MAULES CREEK COAL MINE - MOBILE COAL SIZING AND WASTE TYRE DISPOSAL

MODIFICATION REPORT

SEPTEMBER 2021
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1 INTRODUCTION

This Modification Report has been prepared by Maules Creek Coal Pty Ltd (MCC) for the Maules Creek Coal Mine (MCCM) Mobile Coal Sizing and Waste Tyre Disposal Modification (the Modification).

The MCCM is an open cut coal mine located in the Gunnedah Basin of New South Wales (NSW) approximately 17 kilometres (km) north-east of Boggabri in the Narrabri Local Government Area (LGA) (Figure 1-1). Operating since 2014, the MCCM employs approximately 650 full-time personnel and supports a significant indirect workforce within the region.

The MCCM is a joint venture between Aston Coal 2 Pty Ltd (a wholly owned subsidiary of Whitehaven Coal Limited [Whitehaven]) (75 percent [%]), ICRA MC Pty Ltd (a wholly owned subsidiary of Itochu Corporation) (15%) and J-Power Australia Pty Ltd (a wholly owned subsidiary of Electric Power Development Company) (10%).

1.1 APPROVALS HISTORY

Project Approval (PA) 10_0138 for the MCCM was issued under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) in 2012 and has been modified on six occasions. The most recent modification received approval from the NSW Minister for Planning and Public Spaces on 24 August 2021.

The MCCM was granted approval under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2013 (approval EPBC 2010/5566).

1.2 OVERVIEW OF THE MCCM

The approved MCCM general arrangement, including the approximate disturbance extent and associated mining and coal leases, is shown on Figure 1-2.

The Project Boundary and the real property descriptions associated with the MCCM are included in PA 10_0138.

Land surrounding the MCCM includes Crown land, land owned by Whitehaven and other nearby mining operations, and other privately-owned land (Appendix 4 of PA 10_0138).

As well as the open cut and associated waste rock emplacements, the MCCM includes water supply pipelines and pump stations, electricity transmission lines and switching substation, coal handling and processing plant (CHPP) and its associated facilities, water management infrastructure and other infrastructure.

Mine Infrastructure

The Mine Infrastructure Area (MIA) includes run-of-mine (ROM) coal stockpiles and product coal stockpiles, CHPP, train load out infrastructure, workshops and administration buildings, hardstand and laydown areas, car parking, wash bays and other associated infrastructure.

Mine Operations

The MCCM is authorised to extract up to 13 Million tonnes per annum (Mtpa) of ROM coal and transport up to 12.4 Mtpa of product coal from the site by rail to 31 December 2034. Mining operations are undertaken 24 hours per day, seven days per week.

ROM coal extracted from the open cut is sized using primary, secondary and tertiary coal sizing equipment and screens located in the CHPP. Sized coal is either processed (washed) in the CHPP or bypassed to the product coal stockpile.

Stockpiled product coal is loaded onto trains which travel via the Maules Creek Rail Spur, Shared Rail Spur, and the Werris Creek to Mungindi Railway Line to the Port of Newcastle.

The MCCM fleet includes excavators, loaders, haul trucks, graders, dozers, water carts and other ancillary equipment such as mulchers, rollers, generators, service trucks and lighting plants. The use of mine fleet equipment varies with the progression of the mine.

Waste Tyre Management

Consistent with the description of waste management within the *MCCM Operations Plan* (MCC, 2020b), used heavy vehicle tyres are currently stockpiled in preparation for disposal in the MCCM emplacement areas (however no disposal currently occurs).

LEGEND
- MCCM Mining Tenement Boundary (CL and ML)
- Mine Site
- Local Government Boundary
- State Forest
- State Conservation Area, Aboriginal Area
- Rail Line

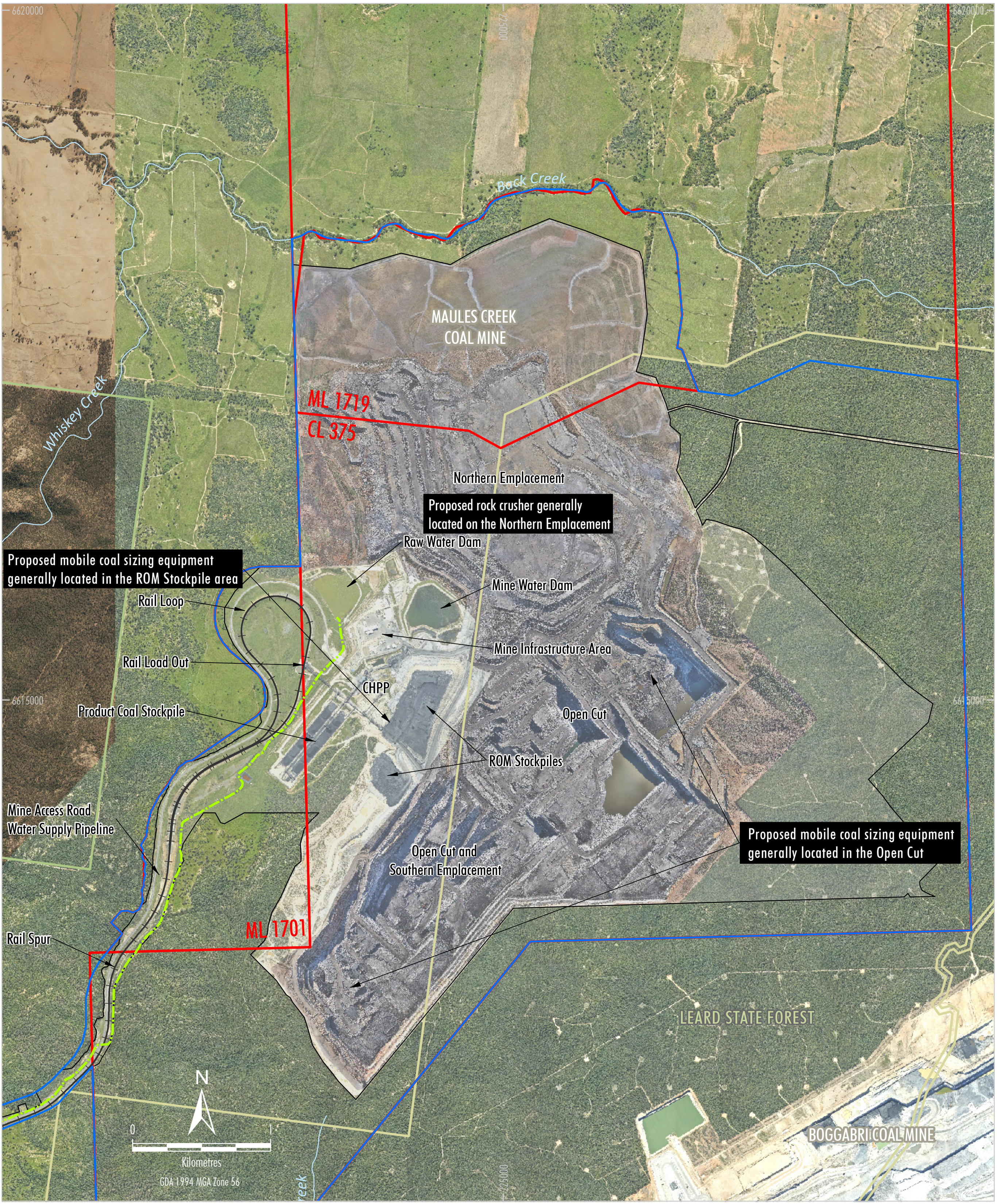
Source: NSW Spatial Services (2019); Geoscience Australia (2011).

WHITEHAVEN COAL

MAULES CREEK COAL MINE

Regional Location

Figure 1-1



LEGEND

- MCCM Mining Tenement Boundary (ML and CL)
- MCCM Approximate Extent of Existing/Approved Surface Development
- MCCM Project Boundary
- State Conservation Area, Aboriginal Area
- State Forest
- Rail Line
- Maules Creek Coal Water Supply Pipeline

Source: NSW Spatial Services (2019); Orthophoto: Whitehaven Coal (2021)

WHITEHAVEN COAL

MAULES CREEK COAL MINE

Approved Mine General Arrangement Incorporating the Modification

Figure 1-2

A range of measures are implemented at the MCCM for the purpose of extending the operational lifespan of mining equipment tyres and minimising disposal rates. These measures include road design, mining equipment speed limits, regular tyre inspection and maintenance, repair of tyres as far as reasonably practicable without impacting safe operation of equipment, and consideration of other beneficial use on-site where practical (e.g. re use as bunding, for intersection construction, etc.).

