China has moved to clean up the air in its highly polluted cities over the last decade or so. The Chunxing plant in China must meet these requirements.

To do so, they get an independent stack testing sampler and laboratory to take quarterly stack samples for a range of air quality parameters, which are then compared with their licence limits. In their three years of operation they have always met these limits. This quarterly monitoring regime also includes testing of air, noise and water quality at the facility's boundary points and in four residential areas to the points of the compass.

All test data has been provided with this application, translated by EPA's nominated certified translation body, and all laboratory certification provided by the independent stack tester in China has also been provided, as translated by EPA's nominated certified translation body.

6. Concern that no additional 'factories' were welcome in the area, regardless of their impacts

This is not a criteria that is weighted towards environmental assessment, so no response is provided.

7. Why does this sort of activity have to be built here – can't it be done overseas?

The location of the proposal was based on many factors, as described in the Works Approval application. Australia's current ULABs are either sent to the ULAB smelter in Wagga Wagga or sent overseas, usually via 'battery breaker' plants located in NSW and Qld, who export lead scrap rather than whole batteries.

Australia is a signatory to the international (multilateral environmental agreement) known as the Basel Convention. One of the aims of the convention is that countries should manage the hazardous waste they produce in an environmentally sound manner, preferably within their boundaries and that export should only occur under strictly permitted conditions and not to developing countries. Recycling of ULABs via environmentally permitted secondary smelting is not only environmentally sound but ensures that lead does not enter the environment in levels that could cause both short and long-term harm. The economics of lead enable this recycling to be commercially viable.

Australia, as a first-world country, is obligated to manage its own wastes, wherever that is technologically possible. Having capable infrastructure onshore is vital in the event of situations like the China Sword decision to halt imports of waste, such as Australia's, which left the Australian (non-hazardous) waste recycling market is disarray, resulting in greater volumes of recyclables going to landfill. Should a similar situation occur for ULABs, the consequences of landfilling or otherwise uncontrolled dumping of ULABs could be environmentally disastrous.

8. Concern about the cumulative impact of lead pollution: collecting on rooves, drinking water, land contamination

EPA's Design Criteria are set protect human health against impacts from breathing pollutants such as lead in ambient air. These take into effect cumulative impacts, as they are predicated on that exposure occurring 24 hours a day for a lifetime.

Emissions from the Chunxing plant are modelled to be so low at sensitive receptor locations that they would be indistinguishable from current background concentrations. This means that, due to the combination of low emissions and large atmospheric dilution, cumulative levels falling on surfaces such as rooves and soil in residential locations will be too low to be measurable.

To quantify this assertion, actual modelled emissions can be calculated as cumulative deposition over a time period, assuming all emissions (of lead for the sake of the exercise) ultimately fall out of the air and land on the ground. From the plume plots from the model, it is assumed that:

- 80% of all air emissions fall to ground within 400m of the stack (within the facility boundary in the east, west and south directions)
- the remaining 20% of air emissions fall to ground between 400m of the stack and 2km from the stack
- no further emissions at all deposit beyond the 2km radius
- all lead remains in the top 150mm of soil.

Calculating the volume of soil impacted within the first 400m radius (πr^2 x 0.15m), and then the remaining soil volume (subtracting the 400m radius volume from the 2km radius volume) gives the following:

- 16.6kg Pb x 80% ÷ 117,825 m^3 = 0.11 mg/kg of Pb deposited in the soil per year, predominantly within the facility boundary
- 16.6kg Pb x 20% ÷ 1,767,375 m^3 = 0.0019 mg/kg of Pb deposited in the soil per year, outside the facility boundary up to 2km from the stack
- Zero Pb deposited in the soil per year, outside 2km from the stack.

The National Environment Protection Measure for Assessment of Contaminated Sites (Contaminated Soil NEPM) contains soil investigation levels for lead. Taking a sensitive land use, such as a childcare or kindergarten facility, the soil investigation levels for lead is 600 mg/kg.

Summarising this information, over a 20-year lifetime of the plant, approximate levels of lead added to soil outside the facility boundary would be 0.04mg/kg on top of what was existing background, which is 0.006% of the Contaminated Soil NEPM's soil investigation level (600 mg/kg) for childcare facilities. This level is negligible.

9. Impacts to property prices

It is difficult to answer this question as it is neither within the expertise of the author or part of the assessment of environmental impacts. The Chunxing plant will be a state of the art industrial facility so will look somewhat different to the older industrial premises nearby.

An artist's impression of the facility is provided in Figure 25.

10. Visual impacts

The Chunxing plant will be a state of the art industrial facility so will look somewhat different to the older industrial premises nearby. An artist's impression of the facility is provided in Figure 25.

11. Concerns about fire risk and plant malfunction risks, such as explosion

The raw materials used for secondary lead smelting, including the lead-acid batteries themselves, are not flammable. The plant will use natural gas to fire the furnaces however. Concerns about plant malfunction impacts are described the Works Approval application (Section 13.1) using a potential plant upset risk identification process. These are controllable and minor, because:

- The thermal aspects of the plant are batch-driven (not continuous), which means the scale of any one production batch is relatively small, and repeated over and over. Furnaces are dimensionally small compared to plant like power station boilers, which allows processes to be stopped rapidly (immediate switching off of gas fuel) in the event of a problem, and processes brought to cool (ambient) temperatures quickly.
- Plant processes occur in highly automated and fully enclosed environments, which limits the possibility of manual intervention/ mistakes, as well as provides higher levels of safety and lower levels of exposure to plant staff.

Section 12.5.4 conducts an assessment specific to fire risk.

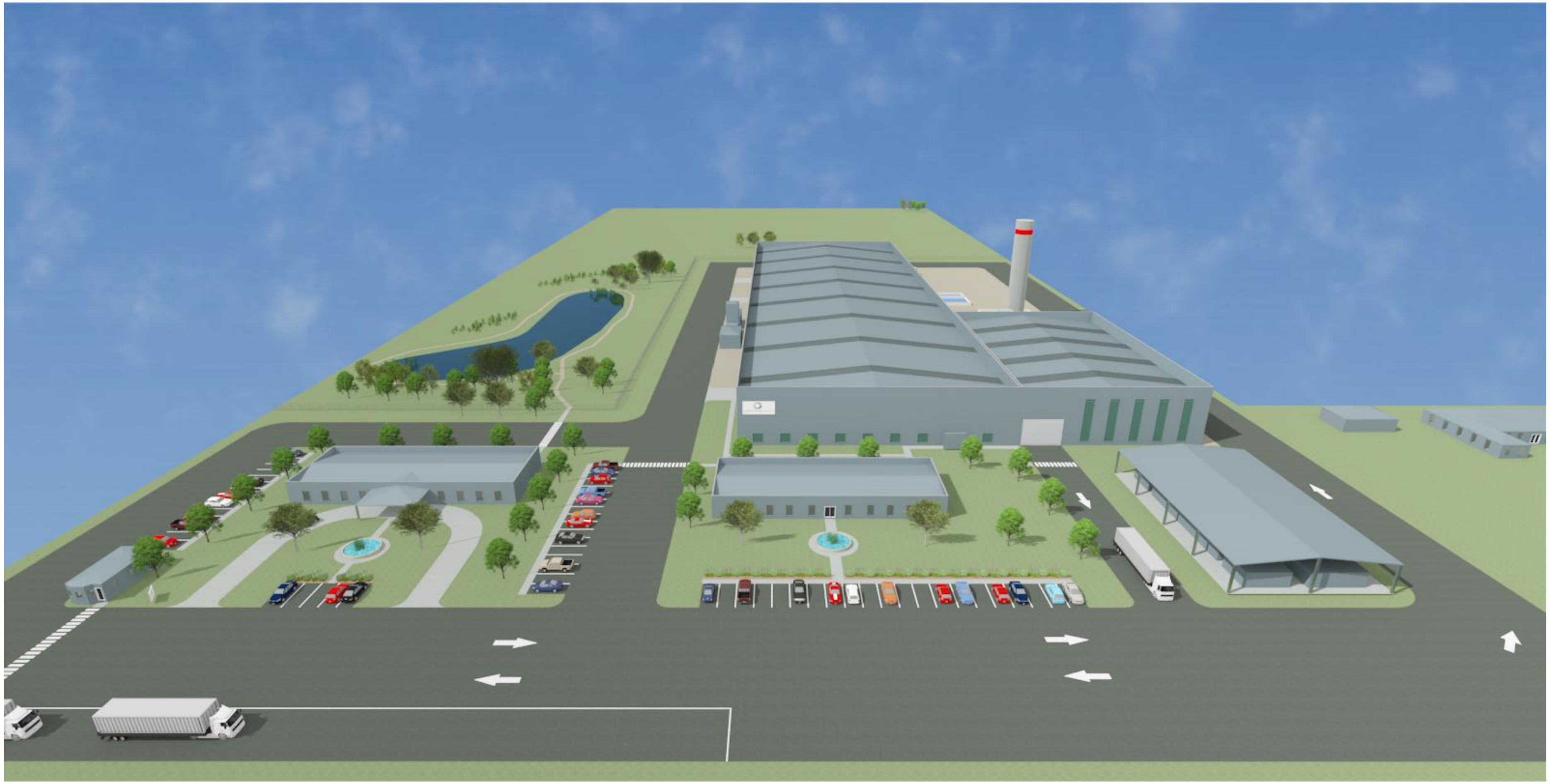

Figure 25: Artist's impression of the Hazelwood North facility (viewed from the east)

12. Concerns about worker health at the facility

Worker health and safety does not directly form part of this (environmental) assessment. However, the Works Approval Application's plant upset risk identification process identifies worker health impacts from lead as a risk.

The potential for lead exposure to workers is common to mining, mine processing, smelting, casting, foundry and abrasives blasting industries. Consequently, strict health and safety requirements exist in Australia to minimise exposure in the work place: https://www.safeworkaustralia.gov.au/topic/lead.

Chunxing staff begin their shift by changing into new uniforms, which are then removed at the end of the shift, where showering and laundering occur onsite. Similar procedures apply for hygiene for breaks and meals during work hours.

The plant is heavily automated. Key work areas are controlled by enclosure and negative pressure to minimise worker exposures. In addition, strict PPE requirements apply during work tasks.

Lead blood tests are carried out before employees commence the work, one month after starting and at regular intervals thereafter. Chunxing adopt a safe level of 2 µg/dL, which is significantly lower than levels required by SafeWork Australia. Workers with blood lead levels above this will be removed from lead-risk work until such time as these levels drop well below them, with regular monitoring to determine this.

There are strict rules under company policy on smoking, alcohol and drug using which will also be monitored in the premises.

13. Can local landfills manage the wastes that will come out of this facility?

Yes. It is likely that most of the waste (the slag) will need to be sent to Suez's Lyndhurst Category B prescribed industrial waste landfill. Both the waste's hazard and volume are well within the capability and capacity of this facility. Waste volumes are low compared to comparable operations elsewhere, such as from the facility in Wagga Wagga.

14. Seeking assurance that community monitoring will be carried out (of operating plant) and that it will be made available online

Potential pollutants such as SO_2, N_2O, and particulates from the melting, desulfurisation, smelting and refining processes are monitored through a continuous emissions monitoring system (CEMS). Since lead is emitted in solid form there is a direct relationship between dust (particles) measurement/ emission and lead emission.

In addition, the above pollutants and others such as sulfuric acid mist, chromium, arsenic, cadmium, antimony and dioxins are measured on a quarterly or annual basis at the China plant, by independent stack testing samplers and laboratories, with reporting required against compliance with local environmental limits. The same monitoring approach will apply to the Hazelwood plant.

Chunxing have committed to providing real time access to the CEMS monitoring data online to the public. They are also investigating the possibility of deploying community monitoring stations in the local area around the site, accessible by the public online, which could measure for lead and other pollutants of concern. One option to enable this is to collaborate with an existing resource, such as EPA monitoring stations (EPA AirWatch)[55], Latrobe Valley Air Monitoring Network (LVAMN)[56] or the recently established Latrobe Valley Information Network (LVIN)[57].

15. Traffic impacts to Tramway Road: current road condition, fog, impacts on a currently busy road.

Traffic impacts from the project are discussed briefly in the EPA Works Approval application. They will be considered in more detail at the planning permit stage, with a Traffic Impact Assessment required to be provided as part of the application.