Environmental Monitoring and Management

MCC prepares and implements environmental plans, strategies and programs in accordance with PA 10_0138 and EPBC Act approval 2010/5566. The following plans are considered relevant to the Modification and are discussed further in Section 6:

- *MCCM Noise Management Plan* (NMP) (MCC, 2014).
- *MCCM Air Quality and Greenhouse Gas Management Plan* (AQMP) (MCC, 2020a).

1.3 OVERVIEW OF THE MODIFICATION

1.3.1 Mobile Coal Sizing

Through ongoing mine planning, MCC has identified an opportunity to improve operating efficiencies at the MCCM through the use of mobile coal sizing equipment. MCC therefore proposes to use mobile coal sizing and associated equipment located in the vicinity of the ROM stockpile area or within the open cut pit. The mobile coal sizing equipment would be used over the remaining mine life to optimise the mix of bypass coal and washed coal transported from the site in response to coal market conditions.

1.3.2 Mobile Rock Crushing

In addition, MCC proposes to use a mobile rock crusher located in the Northern Emplacement Area to resize waste rock to be used on-site for construction, maintaining roads and drainage.

1.3.3 Waste Tyre Disposal

MCC proposes to dispose of used heavy vehicle tyres in the waste rock emplacement areas, consistent with the description of waste management within the *MCCM Mining Operations Plan* (MCC, 2020b).

1.3.4 Summary of the Modification

Accordingly, this Modification seeks approval for:

- the use of mobile coal sizing equipment located in the vicinity of the ROM stockpile area and within the open cut pit;
- the use of mobile rock crushing equipment located in the Northern Emplacement Area; and
- disposal of waste heavy vehicle tyres in the waste rock emplacement areas.

The Modification does not propose to change the approved ROM coal extraction or product coal transport rates for the MCCM, nor any other operational or closure aspect of the MCCM. Further, the Modification can be implemented in accordance with the existing environmental limits and performance measures for the MCCM, and with no increase to the approved disturbance footprint.

A detailed description of the Modification is provided in Section 3.

1.3.5 Alternatives Considered

Coal Sizing

The proposed mobile coal sizing equipment is considered an efficient means of improving operations at the MCCM. The alternative of augmenting the existing coal sizing equipment in the CHPP is not preferred at this time given it would take significantly longer to implement than the Modification and involve greater operational disruption.

Rock Crushing

On-site sourcing of rock for construction, road maintenance and drainage is considered the only viable option. Importing rock from off-site for this purpose would be cost-prohibitive and may result in greater environmental impacts (i.e. due to road haulage).

Waste Tyre Disposal

Recycling of waste heavy vehicle tyres is not considered to be feasible or viable for the MCCM and therefore on-site disposal is the preferred management strategy for this waste stream (Section 7).

MCC would continue to investigate feasible and reasonable opportunities for recycling waste heavy vehicle tyres from the MCCM at a regional location as options become available during the remainder of the mine life.

1.4 REPORT CONTENT

This Modification Report has been developed in accordance with the *State Significant Development Guidelines – Preparing a Modification Report* (NSW Department of Planning, Industry and Environment [DPIE], 2021a) and includes:

- a description of the approved MCCM and the Modification (Section 1);
- a description of the strategic context for the Modification (Section 2);
- a detailed description of the Modification (Section 3);
- a description of the statutory context for the Modification (Section 4);
- a summary of community engagement carried out for the Modification (Section 5);
- a summary of the potential minimal air quality and noise impacts of the proposed mobile coal sizing and rock crushing activities (Section 6);
- a review of the proposed waste tyre disposal methodology (Section 7); and
- evaluation of the Modification (Section 8).

Supporting information is provided as follows:

- Noise Assessment prepared by RWDI Australia (RWDI) (Attachment A).
- Air Quality and Greenhouse Gas Assessment prepared by Todoroski Air Sciences (TAS) (Attachment B).
- Supporting Information on Waste Tyre Disposal (Attachment C)
- Whitehaven Waste Tyre Disposal Environmental Procedure (Attachment D)

2 STRATEGIC CONTEXT

The Modification would provide for the ongoing safe and efficient extraction of a significant coal resource that State and Commonwealth governments have approved to be mined, subject to the environmental performance measures and conditions of the relevant State and Commonwealth approvals.

The Modification is of strategic importance to MCCM, as it would:

- provide MCC an option to optimise the mix of bypass coal and washed coal transported from the site in response to coal market conditions, while maintaining currently approved ROM coal extraction and product coal transport rates;
- enable MCC to utilise crushed rock that would otherwise be emplaced for construction, road maintenance and drainage; and
- provide MCC with the ability to safely dispose of waste heavy vehicle tyres on-site and with minimal environmental impact.

The Modification can be implemented in accordance with the existing environmental limits and performance measures for the MCCM, and with no increase to the previously approved disturbance footprint of the MCCM.

3 DESCRIPTION OF THE MODIFICATION

3.1.1 Mobile Coal Sizing

The mobile coal sizing equipment would include two impact crusher units (also known as impactors or horizontal shaft impactors) which are designed with in-built screens for primary, secondary, or tertiary sizing applications.

The mobile coal sizing equipment would be operated up to 24 hours per day, 7 days per week, and process up to 2.2 Mtpa of ROM coal (combined capacity) when in use.

The proposed mobile coal sizing circuit would include the use of:

- Existing haul trucks to transport ROM coal to the mobile coal sizing equipment located in the ROM stockpile area or the open cut pit (i.e. the Modification does not involve additional haul trucks).
- Two mobile coal sizing units and new rehandling equipment (two excavators and a dozer) to size and rehandle ROM coal.
- Existing haul trucks to transport sized coal to the existing ROM stockpile area for rehandling (when mobile coal sizing equipment is located in-pit).
- Articulated dump trucks to transport sized coal to the existing product stockpiles where it is stockpiled using a radial stockpiler and then reclaimed and conveyed to the rail load-out.

3.1.2 Mobile Rock Crushing

The mobile rock crusher would be located generally in the Northern Emplacement Area and would process approximately 0.4 Mtpa of waste rock (<1% of waste rock generated annually on site), operating up to 7 days per week in day time hours when in use. The crushed waste rock that would otherwise be emplaced would be used on-site for construction, road maintenance and drainage. Existing mine fleet would be used to transport waste rock to the mobile rock crusher where it is crushed and stockpiled before being transported for use at locations across the site.

3.1.3 Waste Tyre Disposal

MCC proposes to dispose of used waste heavy vehicle tyres in the MCCM emplacement areas, consistent with the description of waste management within the *MCCM Mining Operations Plan* (MCC, 2020b). Used tyres from mining equipment would continue to be stockpiled on-site prior to disposal within emplacement areas.

It is estimated up to approximately 400 waste heavy vehicle tyres from mining equipment would be stockpiled per year of operation and require disposal within waste rock emplacements.

In addition, waste tyres which have been stockpiled since the commencement of operations at the MCCM would also be required to be disposed within waste rock emplacements. Disposal of these tyres would be staggered to optimise disposal locations and volumes.

The waste tyre disposal methodology is described in Section 7 along with the environmental management measures implemented when disposing heavy mining equipment waste tyres.

3.1.4 MCCM Components Not Changing

The Modification would not change the approved ROM coal extraction or product coal transport rates, nor change the workforce at the MCCM. The Modification does not involve additional land disturbance or changes to the approved MCCM mine life, operating hours, coal rejects management, water management, or any material change to waste rock management. The Modification does not propose to change any other operational or closure aspect of the approved MCCM.

A summary of the relevant aspects of the approved MCCM and the Modification is provided in Table 3-1.

Table 3-1
Comparison of the Approved MCCM and the Modification

Project Component	Approved MCCM	MCCM Incorporating the Modification
Mining Operations	24 hours per day, 7 days per week until the end of December 2034.	No change.
Coal Extraction	Open cut mining methods extracting up to 13 Mtpa of ROM coal (calendar year).	No change.
Coal Transport	Up to 12.4 Mtpa (calendar year) from the site by rail.	No change.
Coal Handling and Preparation	Primary, secondary and tertiary sizing and screening of ROM coal within the MIA before processing (washing) in the CHPP or bypassing to the product coal stockpile. Product coal stockpiled before being reclaimed and conveyed to train load-out.	Additional mobile coal sizing equipment located in the vicinity of the existing ROM stockpile area or within the open cut pit.
Operational Workforce	650 full-time equivalent employees.	No change.
Waste Rock Management	Waste rock emplacement within the out-of-pit Northern Emplacement Area and the in-pit Southern Emplacement Area.	Mobile crusher used to process a minor portion (<1 %) of waste rock generated on-site for construction, road maintenance and drainage.
Water Demand and Supply	Water demand met by water captured by the on-site water management system and supplementary licensed sources (Namoi River and groundwater).	No change.
Water Management	Usage of mine water and sediment laden water on-site for mine activities. Diversion of up-catchment clean water to downstream environment.	No change.
Waste Management	Stockpiling and ongoing management of heavy vehicle waste tyres.	Stockpiling, ongoing management and disposal of heavy vehicle waste tyres within emplacement areas.