Total trucks that would arise from the operational phase of the plant are estimated at 12 per day. For comparison purposes, Paper Australia's Energy from Waste Works Approval Application Health Impact Assessment[58] estimated an additional 100 vehicles per day from that project once operational. The assessment concluded that, at this rate of truck movements, ""… the number of vehicles added by (the energy from waste) development will have a minimal traffic impact upon the local road network" and that "… no significant reduction in travel times is expected". The estimate for Hazelwood is 10-fold below that estimated for Paper Australia's EfW plant.

Since battery volumes will be coming from Melbourne they will travel on the Princes Freeway then are likely to turn onto Monash Way, Firmins Ln, Tramway Rd and finally turn right onto Fourth Rd.

16. What is the source of the water for use in the plant?

The primary source of water is recycled from the onsite wastewater treatment system, which is fed by the liquids in the batteries themselves (about 12-15% of the ULAB is dilute sulfuric acid) and collected rain and stormwater on the site. If there is a requirement excess to what is available from the recycling circuit it will be drawn from mains supply, but this is not expected to exceed 5m^3 per day (equivalent to less than 10 households' water use). This could occur during prolonged dry spells.

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55 https://www.epa.vic.gov.au/our-work/monitoring-the-environment/epa-airwatch

56 http://lvamninc.com.au

57 https://lvin.org/#/

58 Environmental Risk Sciences 2018, *Maryvale Energy from Waste Plant: Health Impact Assessment*, prepared for Paper Australia and Jacobs, available at: https://cvws.icloud-content.com/B/Aake9PWyiL1PJdqIDz75iLJErXtqAextOvMoXlzr2Q7AvOWYn4xdmJpq/Images.zip?o=ArNXCuMgT5ASfoNcOR8bL-bNZKOGMPNtBSpNdkdfVxqD&v=1&x=3&a=CAoguU0URZY8UgE6wgoON5vAN_zSfUZgU9q77p40faGc4CASJxC3hLfeui0Yt5SyssQtIgEAKggByAD_IfCUYVIERK17aloEXZiaag&e=1564547516&k=xWkbe0L5axdbN3FDcJeYXg&fl=&r=22CEF7E9-A909-4A02-A74F-C81A4A110595-1&ckc=com.apple.largeattachment&ckz=A78ECDBE-21B4-405F-B0A6-50AC63EBE1E4&p=44&s=KFHVQAuQMcBmzNXJDhItbWXYDXE&teh=1

17. What quantity of water is drawn for ongoing processing?

The maximum volume likely to be drawn from the mains supply, based on rainfall records, would be about 5kL (5m^3) per day, which is equivalent to about 10 households' daily water use. It is likely that much of the time there will be a water excess from site operations, which will be stored for later use or discharged to trade waste if necessary.

18. What height is the stack?

Maximum height is 30m.

19. In your assessments do you incorporate the projected emissions form the proposed waste incinerator at APM?

Yes. All emission estimates and comparisons include the contribution from existing industrial sources plus the proposed emissions from the Paper Australia Energy from Waste plant, on the basis that it will be in operation when the Chunxing plant is up and running. These Paper Australia EfW plant emissions are taken from those indicated in their Works Approval Application.

Chunxing's proposed Hazelwood plant's emissions are provided alongside other emission sources in Latrobe Valley, including those predicted from Paper Australia's proposed plant, in Table 26 of the Works Approval Application, which is reproduced below:

Chunxing emissions in the context of the Latrobe Valley airshed

Pollutant	Hazelwood plant		Jeeralang power station	CHH Sawmill	Loy Yang A power station	Loy Yang B power station	Yallourn power station	New Paper Aust EfW plant
	kg/year	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed	% of LV airshed
Sulfur dioxide	1,054	0.001%	0.001%	0.001%	56%	26%	17%	0.2%
Nitrogen oxides	6,655	0.01%	0.3%	0.01%	43%	27%	26%	1%
PM_{10}	1,378[1]	0.02%	0.06%	0.01%	64%	7%	26%	0.5%
$PM_{2.5}$	1,378[1]	0.06%	0.2%	0.04%	36%	16%	36%	3%[2]
Lead	16	1.19%	0.0001%	0.1%	9%	5%	11%	73%
Sulfuric Acid Mist	325	0.36%	-	-	36%	18%	33%	13%[2]
Chromium	4.3	0.26%	0.00004%	0.02%	32%	20%	17%	27%
Arsenic	6.4	2.3%	0.0002%	0.06%	40%	21%	20%	16%
Cadmium	0.3	0.05%	0.0001%	0.01%	47%	7%	8%	37%
Antimony	1.2	0.53%	-	-	24%	-	-	75%
Dioxins and Furans (as TCDD I-TEQs)	0.000017	0.51%	-	0.2%	9%	28%	47%	12%

Notes:

1. Emission is total dust. For theoretically worse case comparison purposes, total dust has been assumed to be made up entirely of $PM_{2.5}$, and therefore also PM_{10}.

2. No figure was modelled for Paper Australia EfW plant. Figures represent current emission from Paper Australia's pulp and paper operations.

C2 Responses to specific claims made by the Action Group

The Action Group opposing the Used Lead Acid Battery (ULAB) recycling facility held community meetings at the Hazelwood North Hall in October 2019. Chunxing Corporation Pty Ltd (and Ascend) requested to attend but the Group declined our request. Consequently, we prepared some responses to key claims made in the Action Group's media release, as well as in their meeting material.

Claim #1: The proposed battery recycling facility in Morwell will release lead in the air

- From our very first community meeting we have demonstrated through modelling (of actual emissions data from the China plant into the Hazelwood North context) that lead emissions will be extremely low – much lower than the other main (modern) plant in Australia.
- The worst case modelling result anywhere in the Hazelwood North area shows lead emissions at 300 times lower than EPA standards set to protect human health.
- At the nearest residences (approx.1.2km plus away) the emissions are virtually zero (1,500 times lower than EPA standards), which is undetectable by field monitoring equipment. The school is further away again (1.6 km).
- Science does not deal in zeroes. There is always a number – a concentration – of pollutants in the air now and from computer modelling. In this case, the modelled number is extremely low.
- Putting this into context, a person spending 24 hours a day at the closest house who also drinks eight glasses of water a day from the tap of a completely safe water supply has the potential to be exposed to around 200 times more lead from drinking that water than from breathing the Hazelwood North air. At no stage would that person be risking their health or at risk of "lead poisoning".

Claim #2: The World Health Organisation (WHO) say "there is no safe level of lead"

- This is a misleading statement.
- The WHO's document[59] is actually written to address a worldwide problem of lead impacts from unregulated, sometimes backyard recycling operations, particularly those in developing countries. The proposed ULAB facility will be heavily regulated using modern technology and techniques to ensure the safety of its employees and the community.
  - To compare the environmental credentials of these approaches with those of the proposed facility is like comparing the speed of a horse and cart with that of a jumbo jet. They both get you from A to B though, in the same way rudimentary and high-technology recycling both recover lead.
- Lead is present in the earth's crust and as a result is naturally present in soil, water and air. It is also found in processed foods and some consumer products. A safe level of lead is measured by a set of standards. The WHO's own safe level of lead in drinking water is set at 10 µg/L. These levels are not and should not be a cause for concern.

[59] https://apps.who.int/iris/bitstream/handle/10665/259447/9789241512855-eng.pdf;jsessionid=55BF2AF42FB395A7AB91BDE9EDB275E7?sequence=1

- There is no question about the health and environmental impacts of lead – that is why it is important to recycle batteries in a highly-controlled facility, so it does not leach into the environment and contaminate soil, water supplies and beyond.

Claim #3: There could be "lead poisoning" due to air emissions from this plant

- This claim is completely unsubstantiated. The level of emissions are such that it would be impossible to get "lead poisoning" from breathing the air in the area of this facility.
- As stated above, any emission levels are so low as to be indistinguishable from background levels – levels which do not cause lead poisoning.
- Lead poisoning is a specific condition from repeated exposure to excessive levels of lead. These days, lead poisoning can occur from unwitting exposure to lead-containing paint, such as when renovating an old house.
- Before 1970, paint used in many Australian houses contained high levels of lead. At that time, the Australian Uniform Paint Standard was amended to reduce the amount of lead in domestic paint from the previously recommended level of 50 per cent to one per cent. The maximum content was further reduced to 0.25 per cent in 1992 and to the current level of 0.1 per cent in 1997. In other words, lead may have been heavily reduced in paint but it has not been "removed".
- The maximum lead concentration modelled at the nearest residence (or the school) is 0.000002 mg/m^3. This converts to 0.00000024 parts per million (ppm). Leaded paint in old houses is 500,000 ppm and the maximum allowable lead in paint today is 1,000 ppm.
- Comparing lead concentrations from paint versus air:
  - Pre-1970s paint is **2,000 billion times** more concentrated in lead than the air around the plant
  - Current legal maximum concentration paints would be **4 billion times** more concentrated in lead than the air around the plant

Claim #4: Any level of lead can cause poisoning

- As described in point 3 above, this statement is categorically wrong. Low levels of lead exposure cannot cause lead poisoning. The levels modelled at the Chunxing facility simply cannot result in lead poisoning – they will not even be able to be measured at people's residences.
- Lead poisoning is a specific condition from repeated exposure to excessive levels of lead. These days, lead poisoning can occur from unwitting exposure to lead-containing paint, such as when renovating an old house.

Claim #5: The proposed facility is "a very old process" and "outdated technology"

- Nothing could be further from the truth. The current China facility is four years old and uses world-leading technology – its Vertical Smelt Furnace has been granted a Chinese invention patent.
- The only thing "very old" about it is the word 'smelting'. Unlike traditional secondary lead smelting, Chunxing maximises lead recovery by employing both a 'melting' furnace (for one type of lead) and a 'smelting' furnace for the other type of lead present. This furnace has unique design characteristics to ensure high reaction efficiency and its chemistry is process-controlled to minimise emissions and maximise lead recovery.

- The evidence of how new this technology is shows in its emissions performance. The other Australian plant is modern (2012), was 'best practice' at the time of its commissioning and is well-run and well-regarded by NSW EPA. Emissions from the Hazelwood North plant are modelled to be significantly lower than this.
- This is because of the intelligent chemistry, process control, automation and other engineering features it uses, plus its comprehensive pollution control system: multiple wet scrubbers, adsorbent dosing, cooling chambers and baghouse. No other ULAB recycler goes this far.

Claim #6: There are new technologies that are less dangerous; "much safer" technologies are based on electrolysis or solvents

- This statement is misguided and incorrect. The new technologies suggested are either far more dangerous or unproven beyond lab scale.
- Other technologies have been evaluated in the Works Approval application, alongside Chunxing's VSF furnace and associated technology. Two other 'newer' technologies were identified:
  - Hydrometallurgical (electrolytic) lead reduction
  - Solvent dissolution followed by electrolysis.
- The only commercially available hydrometallurgical technology is based on leaching with hydrofluoric acid, followed by electrowinning. This technology was trialled 40 years ago in Port Kembla, NSW and could not be commercialised due to major issues around health and safety, and environmental performance. Currently there is one commercial plant believed to be operating in Asia with many challenges of health and safety issues.
  - Fluorinated acids are extremely dangerous. Australia's chemical assessment body (NICNAS) notes of hydrofluoric acid: "acute exposure through either inhalation or skin contact has led to deaths in humans and that even contact with dilute solutions (0.1%) can "cause painful second and third degree burns that heal very slowly."
  - The Action Group's own handout states that hydrofluoric acid can cause harm, including from inhalation: "can cause death from an irregular heartbeat or from fluid build-up in the lungs."
- Apart from these health effects, neither fluosilicic nor fluoboric acid (fluorinated acids similar to hydrofluoric acid) can be kept from decomposing and releasing fluoride ions that could precipitate lead as lead fluoride, which is highly corrosive. The literature states that this "high corrosiveness limits commercialisation of processes using these chemicals."
- Chunxing is not comfortable taking such risks with that kind of technology in Australia due to potential emission fluorine gas and leakage of reagents.
- There is also research currently being undertaken about extraction using Methane-Sulfonic Acid (MSA) followed by Electrowinning. Again, this process has neither been tested commercially nor established, with the process' patent only recently granted (July 2019). It is understood that a company in WA is currently exploring this technology for its lead-bearing ores. The chemistry of lead in ores is totally different from the chemistry of lead in ULABs.
- Dissolution using novel solvents, such as the PLACID process, one promoted by a company called Aquametals and a recent study using 'deep eutectic solvents' are all promising but limited to pilot or laboratory scale, with varying levels of lead recovery rates.