4 STATUTORY CONTEXT

This section outlines the planning framework and statutory context relevant to the assessment of the Modification.

4.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

MCCM was declared to be State Significant Development (SSD) for the purposes of the EP&A Act on 17 August 2018. Approval for the Modification is sought under section 4.55(1A) of the EP&A Act which states:

> ***Modifications involving minimal environmental impact***
>
> *A consent authority may, on application being made by the applicant or any other person entitled to act on a consent granted by the consent authority and subject to and in accordance with the regulations, modify the consent if—*
>
> *(a) it is satisfied that the proposed modification is of minimal environmental impact, and*
>
> *(b) it is satisfied that the development to which the consent as modified relates is substantially the same development as the development for which the consent was originally granted and before that consent as originally granted was modified (if at all), and*
>
> *(c) it has notified the application in accordance with—*
>
> *(i) the regulations, if the regulations so require, or*
>
> *…*
>
> *(d) it has considered any submissions made concerning the proposed modification within any period prescribed by the regulations…*

With respect to section 4.55(1A)(a), MCC considers the Modification to be of minimal environmental impact for the reasons outlined in Sections 6 and 7 of this report.

With respect to section 4.55(1A)(b), clause 3BA(6) in Schedule 2 to the *Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017* operates such that the consent authority must only be satisfied that the proposed modified development is substantially the same as the development approved by the most recent modification of PA 10_0138 under section 75W of the EP&A Act (i.e., Modification 3).

Based on the information contained in this report, the consent authority can be satisfied that the MCCM incorporating the Modification would remain substantially the same as the development authorised by PA 10_0138 as last modified by Modification 3.

Additionally, section 4.55(3) of the EP&A Act states:

> *In determining an application for modification of a consent under this section, the consent authority must take into consideration such of the matters referred to in section 4.15(1) as are of relevance to the development the subject of the application. The consent authority must also take into consideration the reasons given by the consent authority for the grant of the consent that is sought to be modified.*

Table 4-1 provides details of the consideration of relevant matters in section 4.15(1) of the EP&A Act for the Modification.

The following reasons for the grant of development consent for the MCCM are considered relevant to this Modification:

- Noise and dust mitigation measures would be implemented, including predictive meteorological forecasting and real-time dust and noise monitoring to provide adaptive management and mine planning.
- The MCCM would be operated in accordance with conditions in PA 10_0138 for managing potential environmental impacts including noise, air quality, greenhouse gas emissions, and water resources.
- On balance, the benefits of the MCCM outweigh its residual impacts and it is in the public interest to be approved subject to conditions.

The consent authority can be satisfied of the relevant matters in the EP&A Act.

4.1.1 Environmental Planning and Assessment Regulation 2000

Clause 92(1)(d)(ii) of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) requires that the consent authority consider the *Dark Sky Planning Guideline* (Department of Planning and Environment [DP&E], 2016). The Modification would not change night-lighting activities at the MCCM, nor the previously approved impacts on the Siding Springs Observatory or Dark Sky Region.

Table 4-1
Relevant Considerations of Section 4.15(1) of the EP&A Act

Relevant Matters in Section 4.15(1) of the EP&A Act	Response Summary
Matters for consideration—general *In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application—* *(a) the provisions of—* *(i) any environmental planning instrument, and* *…*	State Environmental Planning Policies (SEPPs) of potential relevance to the Modification are considered in Section 4.3 of this report. The MCCM is within the Narrabri Shire Council LGA, for which the *Narrabri Local Environmental Plan* (Narrabri LEP) is relevant (Section 4.4 of this report).
(iii) any development control plan, and	Clause 11 of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP) states that development control plans do not apply to SSD.
(iiia) any planning agreement that has been entered into under section 7.4, or any draft planning agreement that a developer has offered to enter into under section 7.4, and	The existing planning agreement would continue to apply for the development as proposed to be modified.
(iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph), *…* *that apply to the land to which the development application relates,*	Relevant provisions of the EP&A Regulation are considered in Section 4.1.1 of this report.
(b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,	MCC considers the Modification to be of minimal environmental impact for the reasons outlined in Sections 6 and 7 of this report.
(c) the suitability of the site for the development, *…*	The Modification can be implemented in accordance with the existing environmental limits and performance measures for the MCCM, and with no increase to the previously approved disturbance footprint.
(e) the public interest.	The Modification would provide for the ongoing efficient extraction of a significant coal resource that State and Commonwealth governments have approved to be mined, subject to the conditions of the relevant State and Commonwealth approvals.

The application for this Modification contains all of the information required under clause 115(1) of the EP&A Regulation.

Clause 115(8) of the EP&A Regulation also relevantly states:

> *An application for modification of a development consent under Section 4.55(1), (1A) or (2) or 4.56(1) of the Act relating to land owned by a Local Aboriginal Land Council may be made only with the consent of the New South Wales Aboriginal Land Council.*

The MCCM Project Approval includes land that is owned by Red Chief Local Aboriginal Land Council. As such, the consent requirements of the NSW Aboriginal Land Council will be attended to in respect of this Modification.

Clause 117 of the EP&A Regulation (which relates to minimal impact modifications) is not considered to be relevant to this Modification of SSD (Clause 117[3B]).

The consent authority can be satisfied of the relevant matters in the EP&A Regulation.

4.2 OTHER NSW LEGISLATION

The following NSW legislation is not considered to be relevant to the Modification for the reasons stated below:

- An application to change the MCCM tenements under the NSW *Mining Act 1992* (Mining Act) is not proposed given the Modification does not involve development which requires a mining lease to be issued to enable the development to be carried out. Other relevant Mining Act matters are discussed below in Section 4.2.1.

- An Aboriginal cultural heritage impact permit under Section 90 of the NSW *National Parks and Wildlife Act 1974* is not required for the Modification (Section 4.41 of the EP&A Act). Further, the Modification does not seek to change the approved surface development extent and therefore would not involve additional potential impacts on Aboriginal cultural heritage to those previously assessed.
- The Modification does not seek to change the approved surface development extent. Therefore, the consent authority can be satisfied the Modification would not increase the impact on biodiversity values, including on endangered ecological communities and critically endangered ecological communities. A biodiversity development assessment report is not required under Part 7 of the NSW *Biodiversity Conservation Act 2016*.
- The Modification does not propose any changes to MCCM's licenced supplementary water supply from the Namoi River and groundwater sources, which would continue to be managed in accordance with the applicable requirements of the NSW *Water Management Act 2000* (WM Act) and approved *MCCM Water Management Plan* (MCC, 2019).

MCC would continue to obtain the necessary licences and approvals under the relevant legislation as required, including revisions to relevant plans, licences or agreements to incorporate the Modification.

4.2.1 Protection of the Environment Operations Act 1997

The MCCM is currently licensed under Environment Protection Licence (EPL) 20221 to conduct "mining for coal" and "coal works" as defined in Schedule 1 of the NSW *Protection of the Environment Operations Act 1997*.

Given the proposed mobile coal sizing and rock crushing activity would be implemented in accordance with all existing limits on air quality and noise impacts of the MCCM, no variation of EPL 20221 is expected to be required for these activities.

EPL 20221 would be varied for the proposed waste tyre disposal activity in consultation with the NSW Environment Protection Authority (EPA) (Section 5).

4.2.2 Mining Act 1992

The Mining Act regulates environmental protection and rehabilitation of all mining leases, including the requirement for the submission of a Mining Operation Plan. The *MCCM Mining Operations Plan* (MCC, 2020b) or its replacement instrument would be updated to incorporate the Modification.

Under Section 380AA of the Mining Act, MCC is required to procure the written consent of the holders of the MCCM's mining leases to make this modification application. Pursuant to Section 380AA of the Mining Act, the current registered holders of the MCCM mining tenements, being Aston Coal 2 Pty Ltd, ICRA MC Pty Ltd, and J Power Australia Pty Ltd, have provided written consent to MCC to lodge the application for this Modification.

4.3 STATE ENVIRONMENTAL PLANNING POLICIES

The *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) and *State Environmental Planning Policy No 55 – Remediation of Land* (SEPP 55) are considered relevant to the Modification and are described below.

4.3.1 Mining SEPP

Clause 2

Clause 2 of the Mining SEPP relevantly states:

> *The aims of this Policy are, in recognition of the importance to New South Wales of mining, petroleum production and extractive industries—*
>
> *(a) to provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of the State, and*
>
> *(b) to facilitate the orderly and economic use and development of land containing mineral, petroleum and extractive material resources, and*
>
> *(b1) to promote the development of significant mineral resources, and*
>
> *(c) to establish appropriate planning controls to encourage ecologically sustainable development through the environmental assessment, and sustainable management, of development of mineral, petroleum and extractive material resources, and…*

The consent authority can be satisfied the Modification is consistent with the relevant aims of the Mining SEPP because:

- The Modification provides for the ongoing safe and efficient extraction of a significant coal resource that State and Commonwealth Governments have approved to be mined, subject to the conditions of the relevant State and Commonwealth approvals.
- The Modification can be implemented in accordance with the existing environmental limits and performance measures for the MCCM, and with no increase to the previously approved disturbance footprint of the MCCM.

Clause 7

Clause 7(1) of the Mining SEPP relevantly states:

> ***Mining*** *Development for any of the following purposes may be carried out only with development consent—*
>
> *…*
>
> *(b) mining carried out—*
>
> *(i) on land where development for the purposes of agriculture or industry may be carried out (with or without development consent), or*
>
> *(ii) on land that is, immediately before the commencement of this clause, the subject of a mining lease under the Mining Act 1992 or a mining licence under the Offshore Minerals Act 1999,*
>
> *…*

The Modification is entirely within MCCM's existing mine tenements and approved Project Boundary, where development for the purposes of agriculture or industry may be carried out (with or without consent) under the Narrabri LEP.

Clause 12

Clause 12 of the Mining SEPP states that:

> ***Compatibility of proposed mine, petroleum production or extractive industry with other land uses***
>
> *Before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must—*
>
> *(a) consider—*
>
> *(i) the existing uses and approved uses of land in the vicinity of the development, and*
>
> *(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and*
>
> *(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and*
>
> *(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a)(i) and (ii), and*
>
> *(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a)(iii).*

The MCCM incorporating the Modification is considered compatible with existing land uses in proximity to the MCCM, which consists of coal mining, agriculture, state forest, rural residences and the townships of Baan Baa and Boggabri.

Potential air quality and noise impacts of the proposed coal sizing and rock crushing activities on nearby land uses are predicted to be minor (Section 6).

Clause 12AB – Non-Discretionary Development Standards for Mining

Clause 12AB identifies non-discretionary development standards for the purposes of section 4.15(2) of the EP&A Act. Section 4.15(2) of the EP&A Act prescribes:

> *If an environmental planning instrument or a regulation contains non-discretionary development standards and development, not being complying development, the subject of a development application complies with those standards, the consent authority—*
>
> *(a) is not entitled to take those standards into further consideration in determining the development application, and*
>
> *(b) must not refuse the application on the ground that the development does not comply with those standards, and*
>
> *(c) must not impose a condition of consent that has the same, or substantially the same, effect as those standards but is more onerous than those standards,*

and the discretion of the consent authority under this section and section 4.16 is limited accordingly.

Table 4-2 provides details of the non-discretionary development standards listed in clause 12AB of the Mining SEPP and a summary of the environmental assessments carried out for the proposed coal sizing and rock crushing activities. The Modification is predicted to comply with the non-discretionary development standards in clause 12AB of the Mining SEPP.

Clause 13

Where applicable, clause 13(2) of the Mining SEPP relevantly states that:

Before determining an application to which this clause applies, the consent authority must—

(a) consider—

(i) the existing uses and approved uses of land in the vicinity of the development, and

(ii) whether or not the development is likely to have a significant impact on current or future extraction or recovery of minerals, petroleum or extractive materials (including by limiting access to, or impeding assessment of, those resources), and

(iii) any ways in which the development may be incompatible with any of those existing or approved uses or that current or future extraction or recovery, and

(b) evaluate and compare the respective public benefits of the development and the uses, extraction and recovery referred to in paragraph (a)(i) and (ii), and

(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a)(iii).

Table 4-2
Clause 12AB Non-Discretionary Development Standards for Mining

Subclause of Clause 12AB	Compliance of the Modification
(3) Cumulative noise level *The development does not result in a cumulative amenity noise level greater than the recommended amenity noise levels, as determined in accordance with Table 2.2 of the Noise Policy for Industry* (NPfI), *for residences that are private dwellings.*	The cumulative noise levels from the concurrent operation of the MCCM incorporating the Modification and other mining projects would comply with the recommended amenity noise level as determined in accordance with Table 2.2 of the NPfI and contained in PA 10_0138 at all relevant receivers (Section 6.1 and Attachment A).
(4) Cumulative air quality level *The development does not result in a cumulative annual average level greater than 25 μg/m^3 of PM_{10} or 8 μg/m^3 of $PM_{2.5}$ for private dwellings.*	The Modification would not result in any exceedances of the cumulative annual average level greater than 25 micrograms per cubic metre (μg/m^3) of PM_{10} or 8 μg/m^3 of $PM_{2.5}$ at any privately-owned dwelling when considered cumulatively with existing background sources and other mining projects (Section 6.2 and Attachment B).
(5) Airblast overpressure *Airblast overpressure caused by the development does not exceed:* *(a) 120 dB (Lin Peak) at any time, and* *(b) 115 dB (Lin Peak) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.*	MCC proposes no change to the existing blasting practices for the Modification. MCC will continue to comply with the relevant approved operational airblast overpressure conditions and limits in PA 10_0138 and EPL 22021.
(6) Ground vibration *Ground vibration caused by the development does not exceed:* *(a) 10 mm/sec (peak particle velocity) at any time, and* *(b) 5 mm/sec (peak particle velocity) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.*	
(7) Aquifer interference *Any interference with an aquifer caused by the development does not exceed the respective water table, water pressure and water quality requirements specified for item 1 in columns 2, 3 and 4 of Table 1 of the Aquifer Interference Policy for each relevant water source listed in column 1 of that Table.*	MCC proposes no change to the mining rate, extent or depth as a result of the Modification. MCCM incorporating the Modification would continue to have "minimal impact" (as defined by the Aquifer Interference Policy (AIP) [NSW Government, 2012]) to the water table, water pressure and water quality requirements for the relevant water source.

The Modification is entirely consistent and compatible with the currently approved land use, which is coal mining.

The Modification improves the efficiency of handling and processing coal resources approved to be mined at MCCM.

The Modification would not change the approved rehabilitation performance measures to create a final landform that is safe, stable and non-polluting, with a shape that is comparable with naturally occurring landforms in the region, that comprises self-sustaining native forest and woodland communities that are suitable for a conservation final land use.

As such, no additional measures to avoid or minimise incompatibility with existing and approved surrounding land uses are considered to be required.

Clause 14

Clause 14(1) and (2) of the Mining SEPP require that:

> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following—*
>
> *(a) that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable,*
>
> *(b) that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable,*
>
> *(c) that greenhouse gas emissions are minimised to the greatest extent practicable.*
>
> *(2) Without limiting subclause (1), in determining a development application for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider an assessment of the greenhouse gas emissions (including downstream emissions) of the development, and must do so having regard to any applicable State or national policies, programs or guidelines concerning greenhouse gas emissions.*

The Modification would not change the approved MCCM water management system or water demand and supply arrangements. Potential impacts on surface water and groundwater resources would continue to be managed in accordance with the applicable requirements of the WM Act and approved *MCCM Water Management Plan* (MCC, 2019).

The Modification would not change the approved surface development extent, nor the approved potential impacts on threatened species and biodiversity.

The Modification involves a negligible increase in total greenhouse gas emissions associated with the new mobile coal sizing equipment (Section 6.2).

Clause 15

Clause 15 of the Mining SEPP requires that:

> ***Resource Recovery***
>
> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider the efficiency or otherwise of the development in terms of resource recovery.*
>
> *(2) Before granting consent for the development, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at optimising the efficiency of resource recovery and the reuse or recycling of material.*
>
> *(3) The consent authority may refuse to grant consent to development if it is not satisfied that the development will be carried out in such a way as to optimise the efficiency of recovery of minerals, petroleum or extractive materials and to minimise the creation of waste in association with the extraction, recovery or processing of minerals, petroleum or extractive materials.*

The Modification would improve operating efficiencies at the MCCM by enabling MCC to optimise the mix of bypass coal and washed coal transported from the site in response to coal market conditions.

The MCCM incorporating the Modification would continue to progress in accordance with current approvals, including the maximum rate of ROM coal extraction and product coal transport, and environmental performance criteria (limits) for potential noise and air quality impacts.