- None of these hydrometallurgical/electrolytic technologies are yet proven safe enough at sufficient scale or commercially viable enough to be considered for the proposed Latrobe Valley facility.

Claim #7: Lead was removed from paints

- Lead has been reduced from paints but it is still allowed at levels up to 1,000 ppm.
- Before 1970, paint used in many Australian houses contained high levels of lead. Then the Australian Uniform Paint Standard was amended to reduce the amount of lead in domestic paint from the previously recommended level of 50 per cent to one per cent. The maximum content was further reduced to 0.25 per cent in 1992 and to the current level of 0.1 per cent in 1997. In other words, lead may have been heavily reduced in paint but it has not been "removed".
- Lead is still used in Australia in some road line marking paints. That is why emissions of 'road dust' from driving your car anywhere (including the Latrobe Valley) are higher than those from this facility.
- Comparing levels of lead in paint now, as well as those used in the past (old house paint), to proposed levels at the Chunxing facility are incomparable.
  - Pre-1970s paint is **2,000 billion times** more concentrated in lead than the air around the plant.
  - Current legal maximum concentration paints would be **4 billion times** more concentrated in lead than the air around the plant.

Claim #8: This technology produces lead dust and slag, which impacts workers, their families, community and surrounding land

- Potential lead-exposed workers in Australia (and China) are strictly monitored through thorough WorkSafe operational and blood testing regimes. Impacts to workers are heavily exaggerated.
- Potential impacts to their family and the broader area from the proposed plant are also false and create unnecessary and unsubstantiated fear in the community.
- Chunxing's technology is very low emission, highly automated, fully enclosed at every stage of the process and, most importantly, employs many layers of pollution control equipment beyond any other similar operation in Australia and the highest level of controls in the world. Consequently there is no "lead dust".
- If workers were exposed to high lead levels this would show up in their blood. Levels in the blood of workers at the 16-fold larger plant in China are closely monitored to the same standards as those applied by WorkSafe in Victoria and they follow the same procedures of workplace task rotation applied in Australia, for any industry dealing with lead; be it mining, metallurgy, laboratories or construction.
- Lead levels in the blood of workers at the China plant are below those set in both China and Australia, to protect worker health.
- Standard procedures apply to such workers – at the China plant or here – they must change clothes on arrival to work, then shower and change clothes upon leaving work. All laundering of work clothing is done onsite. There is no risk at all of carrying lead from the workplace home to their family or broader community.
- No measurable lead will impact surrounding land and communities since the only pathway for transport is the air – there are no direct water emissions from the facility.

Air emissions are so low as not to be measurable at nearby residences and farms – even cumulative quantities over many years would not be identifiable above background soil levels.

- Slag is the name of the solid glassy waste produced from smelting. There will be approximately 4,500 tonnes of slag produced that will contain lead, albeit at much lower levels than other similar operations and lower quantities of slag. This is handled in a straight-forward manner and will be disposed of at a prescribed waste landfill licensed to accept it in Victoria. There are strict handling and licensing requirements for transport, receipt and environmental monitoring.

Claim #9: "An EcoMENA article states that "in fact lead-acid battery recycling is regarded as one of the worst pollution industries worldwide"

- EcoMENA is a Middle East and North Africa (MENA) sustainability advocacy organisation. The article referred to (https://www.ecomena.org/managing-lead-acid-batteries/) is written entirely to address a worldwide problem of lead impacts from unregulated, sometimes backyard recycling operations, particularly those in developing countries.
- The very same article says: "Recycling of used lead-acid batteries, provided it is done in an environmentally sound manner, is important because it keeps the batteries out of the waste stream destined for final disposal. Lead from storage batteries placed in unlined landfills can even contaminate the groundwater. Recycling prevents the emission of lead into the environment and also avoids the energy usage associated with manufacturing lead from virgin resources."
- There is no question about the health and environmental impacts of lead – that is why it is important to recycle batteries in a highly-controlled facility, so it does not leach into the environment and contaminate soil, water supplies and beyond.

Claim #10: The Victorian EPA only requires a 500m buffer distance (to the nearest residence) while the buffer zone in NSW (for the Wagga Wagga facility) is 5km, so the Hazelwood facility should be located 5km from houses

- There is no "5km buffer zone" in NSW. The NSW EPA does not specify buffer distances at all, but relies on case by case air quality modelling to assess impacts to sensitive receptors.
- The Vic EPA publication on separation distances requires a buffer of 500m for non-ferrous metal production (>2,000 tonnes per year).
- The Chunxing facility is 1.1km away from the nearest residence (sensitive receptor), or 1.2km if you measure from where the facility's building will be placed on the property.
- The Wagga Wagga plant expansion (more than double the capacity of the Hazelwood facility) has recently been approved by NSW EPA, and is located 1.2km away from the nearest residence.

Claim #11: When assessing the Wagga Wagga plant expansion proposal, the NSW Government "noted the 5km buffer distance as a mitigating control in managing these hazards."

- There is no "5km buffer zone" in NSW.
- The NSW Government (Department of Planning and Environment), in its assessment report dated February 2019, simply noted the geographical reality of the 1.2km nearest residence and 5km nearest township.
- The Department's assessment further states: "No public submissions were received during the exhibition of the EIS, likely due to the isolated nature of the facility which is located 1.2km from the nearest residence" (emphasis added).

Claim #12: Dividing the emissions of the China plant by 16 is "not good science"

- The capacity of the reference plant in China is 800,000 tonnes of ULABs; the Hazelwood facility is designed to process 50,000 tonnes of ULABs – $1/16^{th}$ of the size. Applying this ratio is a simple mass balance, because lead is not introduced into the process from anywhere other than feedstock ULABs.
- This approach is entirely valid because the processing and emissions control technology are identical in both cases, designed to produce the same quantity of output lead products and lead emissions per tonne of input lead (ULABs).
- The cornerstone of the US EPA's emissions estimation methodology (US EPA AP 42 program), when estimating emissions with no operating data available, is to use *emission factors* (kg pollutant per tonne of input material), which operate on the assumption that if a process remains of the same design, then the emissions will be the same per tonne of input feedstock.
- Since a Works Approval is dealing with a plant that has not been built yet, emissions (as input into an air quality dispersion model) must be estimated. Rather than using literature-based industry wide emission factors (which are often the only data available) Chunxing has the luxury of an operational reference plant which has independent stack testing carried out on a quarterly basis.
- Even if the 16-fold scaling down was not done at all and the 800,000 tonne plant's emissions were assumed for the Hazelwood North facility, the worst case ground level concentration anywhere in the area would still be 20 times below the EPA limit.

Claim #13: "The plant will emit a cocktail of toxic emissions to the environment"

- This statement is wrong and uses inaccurate and hyperbolic language.
- Emissions from the plant will be so low they will not be measurable at the nearest residence by field monitoring equipment.
- Science doesn't deal in zeroes, there are always numbers produced by modelling, even if they are extremely low. Not only are emissions orders of magnitude below EPA standards, they are likely to be so low that EPA approval and licences may not even be required for air emissions.

Claim #14: This facility will emit significant levels of sulfur dioxide

- This claim is a massive exaggeration – as all of the claims about emissions from the facility are.
- The Chunxing facility will emit such infinitesimally low levels of sulfur dioxide that it will be just 0.001% (1/100,000th) of the existing industrial emissions of sulfur dioxide in the Latrobe Valley.
- Sulfur dioxide levels at the nearest residence are modelled to be almost 3,500 times lower than EPA limits.

Claim #15: "The location of the Council transfer station immediately adjacent to the plant may expose both transfer station employees and members of the public utilising the Council transfer station to pollutants including lead and other toxic pollutants."

- People using or working at the transfer station will not be exposed to "toxic" levels of pollutants.
- The Council transfer station is located within the modelled area, where the worst case ground level concentration modelled anywhere in that area was 300 times below EPA limits set to protect human health.
- These limits assume breathing of that air occurs 24 hours a day across a lifetime.
- The 'worst case' concentration in a model is the worst hour it predicts across five years of hourly data, so this level doesn't occur continuously across a year, a week or even a day. The layers of conservativism in air quality modelling are very high, to ensure confidence in the protective nature of its results.

Claim #16: "EPA limits may not necessarily ensure safe levels for the community." The comparison is then made with lead pollution from SA's Port Pirie lead smelter

- Comparing the Hazelwood North proposal with the primary lead smelter at Port Pirie is misleading and designed to spread fear.
- The Port Pirie smelter is a very large facility. Lead emissions from Port Pirie are 3,500 times higher than the proposed Hazelwood North plant. To suggest the two are equivalent is misleading.
- EPA Victoria does not regulate the Port Pirie plant, whose regulatory arrangements are unrelated to EPA Victoria design criteria.

Claim #17: There is an inference that 2km is some kind of significant boundary or "buffer zone", within which there is potential for health impacts

- The 2km "buffer" has no particular meaning, but has been given a life of its own by the Action Group.
- Chunxing apologises for incorrectly using the words "2km buffer" in the original newspaper advertisement in June 2019, where it was used to (correctly) describe the distance to Morwell, the closest residential area or township, but not the closest residences (which are in Hazelwood North).

- From this small error, the Action Group has continued to infer there is such a thing as a 2km buffer around the plant. The only buffer is the EPA's required separation distance of 500m, which is comfortably achieved.

Claim #18: "To date the company has not adequately consulted with the community"

- In the earliest stages of developing the application for Works Approval, Chunxing held two open community meetings in Morwell in June 2019, as a means of starting a conversation with the local community. The Works Approval Application had not even been started at that time.
- We have not been ready for further full public meetings because the Works Approval application has been in the process of being drafted.
- However, between then and now, Chunxing has had at least 20 more different meetings and engagements with local stakeholders, often one-on-one, over kitchen tables, in local cafes and boardrooms, explaining the proposal in detail. This has also involved letter drops into the Hazelwood North community.
- We have met with the Action Group on at least five occasions and have shared our working draft of the Works Approval application document, as well as all supporting data and other evidence we have used in carrying out the various environmental assessments. We have received no comments on these documents.
- Our request to attend the community meetings held by the Action Group was declined.
- The Works Approval assessment process itself, run by EPA once the Works Approval application has been accepted, is a public process with consultation and requests for public submissions. Everything prior to that is simply proactive engagement initiated by the company by its own choice.

Claim #19: Aqua Metals' "aquarefining" technology doesn't involve smelting at all

- A US company (Aqua Metals) has very recently patented a process for extracting lead using MSA as a solvent, then recovering it using electrowinning.
- It established its first (and currently only) facility in Nevada USA in 2017, a very small-scale demonstration plant whose largest production month (September 2019) was 160 tonnes of lead product. Chunxing's proposed plant is small by world standards, but its output is planned to be 15 times larger than this.
- Aqua Metals own website (https://www.aquametals.com/aquarefining/) illustrates this process as suitable only for the lead paste component, noting that the lead metal plates and grid are "shipped to smelter for processing."
- Therefore, aquarefining is not a full solution for ULAB recycling – such a plant would either require a smelter onsite as well or need to ship lead grid back out again to a smelting facility elsewhere.
- The technology is marketed as bolt-on technology to existing smelters, not standalone.
- Aqua Metals' aquarefining technology is promising but far too early in its development to demonstrate scale, commerciality and safety, and still requires the use of a smelter.

Claim #20: The facility will send "toxic waste" to landfill in trucks through the area

- Slag is a solid waste produced from the process which will contain around 0.2 – 0.5% lead. As a glassy material that closely resembles volcanic rock, slag is relatively inert and quite resistant to leaching of lead.
- Levels of lead in slag from traditional smelting of ULABs are typically 10-fold higher than that from Chunxing's process.
- Such slag is a prescribed industrial waste that is transported by EPA-permitted vehicles to landfill licensed by EPA to accept this waste.
- 4,500 tonnes of slag will be sent to landfill each year. To put this into context, Victorian landfills accepted almost 900,000 tonnes of prescribed industrial wastes in 2017-18.