Clause 16

Clause 16(1) of the Mining SEPP requires that:

> *Before granting consent for development for the purposes of mining or extractive industry that involves the transport of materials, the consent authority must consider whether or not the consent should be issued subject to conditions that do any one or more of the following—*
>
> *(a) require that some or all of the transport of materials in connection with the development is not to be by public road,*
>
> *(b) limit or preclude truck movements, in connection with the development, that occur on roads in residential areas or on roads near to schools,*
>
> *(c) require the preparation and implementation, in relation to the development, of a code of conduct relating to the transport of materials on public roads.*

The Modification would not change vehicle movements on public roads given it would not change employment or transportation of product coal from the site by rail. The MCCM incorporating the Modification would continue to progress in accordance with current approvals, including potential traffic and blasting impacts on public roads.

Clause 17

Clause 17(1) and (2) of the Mining SEPP require that:

> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development.*
>
> *(2) In particular, the consent authority must consider whether conditions of the consent should—*
>
> > *(a) require the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated, or*
> >
> > *(b) require waste generated by the development or the rehabilitation to be dealt with appropriately, or*
> >
> > *(c) require any soil contaminated as a result of the development to be remediated in accordance with relevant guidelines (including guidelines under clause 3 of Schedule 6 to the Act and the Contaminated Land Management Act 1997), or*
> >
> > *(d) require steps to be taken to ensure that the state of the land, while being rehabilitated and at the completion of the rehabilitation, does not jeopardize public safety.*

The Modification would not change the approved final landform, rehabilitation objectives or methodology of the MCCM.

Part 4AA

With respect to clause 17A of the Mining SEPP, the Modification does not involve development which requires a mining lease to be issued to enable the development to be carried out.

The consent authority can be satisfied as to the matters raised in the Mining SEPP.

4.3.2 SEPP 55 - Remediation of Land

SEPP 55 provides for the management of potential land contamination impacts resulting from a change in land use.

As the disposal of waste tyres is limited to previously approved emplacement areas, no change in land use would occur. In addition, the Modification area does not intersect any sites listed in the EPA's Contaminated Land Register. Therefore, SEPP 55 is not considered further for the Modification.

4.4 THE NARRABRI LOCAL ENVIRONMENTAL PLAN 2012

The MCCM is within the Narrabri Shire Council LGA, for which the Narrabri LEP is relevant. Clause 1.9 of the Narrabri LEP states that it is subject to the provisions of any State environmental planning policy that prevails over the Narrabri LEP.

Permissibility

Clause 2.3(2) of the Narrabri LEP relevantly provides:

> *The consent authority must have regard to the objectives for development in a zone when determining a development application in respect of land within the zone.*

The MCCM incorporating the Modification is within land zoned as RU1 – Primary Production under the Narrabri LEP. Development for the purpose of "open cut mining" is permissible with consent on lands zoned *RU1 – Primary Production* which has the following objectives:

> *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
>
> *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
>
> *To minimise the fragmentation and alienation of resource lands.*
>
> *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
>
> *To allow for non-agricultural land uses that will not restrict the use of other land for agricultural purposes.*

The Modification is consistent with the objectives of *RU1 - Primary Production* zone as it is considered to be consistent with the existing and approved mining operation and would not restrict the use of adjoining land uses.

4.5 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The Modification can be implemented in accordance with all conditions attached to the EPBC Act approval 2010/5566 and without affecting any additional items of or areas containing matters of national environmental significance.

5 COMMUNITY ENGAGEMENT

MCC consults with relevant State, Commonwealth and local government agencies on a regular basis in relation to the MCCM operations.

During the preparation of this Modification Report consultation has been conducted with key State government agencies, local council, the local community (including the Maules Creek Community Consultative Committee [CCC]), and neighbouring mines. A summary of consultation to date is provided below.

Consultation will continue during the assessment of the Modification.

5.1 NSW GOVERNMENT AGENCIES

DPIE – Planning & Assessment

MCC provided an overview of the Modification and technical assessments, the proposed approval pathway, and community consultation, in a phone meeting with DPIE – Planning & Assessment on 9 September 2021.

MCC sent a scoping letter to DPIE – Planning & Assessment on 9 September 2021 and received confirmation by letter dated 16 September 2021 that the Modification can progress and the proposed approval pathway (being a section 4.55[1A] Modification) was considered appropriate.

NSW Environment Protection Authority

Correspondence from the EPA regarding Whitehaven's Tarrawonga Coal Mine (dated October 2019) detailed the requirements that would need to be addressed in an environmental assessment for disposal of end-of-life mining equipment tyres within the emplacement areas. These requirements are addressed in this Modification Report as summarised in Table 5-1.

Waste tyre disposal modifications were recently approved for Whitehaven's Tarrawonga Coal Mine (TCM) (MOD 9) and Werris Creek Coal Mine (WCCM) (MOD 4) and Environmental Protection Licences varied accordingly. Feedback from the EPA on these approvals has been considered in this Modification Report.

MCC provided an email to the EPA on 2 September 2021 outlining the proposed coal sizing activity and key assessments for the Modification.

5.2 NARRABRI SHIRE COUNCIL

MCC holds regular meetings with Narrabri Shire Council (NSC) in relation to the MCCM.

Feedback from the NSC on the recent TCM (MOD 9) modification has been considered in this Modification Report.

The NSC was briefed on the Modification via the CCC (Section 5.3) and by MCC directly on 14 September 2021.

Table 5-1
EPA Waste Tyre Disposal Environment Assessment Requirements

EPA Environmental Assessment Requirement	Report Section
1. *A copy of any environmental impact assessment and planning approval that relates in-pit mine tyre disposal at Maules Creek Coal Mine.* *If this cannot be supplied, please provide an environmental impact assessment for the activity that includes but is not necessarily limited to:*	This Modification Report
a. the types of tyres to be disposed of onsite; *b. proposed locations for disposal of tyres;* *c. the method of disposal;* *d. any and all long-term effects that the disposal will have on mine rehabilitation;* *e. how disposal locations will be monitored; and* *f. how tyres will be tracked and recorded.*	Section 7.3
2. *An accurate estimate of the volume of tyres that would be disposed of on-site over the life of the mine.*	Section 7.2
3. *Consideration of alternate options for disposal including recycling, and justification as to why onsite disposal is the preferred option*	Section 7.1

Issues raised by NSC have been considered in this Modification Report as follows:

> *The supporting documentation should clearly outline the type of mobile plant to be utilised and ensure that the impact assessment has due regard to the operational particulars of the selected plant.*

The Noise Assessment prepared by RWDI and the Air Quality Assessment prepared by TAS for the Modification (Attachments A and B respectively) were based on the proposed mobile coal sizing circuit and site-specific information. The assessments are summarised in Section 6.

> *Coal dust emanating from wagons within the rail transportation corridor has been an ongoing issue of community concern within the Gunnedah Basin. As a consequence, it is recommended that the mechanisms for management of associated 'fines' be appropriately addressed and outlined in the submitted documentation along with intended mitigation measures.*

The Modification does not change the amount of product coal transported by rail from the MCCM (Section 3). Over the long term, the proportion of bypass coal transported from the MCCM would not materially change. Further, the proposed mobile coal sizing equipment would not change the physical properties of the bypass coal. Air quality emissions would therefore continue to be managed in accordance with the approved AQMP (as described in Section 6.2.1).

5.3 LOCAL COMMUNITY

Community Consultative Committee

The Maules Creek CCC was established in accordance with the PA 10_0138 to provide a mechanism for ongoing communication between MCC and the local community. Membership of the CCC includes representatives of the local community, the Narrabri Shire Council, and MCC, with meetings held quarterly.

MCC provided an overview of the proposed waste tyre disposal activity at the May 2021 CCC meeting. The proposed mobile coal sizing and rock crushing activities, and supporting technical assessments, were outlined to the CCC at the 8 September 2021 meeting.

Nearby Mining Operations

No direct interaction is expected between the Modification and the neighbouring Boggabri Coal Mine (BCM) and TCM. The increase in MCCM's contribution to cumulative noise and dust levels due to the proposed coal sizing and rock crushing activities is predicted to be negligible (Section 6).

MCC consulted with representatives of BCM on the Modification and technical assessments in September 2021. No material issues were raised.

Landholders

MCC also consults with relevant landholders regarding activities relating to the MCCM on an ongoing basis.

NSW Forestry Corporation were advised of MCC's intention to seek approval for the proposed Modification. The Local Aboriginal Land Council was briefed on the Modification.

Public Consultation

The Whitehaven Coal website provides environment and community information relating to the MCCM, including complaints register, compliance reports and approval documents. The MCCM community hotline (1800 942 836) allows members of the public to submit enquiries, feedback or complaints about the MCCM.

6 ASSESSMENT OF MOBILE COAL SIZING AND ROCK CRUSHING IMPACTS

The Modification would not change the MCCM mining or product coal transport rates and involves only a minor increase in mining fleet to include the mobile coal sizing and rock crushing equipment. The Modification is predicted to involve minimal incremental noise and air quality impacts as described in the following sections.

6.1 NOISE

A Noise Assessment was prepared by RWDI for the Modification (Attachment A) and considered the additional noise associated with the mobile coal sizing and waste rock crushing equipment. The assessment was conducted in accordance with the *Noise Policy for* Industry (NPfI) (NSW EPA, 2017b).

6.1.1 Background

Previous Assessment

Noise assessments of the approved MCCM were undertaken by Bridges Acoustics as part of the MCCM Environmental Assessment (EA) (Bridges Acoustics, 2011) and by Global Acoustics as part of the MCCM Mod 2 (Global Acoustics, 2014).

The most recent assessment of potential noise impacts associated with the approved MCCM was undertaken by Wilkinson Murray as part of the MCCM Modification 7 (Wilkinson Murray, 2020).

In relation to operational noise, the EA and Mod 2 noise assessment predicted certain privately-owned residences would experience significant noise impacts, while others would experience moderate or minor noise impacts. With the exception of Receiver 108, all of these privately-owned residences have since been acquired by Aston Coal 2 Pty Ltd or Boggabri Coal Pty Ltd. Receiver 108 was predicted to experience moderate noise impacts (i.e. between 37-40 A-weighted decibels [dBA]) (Bridges Acoustics, 2011).

The noise assessment for Modification 7 predicted Receiver 108 would experience exceedances of up to 5 dBA above the noise limits in PA 10_0138 under worst-case meteorological conditions and without the use of real-time and proactive mitigation measures.

Noise Management and Monitoring Regime

The ongoing management of noise at MCCM is undertaken in accordance with the approved NMP which includes:

- noise management objectives and PA 10_0138 noise criteria;
- noise controls and mitigation measures; and
- procedures for the management of exceedances and complaints.

MCC undertakes noise monitoring using a combination of operator-attended and continuous real-time noise monitoring at on-site and local monitoring locations.

In addition, MCC operates a comprehensive on-site noise management system in which predictive meteorological forecasting and real-time noise monitoring data guide the implementation of real-time and proactive noise management measures during adverse meteorological conditions.

Real-time noise management actions include:

- reviewing predicted weather conditions to identify if noise enhancing conditions are forecast;
- reviewing predicted noise impacts against actual observations;
- monitoring changes in noise levels; and
- reviewing noise generating activities and making preparations to reduce potential noise levels, including moving equipment into an acoustically protected area, augmenting equipment operations (e.g., number of items or operating speed), or temporarily shutting down certain equipment if noise levels remain elevated.

Compliance

MCCM has generally been operated in compliance with the existing PA 10_0138 noise criteria through a combination of property acquisition and the implementation of existing noise controls and management measures, including the real-time and proactive noise management system.

In the reporting period for the *MCCM 2020 Annual Review* (MCC, 2021a) MCCM recorded one exceedance of the $L_{Aeq(15minute)}$ criteria of 4 dBA on 1 April 2020, which included a 5 dBA low-frequency modifying factor. In addition, a limited number of mine equipment recorded sound power levels not in accordance with PA 10_0138 requirements (i.e. equal to or better than the sound power levels in the EA). All other monitoring results were compliant.

Complaints

MCC maintains a register of complaints in accordance with PA 10_0138. All noise related complaints received by MCC are responded to and investigated in accordance with the *MCCM Environmental Management Strategy* (MCC, 2021b).

One noise-related complaint was received in 2020 and responded to by reviewing monitoring data and operations.

A higher number of noise-related complaints have been received in 2021. MCC reviewed monitoring data and operations and provided a response to all complaints received. It is noted that attended noise monitoring results for 2021 (through to August) show compliance with the relevant noise limits.

6.1.2 Applicable Criteria

Existing noise assessment criteria for both MCCM-only and cumulative noise impacts are specified in PA 10_0138. RWDI has assessed potential noise impacts from the Modification against these criteria.

6.1.3 Impacts Assessment

For this Modification, RWDI adopted the contemporary MCCM noise model developed in accordance with the NPfI methodology for the Modification 7 noise assessment (Wilkinson Murray, 2020). This includes adoption of an inversion class consistent with the NPfI methodology (i.e. F-Class inversions). Further details of the modelling methodology are provided in Attachment A.

RWDI modelled and assessed the Modification using the Year 2021 and Year 2023 scenarios adopted for the Modification 7 noise assessment. These scenarios were selected for modelling as they represent operations with the greatest potential for noise impacts at nearby privately-owned receivers.

RWDI concluded (Attachment A):

- With the implementation of existing noise mitigation measures, including the real-time and proactive noise management system (i.e. augmentation of operations, plant shut-down during adverse meteorological conditions), the Modification would be implemented in accordance with the noise limits in PA 10_0138.
- Without the use of real-time and proactive noise management measures predicted night-time noise levels would increase by 1 dBA at up to ten privately-owned residences where noise levels are already predicted to exceed the PA 10_0138 criteria for the approved MCCM (depending on the location of mobile coal sizing equipment).
- Cumulative noise impacts resulting from MCCM incorporating the Modification and the concurrent approved Tarrawonga and Boggabri operations would comply with the PA 10_0138 criteria and NPfI amenity noise levels at all privately-owned residences.

6.1.4 Mitigation Measures

MCC would continue to implement existing noise mitigation measures described in the NMP, including the real-time and proactive noise management system, to comply with the noise limits in PA 10_0138. The NMP would be updated, where necessary, to incorporate the Modification.

6.2 AIR QUALITY

An Air Quality and Greenhouse Gas Impact Assessment has been undertaken by TAS (2021) for the Modification and is presented in Attachment B.

The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (NSW EPA, 2017a).

6.2.1 Background

Previous Assessment

An air quality and greenhouse gas assessment of the approved MCCM was undertaken by PAE Holmes as part of the MCCM Environmental Assessment (EA) (PAE Holmes, 2011). Pacific Environment Limited (PEL) also prepared an air quality assessment as part of the MCCM Modification 1 (Mod 1) (PEL, 2013).

The most recent assessment of potential air quality impacts associated with the approved MCCM was undertaken by TAS as part of the MCCM Modification 7 (TAS, 2020).

The EA and Mod 1 air quality assessments predicted certain privately-owned receptors would experience exceedances of PM_{10}[1] criteria for the MCCM-only and cumulatively. All of these privately-owned receptors have since been acquired by Whitehaven or its subsidiaries.

The Mod 7 assessment predicted that the approved MCCM would comply with relevant dust criteria at all privately-owned receptors for the MCCM-only and cumulatively.

The EA greenhouse gas assessment considered scope 1, 2 and 3 emissions and predicted that on average approximately 30 million tonnes of carbon dioxide equivalent emissions would occur each year.

Air Quality and Greenhouse Gas Management and Monitoring Regime

The ongoing management of air quality and greenhouse gas emissions at MCCM is undertaken in accordance with the approved AQMP, including:

- air quality and greenhouse gas management objectives and PA 10_0138 air quality criteria;
- dust and air quality controls and mitigation measures;
- procedures for the management of air quality exceedances and complaints; and
- procedures for minimising electricity use and diesel consumption.

MCC undertakes air quality and dust monitoring at on-site and local monitors, including three tapered element oscillating microbalance (TEOM) units measuring PM_{10} and $PM_{2.5}$[2] concentrations, a high-volume air sampler (HVAS) measuring PM_{10} and Total Suspended Particulate (TSP) concentrations, and four depositional dust gauges (DDG) measuring depositional dust.

Greenhouse gas emissions are reported in annual reviews and through MCC's participation in the National Greenhouse and Energy Reporting (NGER) Scheme.

Existing Dust Controls

Operational and physical mitigation measures are implemented as described in the AQMP to control dust generation and include (but are not limited to):

- use of water carts and/or sprays on coal-handling and stockpile areas to minimise dust generation as necessary and practicable;
- optimisation of fleet movements (e.g., modifying travel distances and speeds);
- enclosure of coal conveying and transfer equipment, where practicable; and
- modifying operations during adverse weather conditions (e.g., equipment shut-downs or relocation).

Compliance

In the reporting period for the *MCCM 2020 Annual Review* (MCC, 2021a) MCCM complied with all PA 10_0138 air quality criteria.

Complaints

All dust-related complaints received by MCC are responded to and investigated in accordance with the AQMP.

One dust-related complaint was received in 2020 and responded to by reviewing monitoring data and operations. No dust-related complaints have been received so far in 2021.

1 PM_{10} = Particulate matter with an equivalent aerodynamic diameter of 10 micrometres (μm) or less (a subset of TSP).

2 $PM_{2.5}$ = Particulate matter with an equivalent aerodynamic diameter of 2.5 μm or less (a subset of TSP and PM_{10}). Often referred to as the fine particles.