Claim #21: Mulch from O'Connor's will be contaminated with lead, so people buying mulch from Bunnings will be buying lead-contaminated mulch

- Mulch or any other nearby industry's material/soil/surface will not be "contaminated" with lead.
- Air emissions are so low as not to be measurable at nearby residences and farms – even cumulative quantities over many years would not be identifiable above background soil levels.
- Regardless, levels of metals like lead are closely regulated in soils, composts and mulches via the Australian Standard (AS 4454—2003),

Claim #22: The facility will use a lot of gas, increasing greenhouse gas emissions

- The Works Approval Application devotes an entire chapter to assess *Energy Use and Greenhouse Gas Emissions (GHG)*. The GHG impact of operating the proposed Hazelwood ULAB plant is to add 17,442 tonnes CO_2-e per year (0.04% of national emissions).
- In the context of total lifecycle emissions (subtracting those emissions avoided from creating the same amount of lead from primary extraction and production activities) that impact becomes a net GHG <u>reduction</u> of 32,118 tonnes CO_2-e per year.
- According to the US EPA's Greenhouse Gas Equivalencies Calculator, this is equivalent to removing 70,000 cars from the road.

Appendix D

Community engagements held

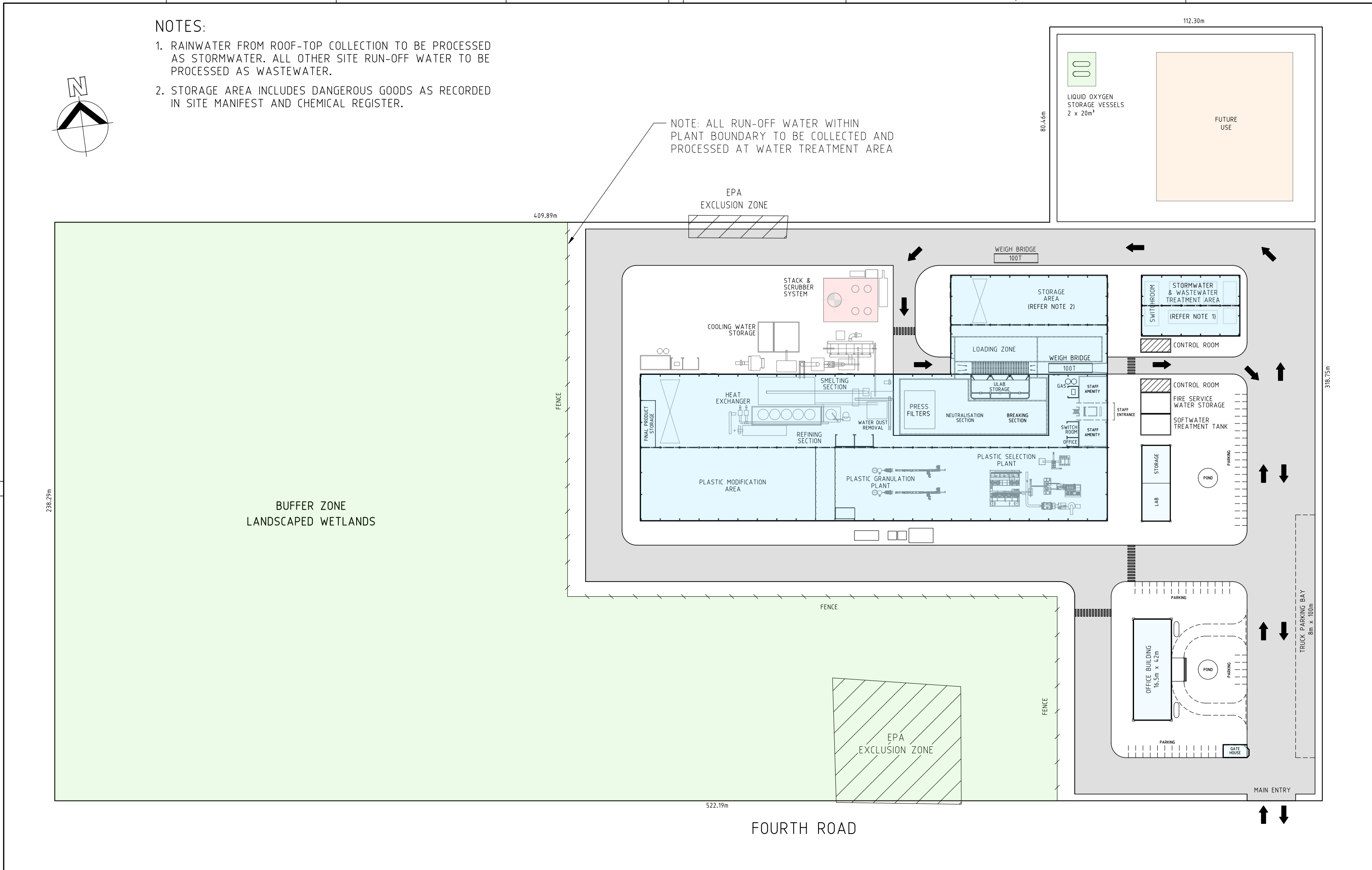
The following engagement activities have been carried out prior to submission of the Works Approval Application, in descending date order.

Date	Name	Types of engagement	Chunxing actions post meeting
29/10/19	Community Consultation Meeting #3	Open community presentation and Q&A	Website updated with presentation, mailout sent with invitation to future updates
25/9/19	Hazelwood North Action Group: Peter Leviston	Face to face meeting	Provided further details about plant improvements and design plans
19/8/19	Voices of the Valley: Wendy Farmer, Ian Martin and Hazelwood North Action Group representatives	Face to face meeting	Phone follow ups with Wendy Farmer and Ian Martin. Provision of project and Works Approval Application summary documents.
12/8/19	Hazelwood North action group: Peter Ingwersen and Peter Leviston	Face to face presentation/ meeting	Email and phone follow ups. Provision of full draft Works Approval Application document plus <u>all</u> supporting technical reports, calculations and China plant data.
	Karen Egan and Gail Gatt (Latrobe City Council)	email	
12/8/19	Don and Marion Ireland	Coffee meeting	Provided presentation and summary documents. Advice and other information shared via several email conversations.
12//8/19	Alex Arbuthnot AM (Gippsland Climate Change)	Coffee meeting	Provided project summary documentation
12/8/19 16/7/19	Hazelwood North Primary School: Paul Jorgensen (Principal) and school council members (6)	Face to face presentation/ meeting Emails, phone calls	Follow up emails, presentation copy, WAA summary document and follow up information about blood lead levels of China plant workers
5/8/19	All Latrobe City Councilors	Presentation	Multiple follow ups with key Council staff (mainly Bruce Connolly and Gail Gatt)
4/8/19 & 12/8/19	Don and Pat Evenden	Meetings	Various follow up phone conversations
25/7/19	Bob Temple (retired industrial chemist)	Email	Responses to technical queries raised
25/6/19	Community Consultation Meeting #2 (23 attendees)	Open community presentation and Q&A	Distribution of presentation copies
25/6/19	Lorraine Bull, LV Sustainability Group	Face to face presentation/ meeting	Distribution of presentation copies
25/6/19	Scott McArdle LV Authority	Face to face presentation/ meeting	Distribution of presentation copies
19/6/19	Community Consultation Meeting #1 (25 attendees)	Open community presentation and Q&A	Distribution of presentation copies
8/6/19	Voices of the Valley: Wendy Farmer, Ian Martin and 3 other representatives of VotV	Face to face presentation/ meeting	Presentation copies sent and follow up emails and calls
6/6/19	Keith Brownbill (Advance Morwell)	Face to face presentation/ meeting	Presentation copies sent and follow up emails and calls
29/5/19	Harriet Shing, State MP	Email and letter sent	

Date	Name	Types of engagement	Chunxing actions post meeting
	Councilor Dale Harriman	Email and letter sent	Follow up discussions
29/5/19	Russell Northe, State MP	Email and letter sent Meeting	Follow up discussions
28/5/19	Bruce Connolly (Latrobe City Council)	Phone call/ email	Multiple discussions, meetings, emails since this first contact
Throughout May ‘19	Door-knock of Church Road local community houses	Introduction and discussion	Introductory project letters provided
Throughout May ‘19	Door-knock meetings with all immediate neighbouring businesses	Introduction and discussion	Provision of simple project summary

Appendix E

Site layout and plant details



REFERENCE DRAWINGS		REVISION				
DESCRIPTION	DRAWING No.	REV	DATE	DESCRIPTION	CHKD	APP
-	-	04	12.11.19	ISSUED FOR COMMENT	-	-
		03	28.10.19	ISSUED FOR COMMENT	-	-
		02	24.10.19	ISSUED FOR COMMENT	-	-
		01	22.10.19	ISSUED FOR COMMENT	-	-

CHUNXING CORPORATION PTY LTD

DRAWN	NB/PD
DATE	10/19
CHECKED	GC/PD
APPROVED	X

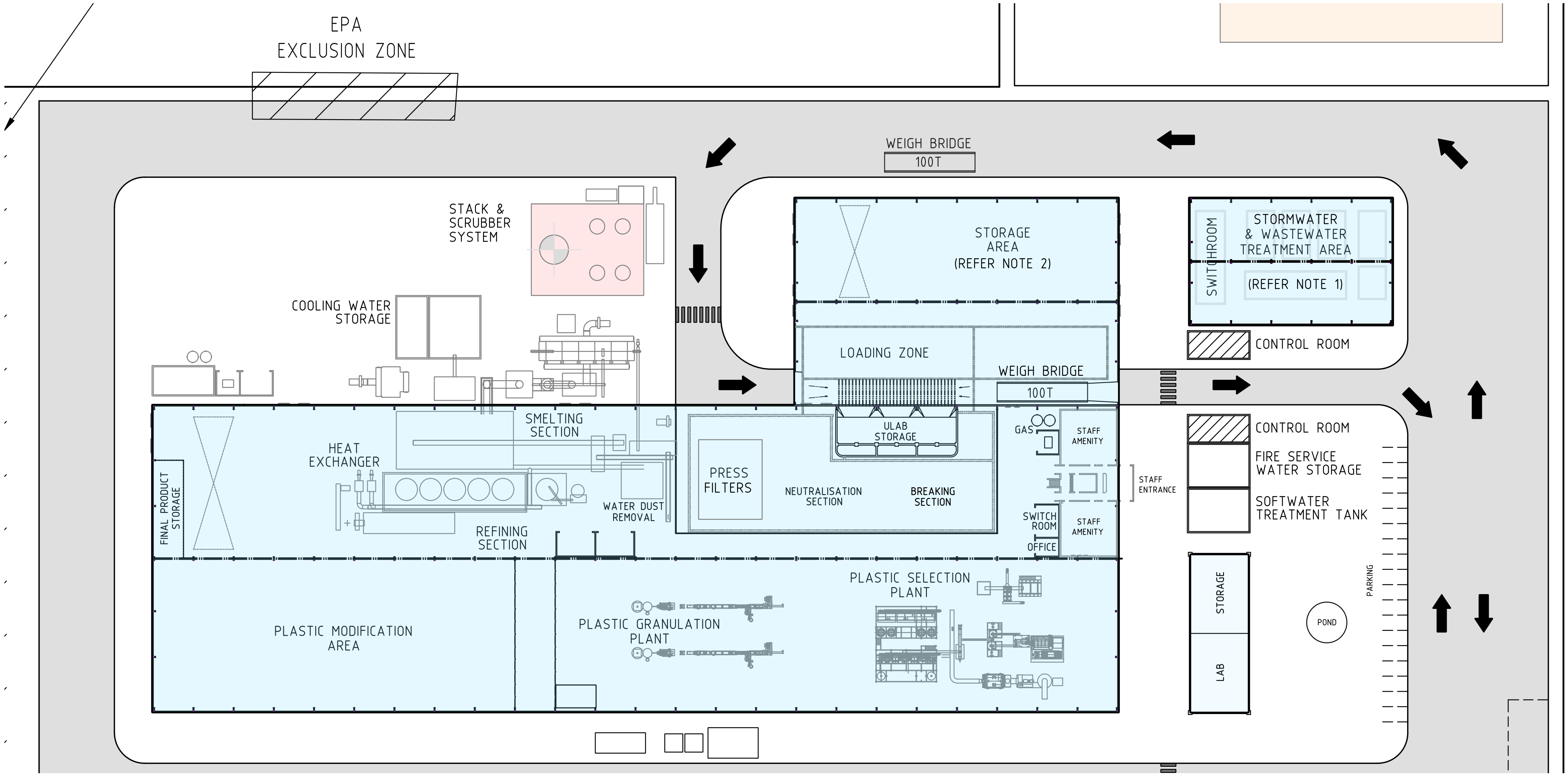
Pro Draft PTY LTD
ENGINEERING DRAFTING
PHONE: (03) 5133 8007
FAX: (03) 5133 6961

DRG No. PD2019-0084-001
REV 04

CHUNXING CORPORATION
BATTERY RECYCLING FACILITY
FOURTH ROAD, HAZELWOOD NORTH
SITE PLAN

THIS DRAWING AND ALL TECHNICAL DATA CONTAINED HEREIN IS THE PROPERTY OF CHUNXING CORPORATION AND MUST NOT BE DISCLOSED TO THIRD PARTIES, OR COPIED, OR REPRODUCED WHOLLY, OR IN PART, OR IN ANY FORM WITHOUT THE WRITTEN CONSENT OF THE OWNERS.