6.2.2 Applicable Criteria

Existing dust assessment criteria for both MCCM-only and cumulative dust impacts are specified in PA 10_0138. TAS has assessed potential air quality impacts from the Modification against these criteria.

6.2.3 Impacts Assessment

For this Modification, TAS adopted the contemporary MCCM air quality model developed for the Modification 7 air quality assessment. Further details of the modelling methodology are provided in Attachment B.

TAS modelled and assessed the Modification using the Year 2023 scenario adopted for the Modification 7 air quality assessment. This scenario was selected for modelling as it represents operations with the greatest potential for air quality impacts.

TAS also considered the additional diesel consumption associated with the proposed mobile coal sizing and rock crushing equipment. Associated greenhouse gas emissions were calculated using the relevant *National Greenhouse Accounts Factors* (Department of Industry, Science, Energy and Resources, 2020) methods.

TAS concluded (Attachment B):

- The incremental increase in dust levels due to the Modification is predicted to be minor for 24-hour average PM_{10} and annual-average TSP concentrations, and negligible for all other relevant dust metrics, and therefore not discernible at any privately-owned receptors.
- The MCCM incorporating the Modification would continue to comply with all relevant air quality criteria at all privately-owned receptors.
- The increase in MCCM's contribution to cumulative dust levels due to the Modification is predicted to be negligible and would not result in any additional exceedances of the relevant air quality criteria.
- Air quality emissions would continue to be managed in accordance with existing controls.
- The Modification would involve a negligible increase in annual greenhouse gas emissions.

6.2.4 Mitigation Measures, Management and Monitoring

MCC would continue to implement existing dust mitigation measures described in the AQMP, including operational and physical mitigation measures, to comply with the dust limits in PA 10_0138. Greenhouse gas emissions would continue to be minimised in accordance with PA 10_0138 and described in the AQMP. The AQMP would be updated, where necessary, to incorporate the Modification.

6.3 OTHER MATTERS

As described in Section 3, the Modification does not propose to change coal extraction or transport rates, employment, land disturbance, mine life, operating hours, or any other operational or closure aspect of the approved MCCM.

Consequently, there would be no change to the following approved potential impacts of the MCCM:

- land disturbance and associated biodiversity offsetting;
- Aboriginal heritage values;
- noise impacts associated with blasting activities;
- surface water and groundwater resources;
- road and rail transport;
- visual amenity and off-site lighting;
- waste generated by the project; and
- social and employment.

These matters would continue to be managed in accordance with MCC's existing State and Commonwealth project approval conditions and relevant management plans.

7 REVIEW OF WASTE TYRE DISPOSAL

7.1 FEASIBILITY OF WASTE TYRE RECYCLING

The following notes regarding the limited feasibility and viability of recycling waste heavy vehicle tyres have been primarily sourced from material included in Attachment C (ACARP, 2000; Department of Environment and Science, 2014):

- Disposal of heavy vehicle tyres in spoil emplacements is acceptable, provided the tyres are placed as deep as possible but not directly on the pit or emplacement floor. Placement should ensure waste tyres do not impede saturated aquifers and do not compromise the stability of the consolidated final landform.
- Currently available recycling technology is predominantly focused around passenger tyres (i.e. not heavy vehicle tyres).
- Recycling facilities do not exist proximal to the MCCM and transport of waste heavy vehicle tyres to these facilities is not viable. These recycling facilities are also generally designed on a local council scale mostly for on-road passenger tyres and thus capacity for storage, handling capability, and processing of large heavy vehicle tyres is an issue.
- The perception that whole tyres disposed in landfill "float" upward and may surface overtime is not supported by experimental evidence and is considered unlikely due to the weight and rigidity of heavy vehicle tyres, as well as the depth of disposal.

The EPA (refer to DPIE, 2021b) and Tyre Stewardship Australia (2020) acknowledge that further development and investment is required within the recycling industry to enable processors to adapt to mining equipment tyres.

Waste tyre management options are currently limited for mining operations in NSW and across Australia, due to a general lack of available recycling technologies and transport restrictions associated with remote locations (DPIE, 2021b).

Recycling of waste heavy vehicle tyres via processing into crumbled rubber and steel is not currently feasible in Australia. Waste tyre recycling is an energy intensive process which requires multiple stages of size reduction, adding to processing costs (Tyre Stewardship Australia, 2020). There are several pyrolysis plants that have either been built, are in commissioning, under construction or in early planning stages in Australia, however it is not clear whether any are located in NSW (Tyre Stewardship Australia, 2020).

On this basis, recycling of waste heavy vehicle tyres is not considered to be feasible or viable for the MCCM and therefore on-site disposal is the preferred management strategy for this waste stream. MCC would continue to investigate feasible and reasonable opportunities for recycling waste heavy vehicle tyres from the MCCM at a regional location is options become available during the remainder of the mine life.

7.2 VOLUME OF TYRES TO BE DISPOSED

It is estimated up to approximately 400 waste heavy vehicle tyres from mining equipment would be stockpiled per year of operation and require disposal within waste rock emplacements.

In addition, waste tyres which have been stockpiled since the commencement of operations at the MCCM would also be required to be disposed within waste rock emplacements. Disposal of these tyres would be staggered to optimise disposal locations and volumes.

A range of measures are implemented at the MCCM for the purpose of extending the operational lifespan of mining equipment tyres and minimising disposal rates. These measures include road design, mining equipment speed limits, regular tyre inspection and maintenance, repair of tyres as far as reasonably practicable without impacting safe operation of equipment and consideration of other beneficial use on-site, where practical (e.g. re-use as bunding, for intersection construction etc.).

7.3 ON-SITE DISPOSAL METHODOLOGY

7.3.1 Scope

MCCM will maintain a comprehensive inventory of all waste heavy vehicle tyres buried on-site as well as dump locations within the waste rock emplacements.

Prior to the selection of an appropriate disposal area for the waste heavy vehicle tyres, MCC will undertake a preliminary Environmental Risk Assessment which would consider the potential for unacceptable risk of soil; sediment; groundwater or surface water contamination, as well as proximity to coal rejects and potentially acid-forming (PAF) material.

7.3.2 Proposed Methodology

Disposal of waste heavy vehicle tyres will include stockpiling and transport to identified disposal locations within the waste rock emplacement areas, as determined by mine progression. The disposal methodology will generally include the following:

- operational personnel will initiate tyre disposal once a stockpile has accumulated that warrants a feasible disposal event;
- completion of a pre-task risk assessment for each waste tyre disposal event, to consider both the location and manner in which the tyres will be disposed, as well as required monitoring;
- relocation of the tyres will be undertaken in accordance with Whitehaven's internal *Mine Tyre Disposal Environmental Procedure* (provided in Attachment D for reference);
- tyres will be placed as deep into the waste rock emplacement area as is reasonably practical, with a minimum of 20 metres of material to be dumped over all tyre disposal areas;
- tyres will not be disposed of in areas with potential to impede saturated aquifers, compromise the stability of the consolidated final landform or have any long-term effects on rehabilitation;
- tyre dumps will be located more than 15 metres from any coal rejects or PAF material emplacement areas to minimise the potential for spontaneous combustion.

The pre-task risk assessment must consider the following:

- fire hazards and their management;
- safety hazards and their management;
- potential for saturated/perched aquifers to be disturbed or impeded;
- required depth to prevent uprising and ensure stability of the final consolidated landform; and
- proximity to coal rejects, PAF and depth of cover.

Whitehaven's internal Mine *Tyre Disposal Environmental Procedure* (Attachment D) provides further detail on proposed used heavy vehicle tyre storage and disposal methods, and will be reviewed periodically and amended as required. The method of disposal described in the procedure includes the loading of waste tyres at the designated storage location onto a flat-bed type truck or equivalent piece of heavy equipment suitable for transporting large heavy equipment tyres, for transportation to and unloading at the final disposal location.

Stockpiling of tyres at the allocated disposal area may be required prior to final coverage and burial. Stockpiles will be sized and located in consideration of potential fire risk and would be temporary only.

Consistent with the existing MCCM fire management system and internal fire and explosion management plan, other fire control strategies and management methods in the event of a fire include:

- provision of water tankers available for firefighting and prevention;
- availability of fire extinguishers on all mobile equipment and at other appropriate locations; and
- maintenance of access tracks and fire breaks around tyre storage areas.

MCC will maintain a register documenting all waste tyre disposal. Key information to be included in the register will include:

- serial number;
- type/make and quantity;
- disposal date;
- surveyed co-ordinates of the disposal site area (Easting, Northing, relative level [RL]), and
- summary description of the disposal area.

At the completion of each disposal event, the register will be updated by the relevant operational personnel. Waste tyre disposal information would also be reported in the MCCM annual reviews in accordance with Condition 70, Schedule 3 of the PA 10_0138 and can be reported to the EPA upon request.