400 X 564mm
PLOT SCALE = 1:1000
A2


EPA
EXCLUSION ZONE
WEIGH BRIDGE
100T
STACK & SCRUBBER SYSTEM
COOLING WATER STORAGE
STORAGE AREA (REFER NOTE 2)
STORMWATER & WASTEWATER TREATMENT AREA
(REFER NOTE 1)
SWITCHROOM
CONTROL ROOM
LOADING ZONE
WEIGH BRIDGE
100T
SMELTING SECTION
HEAT EXCHANGER
FINAL PRODUCT STORAGE
REFINING SECTION
WATER DUST REMOVAL
PRESS FILTERS
ULAB STORAGE
NEUTRALISATION SECTION
BREAKING SECTION
GAS
STAFF AMENITY
SWITCH ROOM
OFFICE
STAFF AMENITY
STAFF ENTRANCE
CONTROL ROOM
FIRE SERVICE WATER STORAGE
SOFTWATER TREATMENT TANK
PLASTIC SELECTION PLANT
PLASTIC MODIFICATION AREA
PLASTIC GRANULATION PLANT
STORAGE
LAB
POND
PARKING

Appendix F

GHG assessment: Excerpt from Chunxing WAA_GHG emissions v3.xls

	A	B	C	D	E	F	G	H	I	J
1	**GHG Emissions - estimates for Chunxing Hazelwood North**									
2										
3	**Emissions source**	**Activity data**	**Activity data unit**	**Energy content factor**	**Energy content factor unit**	**Emission factor(s)**	**Emission factor unit**	**GHG emission (t CO2-e) per year**	**Notes**	**References**
4	**SCOPE 1**									
5	Natural gas combustion (furnaces)	1,680,000	m^3	0.0393	GJ/m^3	51.4	CO_2, as kg CO2-e/GJ	3,394	Natural gas distributed in a pipeline	National Greenhouse Accounts Factors July 2017, p.13, Table 2
6	Natural gas combustion (furnaces)	1,680,000	m^3	0.0393	GJ/m^3	0.1	CH_4, as kg CO2-e/GJ	6.6	Natural gas distributed in a pipeline	National Greenhouse Accounts Factors July 2017, p.13, Table 2
7	Natural gas combustion (furnaces)	1,680,000	m^3	0.0393	GJ/m^3	0.03	N_2O, as kg CO2-e/GJ	2.0	Natural gas distributed in a pipeline	National Greenhouse Accounts Factors July 2017, p.13, Table 2
8	Direct process emissions (smelting)	-	-			-	-	3,645	Calculated from mass of coal fines added in smelting, assuming all C --> CO_2 (see 'Direct process' tab)	See 'Direct process tab and chemical reactions in WAA
9	Onsite forklift (LPG) emissions	10	kilolitres of LPG	25.7	GJ/kL	60.2	CO_2, as kg CO2-e/GJ	15.5	LPG	National Greenhouse Accounts Factors July 2017, p.15, Table 3
10	Onsite forklift (LPG) emissions	10	kilolitres of LPG	25.7	GJ/kL	0.2	CH_4, as kg CO2-e/GJ	0.1	LPG	National Greenhouse Accounts Factors July 2017, p.15, Table 3
11	Onsite forklift (LPG) emissions	10	kilolitres of LPG	25.7	GJ/kL	0.2	N_2O, as kg CO2-e/GJ	0.1	LPG	National Greenhouse Accounts Factors July 2017, p.15, Table 3
12										
13	*Total Scope 1*							7,063		
14	**SCOPE 2**									
15	Site-wide electricity use	2,800,000	kWh			0.00108	t CO2-e/kWh	3,024	Victorian Electricity Factor	National Greenhouse Accounts Factors July 2017, p.20, Table 5
16	*Total Scope 2*							3,024		
17										
18	***Total scope 1 & 2 GHG emissions***							10,087		
19										
20	**EMISSIONS AVOIDED**									
21	Primary lead smelting (i.e. Port Pirie)	28,000	t/yr Pb that Hazelwood would displace from primary smelting at Port Pirie			0.96	t CO2-e/ t Pb product	26,880	GHG emission if this amount of Pb was produced at Port Pirie	
22	Pb ore mining and concentrating	28,000				0.81	t CO2-e/ t Pb product	22,680		
23								49,560		
24	**NET EMISSIONS**							(39,473)	Equivalent to removing 8,381 cars from the road per year	US EPA Greenhouse Gas Equivalencies Calculator
25										
26										
27	ENERGY USED									
28	Electricity	2,800,000	kWh	10.1	TJ				1 kWh = 3.6MJ	
29	Fuel	1,680,000	m^3	66.0	TJ				1TJ = 1,000,000MJ; 1TJ = 1,000GJ	
30	**Total**			**76.1**	**TJ**					
31										

Appendix G

Air Quality Impact Assessment report

See separately provided document *AUBIN_AQIA_Chungxing_REV1.pdf*

Appendix H

China reference plant air quality monitoring data

See separately provided Excel and pdf files:

(Quarterly reports: English-translated by NAATI – pdf's)

2017
- *Test Report Q1';2017_Translation*
- *Test Report Q2';2017_Translation*
- *Test Report Q3';2017_Translation*
- *Test Report Q4';2017_Translation*

2018
- *Test Report Q1';2018_Translation*
- *Test Report Q2';2018_Translation*
- *Test Report Q3';2018_Translation*
- *Test Report Q4';2018_Translation*

2019
- *Test Report Q1';2019_Translation*
- *Test Report Q2';2019_Translation*
- *Test Report Q3'2019_Translation*

(Quarterly reports: as Excel workbooks)

- *JS Chunxing Test Reports 2017.xlsx*
- *JS Chunxing Test Reports 2018.xlsx*
- *JS Chunxing Test Reports 2019 inc Q3.xlsx*
- *Dioxins Test Report.xlsx*
- *20190701 Dioxins Test Report.xlsx*
- *Dioxins Stack Parameters 1.jpg*
- *Testing methods and standards.xlsx*

NOTE THAT ALL OF THE ABOVE AIR EMISSIONS DATA FROM THE CHINA PLANT IS INCLUDED IN THE AIR QUALITY MODELLING REPORT ACCOMPANYING WORKBOOK "CALCS_Chungxing.XLSX" (current to Q2)

(Lab accreditation records (NAAT1 translated))

- *transaltion-硫酸雾资质认定书.pdf*
- *translation-低浓度颗粒物资质认定书.pdf*
- *translation-废气金属资质认定书.pdf*
- *translation-资质认定证书.pdf*

Appendix I

Hazelwood plant estimated emission comparison data

Notes and assumptions for data in this Appendix:

1. kg/yr figures for all facilities except Chunxing plants and the current Australian ULAB smelter are taken from the National Pollutant Inventory, 2017-18 data

2. Chunxing China plant kg/yr is taken from 2017- 2019 Quarterly report stack testing data, using supplied results in mg/m^3 and supplied air flows for each stack

3. The current Australian ULAB smelter's emissions are calculated from quarterly monitoring data[60] reports and indicative stack flow estimates (per monitoring point) provided by Enirgi as part of their current EIS process for a plant expansion[61].

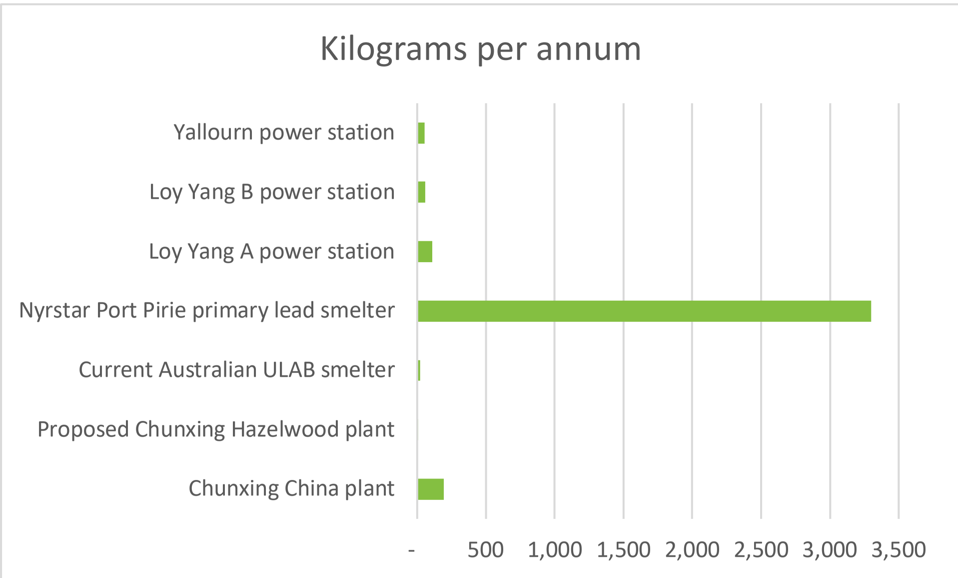
4. The current Australian ULAB smelter is assumed to produce 24,000 t/yr lead and alloys from 46,000 t/yr ULAB feedstock (supplied by Engitec Technologies: http://www.engitec.com/en/rmt__pty/)

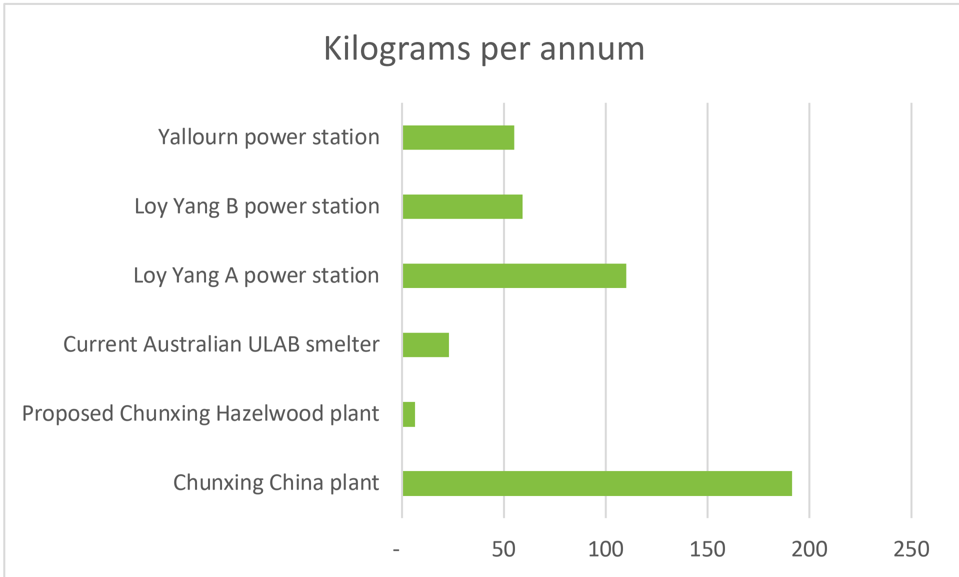
5. Although not currently in operation, Hydromet Laverton's annual emission is estimated as a theoretical maximum permitted, based on the maximum their licence allows.

[60] EPSR monitoring reports dated July 2018, September 2018, February 2019 and May 2019, available from: http://www.enirgipower.com.au/recycling/recycling-facility/environmental-data/

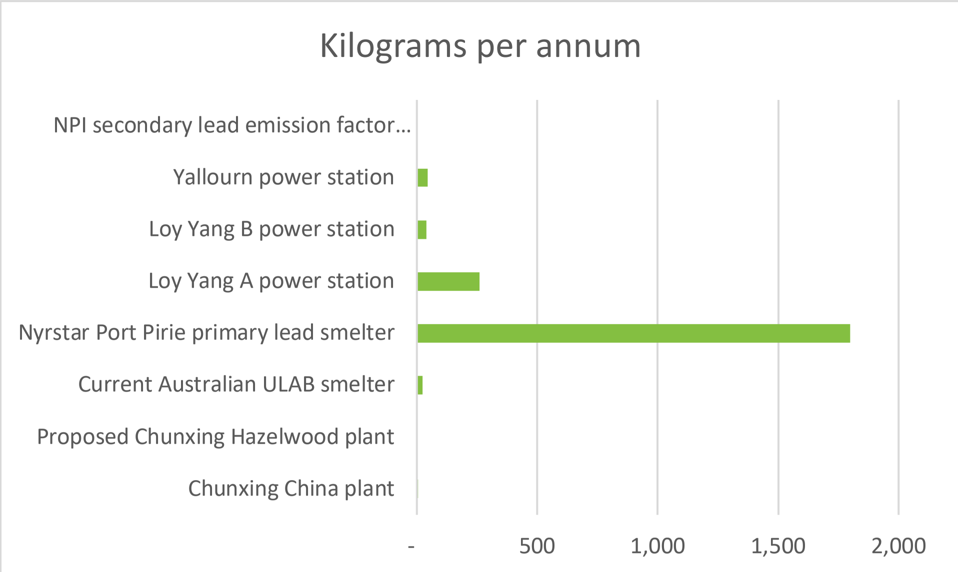
[61] GHD 2018, *Report for Enirgi Power Storage Recycling - Enirgi Power Storage Recycling Consolidation Project EIS, Response to Submissions*, available at: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-6619%2120190307T062507.816%20GMT

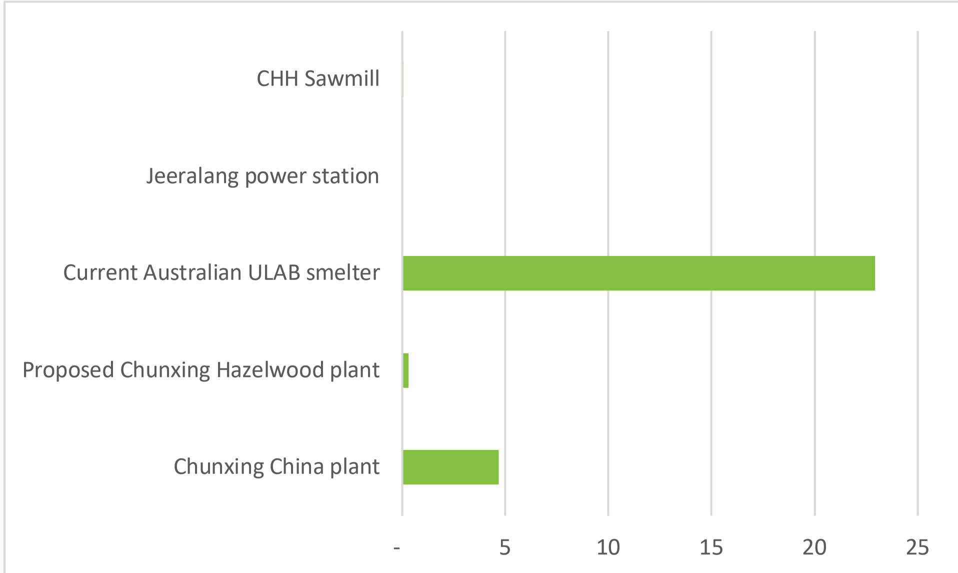
Arsenic emission unit of measure	Arsenic emission facility							
	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Loy Yang A power station	Loy Yang B power station	Yallourn power station	NPI secondary lead emission factor (controlled)
Kilograms per year	191	6.4	23	3,300	110	59	55	-
Grams per minute	0.36	0.012	0.044	6.28	0.21	0.11	0.10	-
Ratio of emission per year	30	1	4	515	17	9	9	-
Gram per tonne of ULABs processed	0.24	0.13	0.50	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	0.43	0.23	0.96	5	N/A	N/A	N/A	27,000



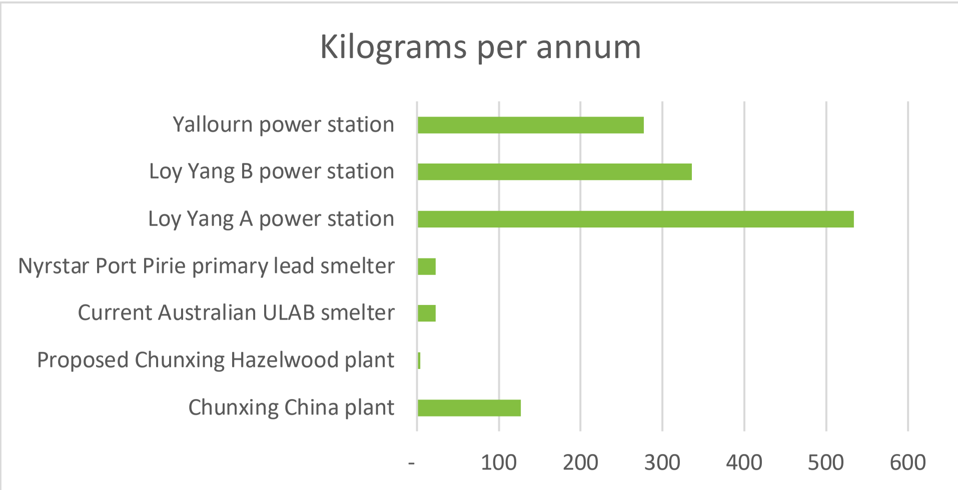


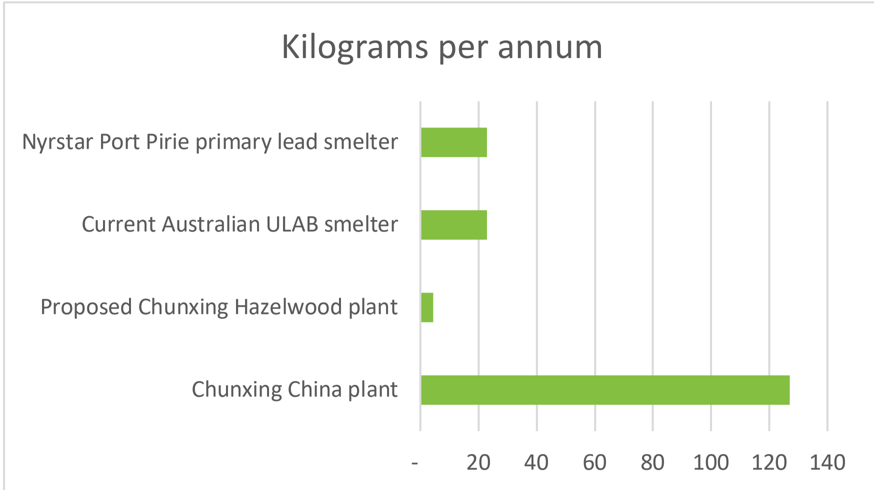
Cadmium emission unit of measure	Cadmium emission facility									
	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Loy Yang A power station	Loy Yang B power station	Yallourn power station	NPI secondary lead emission factor (controlled)	Jeeralang power station	CHH Sawmill
Kilograms per annum	5	0.3	23	1,800	260	39	44	-	0.00030	0.039
Grams per minute	0.01	0.001	0.044	3.4	0.49	0.07	0.08	-	0.000001	0.00007
Ratio of emissions per year	16	1	80	6,248	902	135	153	-	0.001	0.1
Gram per tonne of ULABs processed	0.01	0.01	0.5	N/A	N/A	N/A	N/A	-	-	-
Gram per tonne of lead produced	0.01	0.01	1.0	3	N/A	N/A	N/A	27000	-	-



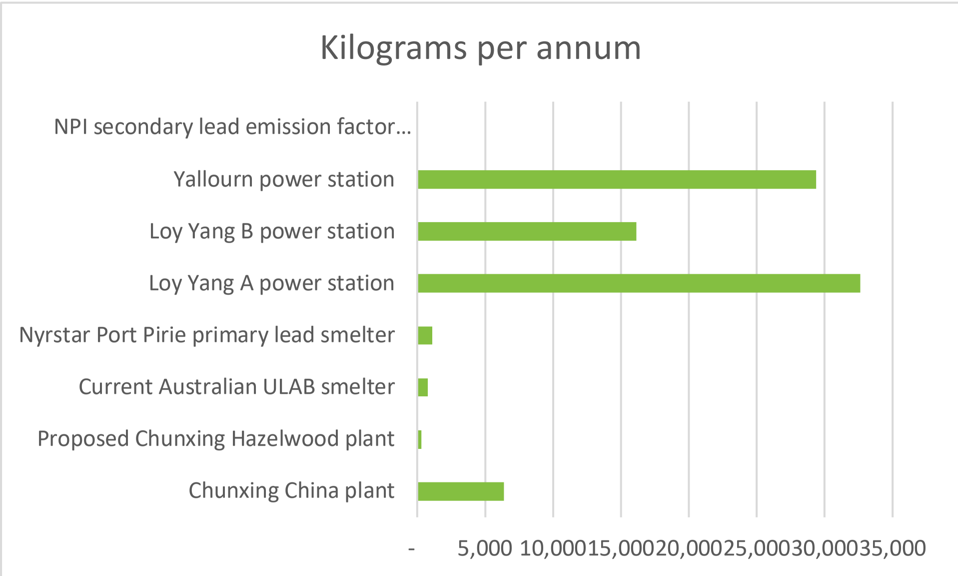


	Chromium emission facility						
Chromium emission unit of measure	**Chunxing China plant**	**Proposed Chunxing Hazelwood plant**	**Current Australian ULAB smelter**	**Nyrstar Port Pirie primary lead smelter**	**Loy Yang A power station**	**Loy Yang B power station**	**Yallourn power station**
Kilograms per annum	127	4.3	22.9	23	534	336	277
Grams per minute	0.24	0.008	0.0436	0.04	1.02	0.64	0.53
Ratio of emissions per year	29	1	5.3	5	124	78	64
Gram per tonne of ULABs processed	0.16	0.09	0.498	N/A	N/A	N/A	N/A
Gram per tonne of lead produced	0.28	0.15	0.955	0.037	N/A	N/A	N/A

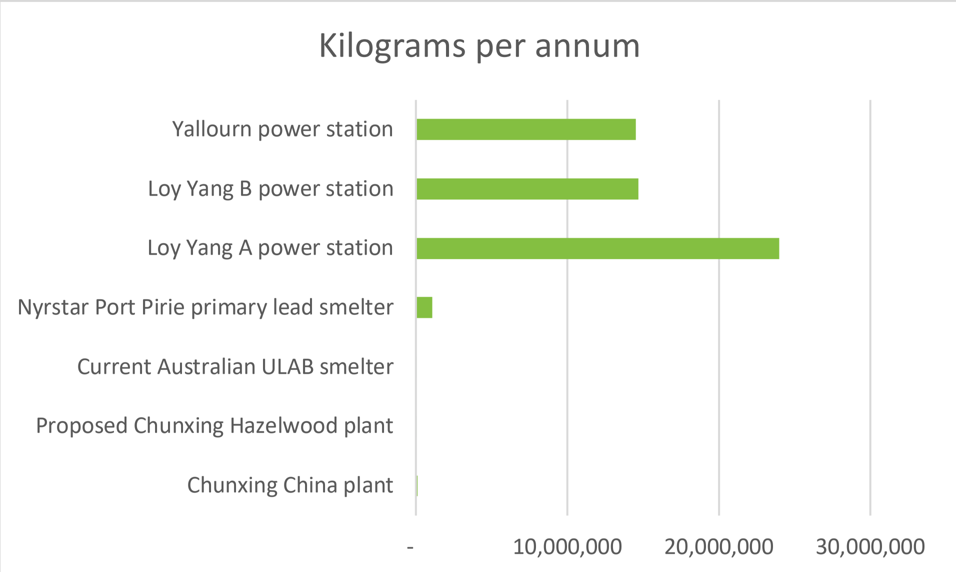


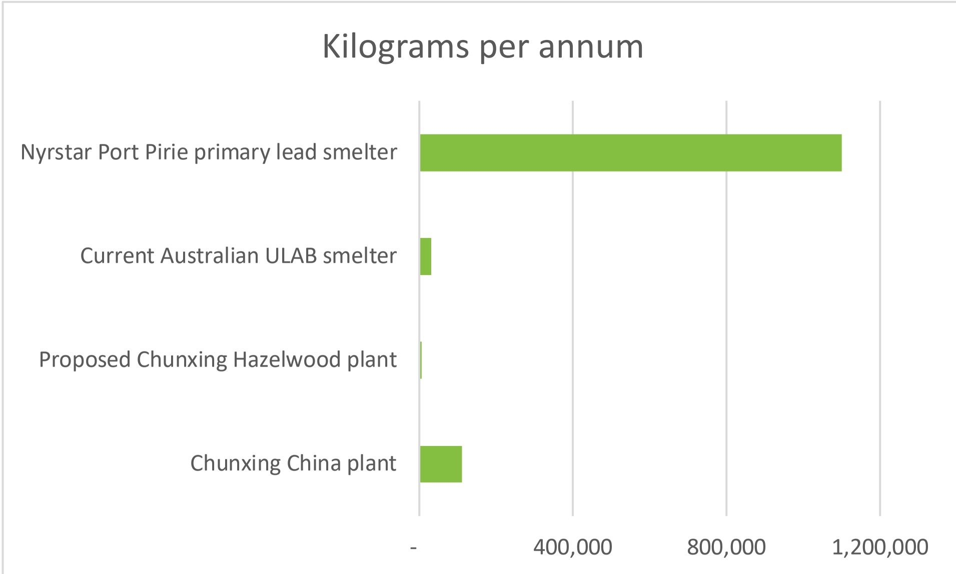


	Sulfuric acid emission facility							
Sulfuric acid emission unit of measure	**Chunxing China plant**	**Proposed Chunxing Hazelwood plant**	**Current Australian ULAB smelter**	**Nyrstar Port Pirie primary lead smelter**	**Loy Yang A power station**	**Loy Yang B power station**	**Yallourn power station**	**NPI secondary lead emission factor (controlled)**
Kilograms per annum	6,394	325	793	1,100	32,641	16,157	29,362	-
Grams per minute	12	0.62	1.509	2	62	31	56	-
Ratio of emissions per year	20	1	2	3	100	50	90	-
Gram per tonne of ULABs processed	8.0	6.5	17	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	14	12	31	2	N/A	N/A	N/A	-



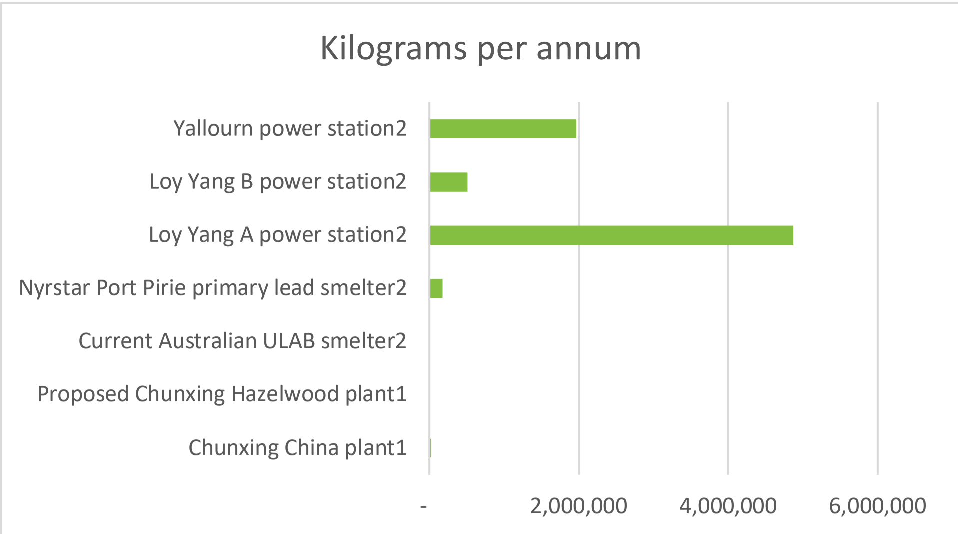
NOx emission unit of measure	NOx emission facility							
	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Loy Yang A power station	Loy Yang B power station	Yallourn power station	NPI secondary lead emission factor (controlled)
Kilograms per annum	110,790	6,655	31,000	1,100,000	24,000,000	14,700,000	14,500,000	-
Grams per minute	211	13	59	2,093	45,662	27,968	27,588	-
Ratio of emissions per year	17	1	5	165	3,606	2,209	2,179	-
Gram per tonne of ULABs processed	138	133	674	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	247	238	1,292	1,774	N/A	N/A	N/A	-

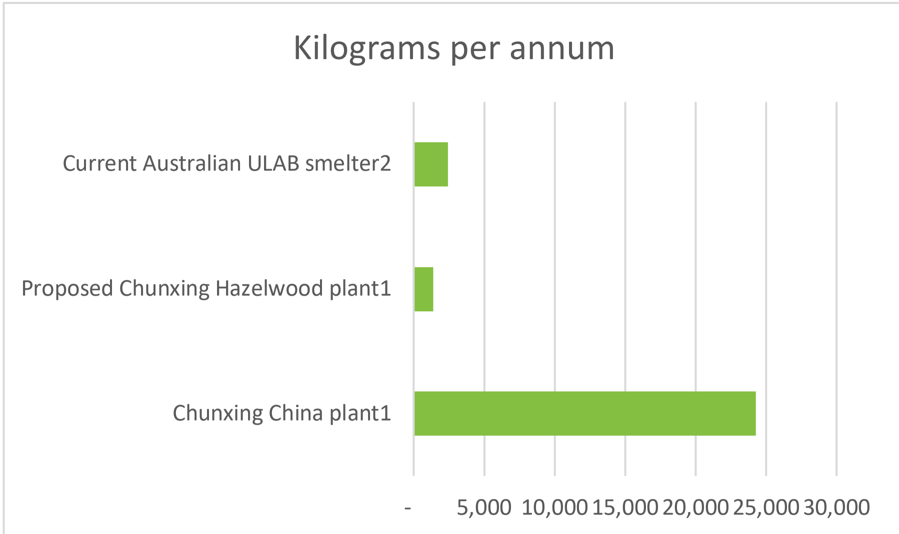




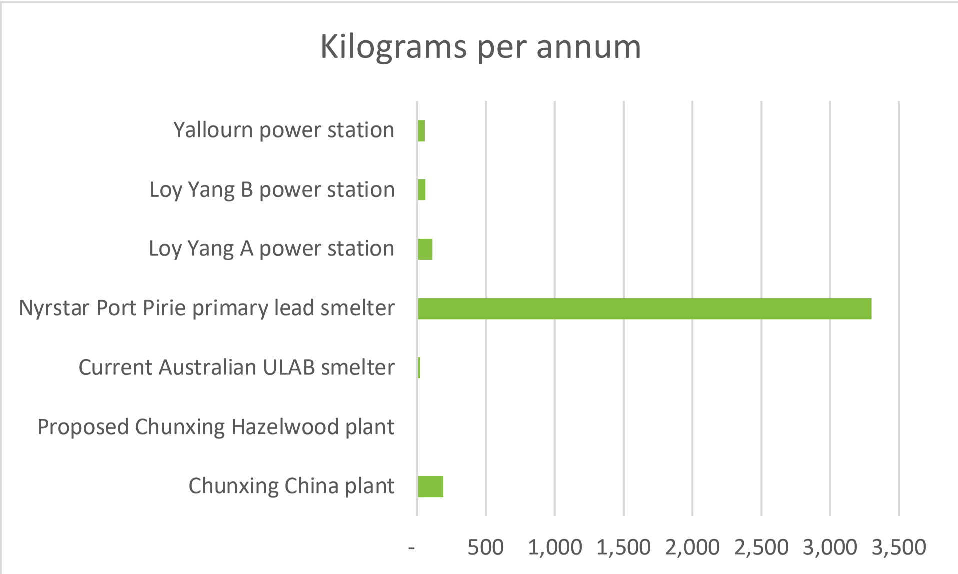
Particulates unit of measure	Particulates emission facility							
	Chunxing China plant[1]	Proposed Chunxing Hazelwood plant[1]	Current Australian ULAB smelter[2]	Nyrstar Port Pirie primary lead smelter[2]	Loy Yang A power station[2]	Loy Yang B power station[2]	Yallourn power station[2]	NPI secondary lead emission factor (controlled)[2]
Kilograms per annum	24,291	1,378	2,423	180,000	4,867,973	508,231	1,965,784	-
Grams per minute	46	3	5	342	9,262	967	3,740	-
Ratio of emissions per year	18	1	2	131	3,532	369	1,426	-
Gram per tonne of ULABs processed	30	28	53	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	54	49	101	290	N/A	N/A	N/A	1,120

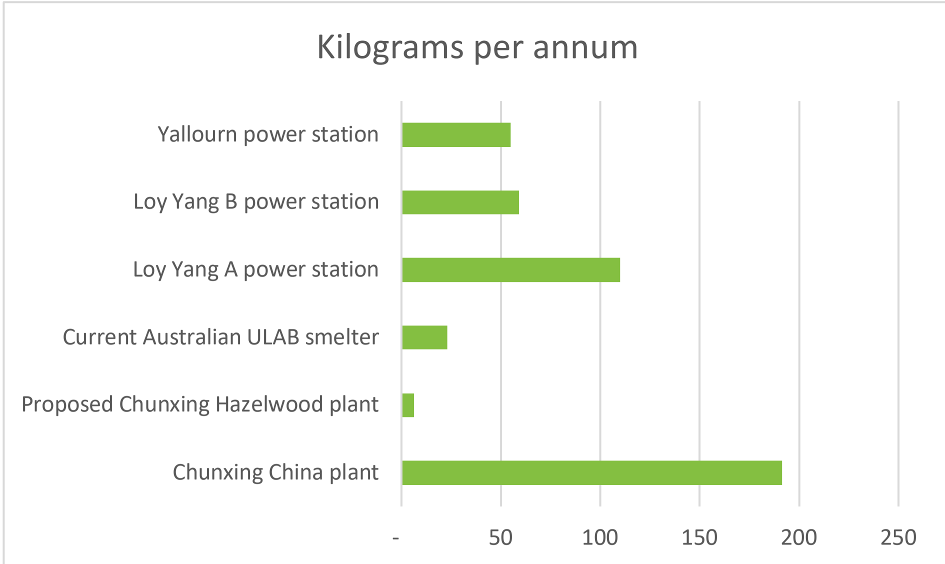
1. = as total dust
2. = as PM10



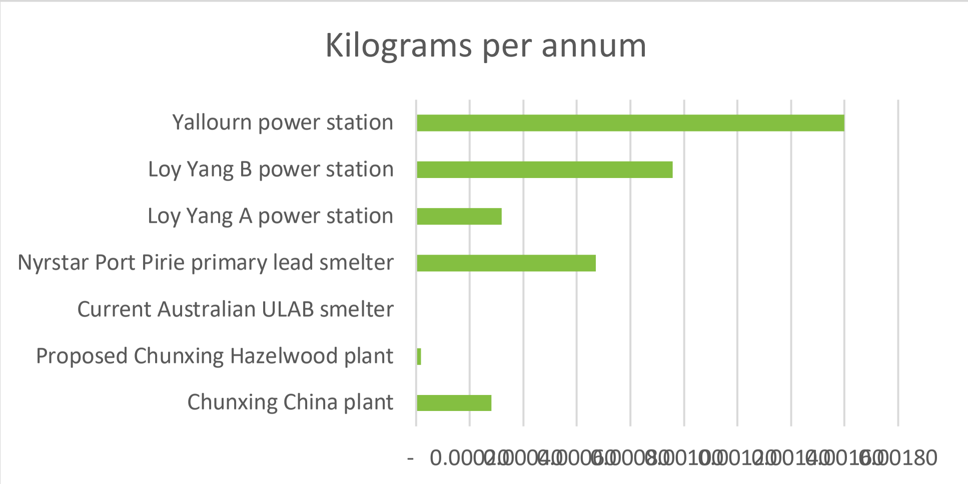


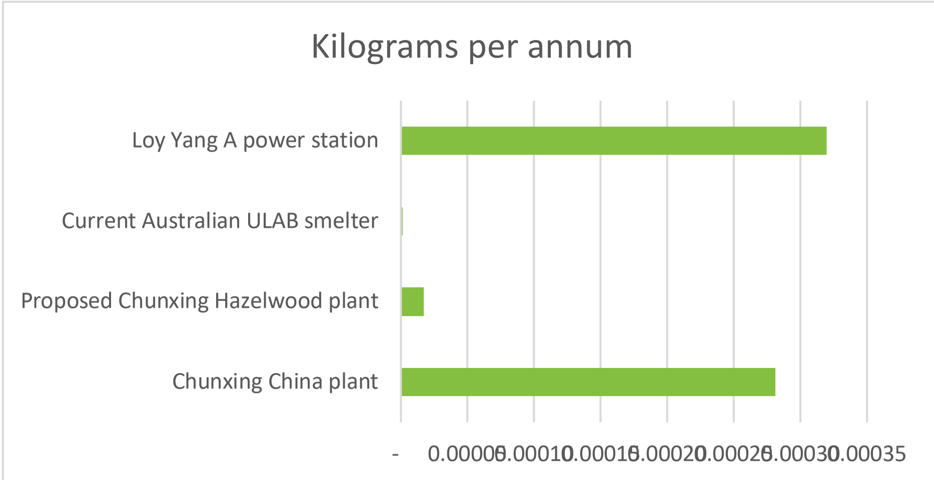
Lead emission unit of measure	Lead emission facility								
	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Hydromet Laverton licence limit	Loy Yang A power station	Loy Yang B power station	Yallourn power station	NPI secondary lead emission factor (controlled)
Kilograms per year	274	16	275	58,000	2,628	130	73	150	-
Grams per minute	0.52	0.031	0.52	110	5	0.25	0.14	0.29	-
Ratio of emission per year	17	1	17	3,515	159	8	4	9	-
Gram per tonne of ULABs processed	0.34	0.33	6.0	N/A	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	0.61	0.59	11	94	N/A	N/A	N/A	N/A	150



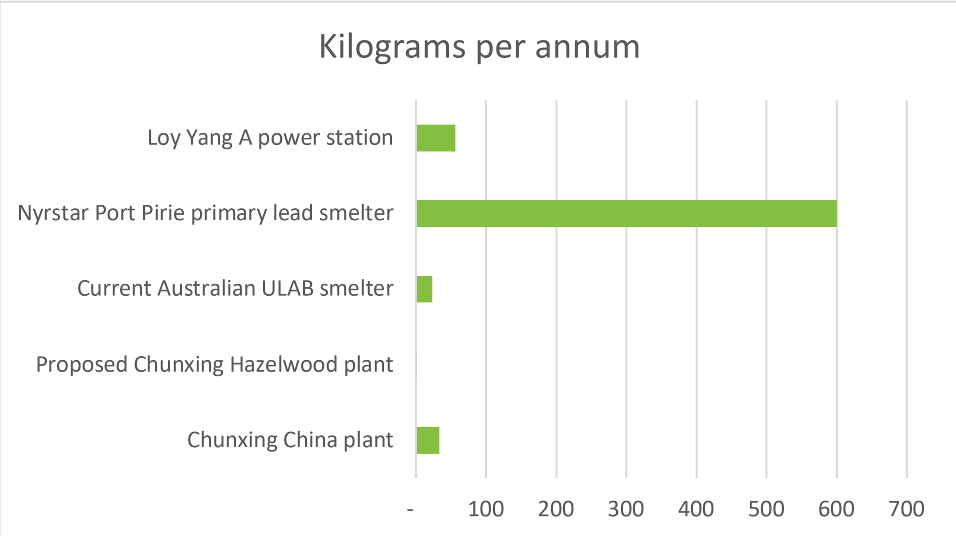


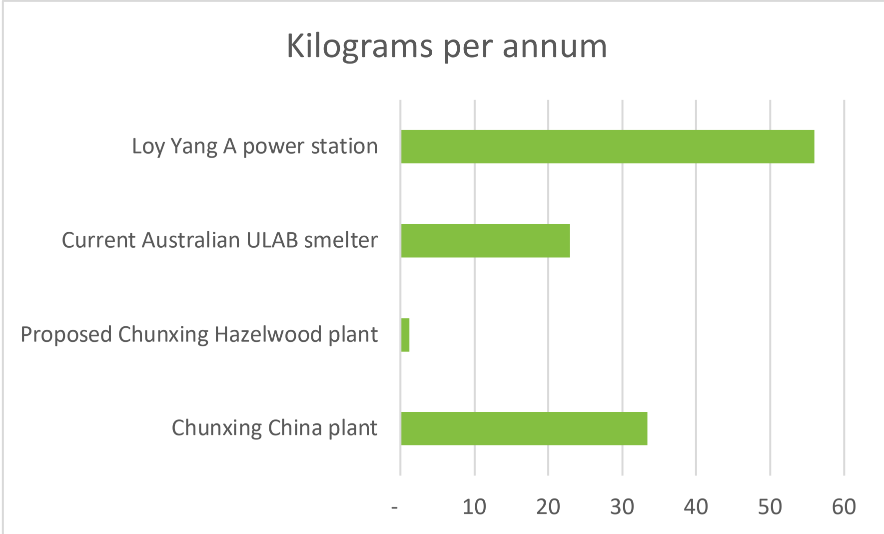
	Dioxins emission facility							
Dioxins emission unit of measure	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Loy Yang A power station	Loy Yang B power station	Yallourn power station	NPI secondary lead emission factor (controlled)
Kilograms per annum	0.00028	0.00001738	0.0000011	0.00067	0.00032	0.00096	0.00160	-
Grams per minute	0.000000535	0.000000033	0.000000002	0.000001275	0.000000608	0.000001821	0.000003044	-
Ratio of emissions per year	16	1	0.1	39	18	55	92	-
Gram per tonne of ULABs processed	0.0000004	0.0000003	0.00000002	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	0.0000006	0.0000006	0.00000005	0.000001	N/A	N/A	N/A	-



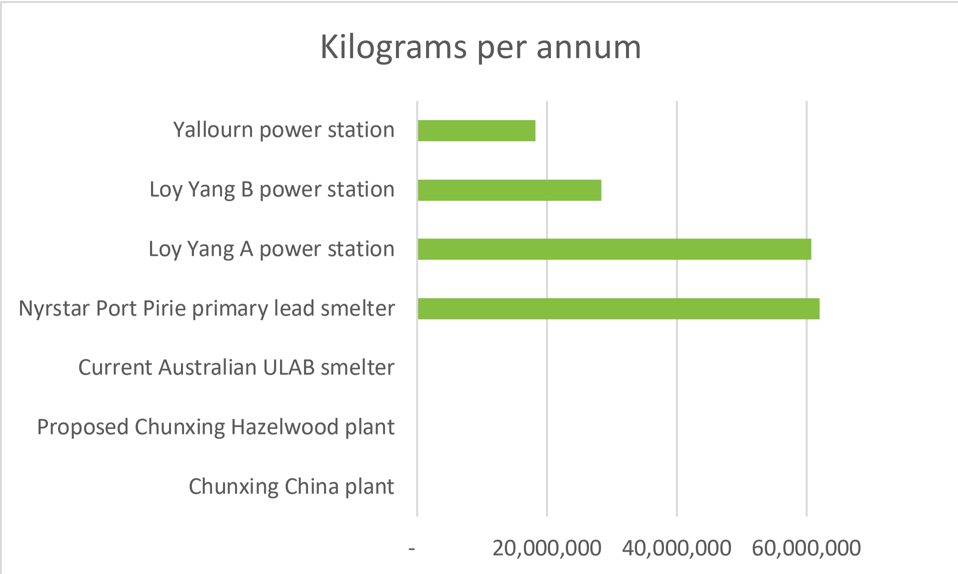


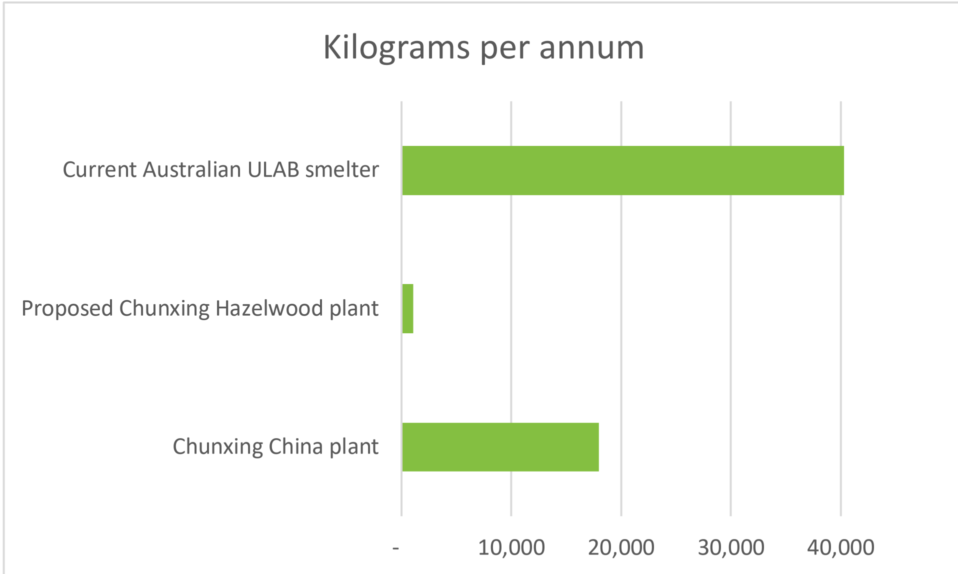
	Antimony emission facility				
Antimony emission unit of measure	Chunxing China plant	Proposed Chunxing Hazelwood plant	Current Australian ULAB smelter	Nyrstar Port Pirie primary lead smelter	Loy Yang A power station
Kilograms per annum	33	1.2	22.9	600	56
Grams per minute	0.06	0.002	0.04	1	0.11
Ratio of emissions per year	27	1	18.5	485	45
Gram per tonne of ULABs processed	0.04	0.02	0.498	N/A	N/A
Gram per tonne of lead produced	0.07	0.04	0.955	1	N/A





	SO_2 emission facility							
SO_2 emission unit of measure	**Chunxing China plant**	**Proposed Chunxing Hazelwood plant**	**Current Australian ULAB smelter**	**Nyrstar Port Pirie primary lead smelter**	**Loy Yang A power station**	**Loy Yang B power station**	**Yallourn power station**	**NPI secondary lead emission factor (controlled)**
Kilograms per annum	17,991	1,124	40,298	62,000,000	60,700,000	28,400,000	18,200,000	-
Grams per minute	34	2	77	117,960	115,487	54,033	34,627	-
Ratio of emissions per year	16	1	36	55,140	53,984	25,258	16,186	-
Gram per tonne of ULABs processed	22	22	876	N/A	N/A	N/A	N/A	-
Gram per tonne of lead produced	40	40	1,679	100,000	N/A	N/A	N/A	27,000





Appendix J

Relevant offence declaration