The *MCCM Hazard Management Plan* would be updated to incorporate management and control measures for waste tyre disposal in line with the pre-task risk assessment and *Whitehaven's Mine Tyre Disposal Environmental Procedure* (Attachment D).

7.4 MONITORING

MCC will monitor on-site stockpiling of waste tyres to identify when a disposal event is required.

Monitoring of disposed waste tyres will assess the final shaped grade and stability of the landform over the disposed waste tyre area prior to topsoil placement to ensure no up-rising of waste tyres has occurred, and that at least 20 metres of emplacement material is over the disposed waste tyre area.

Regular monitoring and inspection of tyre stockpiles and disposal locations will be undertaken to identify any potential fire hazards. Outcomes of this monitoring would be reported in the annual review and used to inform future storage and disposal methods.

Monitoring of disposed waste tyres will also be undertaken as a component of rehabilitation monitoring, consistent with the MCCM Mining Operations Plan and other applicable site management plans.

The monitoring program includes assessing the final shaped and rehabilitated landform including aspects such as slope stability, erosion and vegetation establishment. Actions in relation to remediation of the rehabilitated landform, if required, are implemented as per controls specified in the MCCM Mining Operations Plan.

An existing groundwater quality monitoring program is undertaken in accordance with the *MCCM Water Management Plan* (MCC, 2019) and includes a suite of analytes which will assist in identifying any potential contamination from waste tyre disposal and prompt remediation actions.

7.5 CONCLUSION

Based on the above, the proposed waste tyre disposal activity is considered to be of minimal environmental impact given:

- A range of measures are implemented at the MCCM to extend the operational lifespan of mining equipment tyres and minimise the number of waste tyres requiring disposal.
- Disposal of waste tyres would reduce the potential for environmental impacts associated with long-term surface storage of waste tyres (i.e. fire risk).
- Waste tyres will be disposed in the waste rock emplacement areas which have sufficient capacity to receive the predicted number of waste tyres requiring disposal.
- Waste tyres will be disposed with a minimum of 20 metres of material dumped over all tyre disposal areas.
- Waste tyres will not be disposed of in areas with potential to impede saturated aquifers, compromise the stability of the consolidated final landform or have any long-term effects on rehabilitation.
- The limited potential for environmental impacts associated with chemical leaching of waste tyres would be further reduced by disposing of the waste tyres whole (i.e. not shredded or chipped) and not within known saturated aquifers.
- Waste tyres will be located more than 15 metres from any coal rejects or PAF material emplacement areas to minimise the potential for spontaneous combustion.

8 EVALUATION

This Modification application seeks approval for the use of mobile coal sizing equipment and mobile rock crushing equipment, and for disposal of waste heavy vehicle tyres in the emplacement areas, which would be of minimal environmental impact.

The mobile coal sizing and rock crushing equipment would be used over the remaining mine life to optimise the mix of bypass coal and washed coal transported from the site in response to coal market conditions.

Disposal of waste heavy vehicle tyres and associated monitoring would be undertaken in accordance with the methodology described above and in Whitehaven's *Waste Tyre Disposal Environmental Procedure* (Attachment D).

The Modification does not propose to change any other operational aspect of the MCCM, nor would it materially alter the previously assessed and approved potential impacts, including noise and air quality.

Based on the information contained in this report, the consent authority can be satisfied that the MCCM incorporating the Modification would remain substantially the same as the development authorised by PA 10_0138 as last modified by Modification 3 and that the proposed Modification is of minimal environmental impact.

Overall, the MCCM has operated in a manner that has achieved an acceptable level of environmental performance. MCC has been proactive to manage any environmental issues that have arisen and any complaints raised by the local community.

The Modification can be implemented in accordance with the existing environmental limits and performance measures for the MCCM, and with no increase to the previously approved disturbance footprint.

9 REFERENCES

Australian Coal Association Research Program (2000) *Management of Waste Tyres in the Mining Industry*.

Bridges Acoustics (2011) *Acoustics Impact Assessment. Appendix G of the Maules Creek Coal Mine Environmental Assessment.*

Department of Environment and Science (2014) *Mining Operational Policy – Disposal and storage of scrap tyres at mine sites*.

Department of Industry, Science, Energy and Resources (2020) *National Greenhouse Accounts Factors*.

Department of Planning, Infrastructure and Environment (2021a) *State Significant Development Guidelines, Appendix E – Preparing a Modification Report*.

Department of Planning, Industry and Environment (2021b) *Tarrawonga Coal Mine Modification 9 – Waste Tyre Disposal Planning Secretary's Assessment Report*.

Global Acoustics (2014) *Maules Creek Coal Project – Project Approval Modification.*

Maules Creek Coal Pty Ltd (2014) *Maules Creek Coal Mine Noise Management Plan*

Maules Creek Coal Pty Ltd (2019) *Maules Creek Coal Mine Water Management Plan*

Maules Creek Coal Pty Ltd (2020a) *Maules Creek Coal Mine Air Quality and Greenhouse Gas Management Plan*

Maules Creek Coal Pty Ltd (2020b) *Maules Creek Coal Mine Mining Operations Plan*

Maules Creek Coal Pty Ltd (2021a) *Maules Creek Coal Mine 2020 Annual Review*

Maules Creek Coal Pty Ltd (2021b) *Maules Creek Coal Mine Environmental Management Strategy*

NSW Department of Planning and Environment (2016) *The Dark Sky Planning Guideline.*

NSW Environment Protection Authority (2017a) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.*

NSW Environment Protection Authority (2017b) *Noise Policy for Industry.*

NSW Government (2012) *Aquifer Interference Policy.*

PAE Holmes (2011) *Maules Creek Coal Project – Air Quality Impact Assessment.*

Pacific Environment Limited (Pacific Environment) (2013) *Maules Creek Coal Project Modification. Prepared for Hansen Bailey Pty Ltd.*

RWDI Australia (2021) *Noise Impact Assessment for the Maules Creek Mobile Coal Sizing Modification*

Todoroski Air Sciences (2020) *Air Quality Impact Assessment for the Maules Creek Landform Modification.*

Todoroski Air Sciences (2021) *Air Quality Quality and Greenhouse Gas Impact Assessment for the Maules Creek Mobile Crusher Modification.*

Tyre Stewardship Australia (2020) *Mining Industry - Off-The-Road Used Tyre Analysis.*

Wilkinson Murray (2020) *Noise Impact Assessment for the Maules Creek Landform Modification.*

ATTACHMENT A

NOISE ASSESSMENT

September 8, 2021

Jorge Moraga
General Manager – Maules Creek
Whitehaven Coal Limited
Off Therribri Rd
Boggabri NSW 2382

Dear Jorge

Re: Maules Creek Coal Mine – Mobile Coal Sizing Modification – Noise Assessment

Introduction

RWDI Australia (RWDI) was commissioned by MCC to undertake an environmental noise assessment for the proposed Mobile Coal Sizing Modification (the Modification).

The assessment is based on the following NSW noise policies and guidelines:

- NSW Department of Planning & Environment (DP&E) (2018) *Voluntary Land Acquisition and Mitigation Policy (VLAMP)*.
- NSW EPA (2017) *NSW Noise Policy for Industry (NPfI)*.

The Maules Creek Coal Mine (MCCM) is authorised to extract up to 13 Million tonnes of run-of-mine (ROM) coal per annum (Mtpa) and transport up to 12.4 Mtpa of product coal from the site by rail. ROM coal extracted from the open cut is sized using primary, secondary and tertiary coal sizing equipment and screens located in the Mine Infrastructure Area (MIA). Resized coal is either processed (washed) in the Coal Handling and Preparation Plant (CHPP) or bypassed to the product stockpile.

Through ongoing mine planning, Maules Creek Coal Pty Ltd (MCC) has identified an opportunity to improve operating efficiencies at the MCCM through the use of mobile coal sizing equipment. MCC is therefore seeking to modify the MCCM Project Approval (10_0138) to use mobile coal sizing (crushing) and associated equipment located generally in the ROM stockpile area or within parts of the open cut pit. MCC proposes to utilise the mobile coal sizing equipment over the remaining mine life.

Description of Proposed Modification

Coal sizing equipment would include two impact crusher units (also known as impactors or horizontal shaft impactors) which are designed with in built screening for primary, secondary, or tertiary sizing applications. The mobile coal sizing equipment would be operated 24 hours per day, 7 days per week, and process up to 2.2 Mtpa of ROM coal (combined capacity) when in use.

The Modification includes three potential mobile coal sizing site locations which may be used throughout the life of the project:

- ROM stockpile area;
- southwest in-pit area; and
- northeast in-pit area.

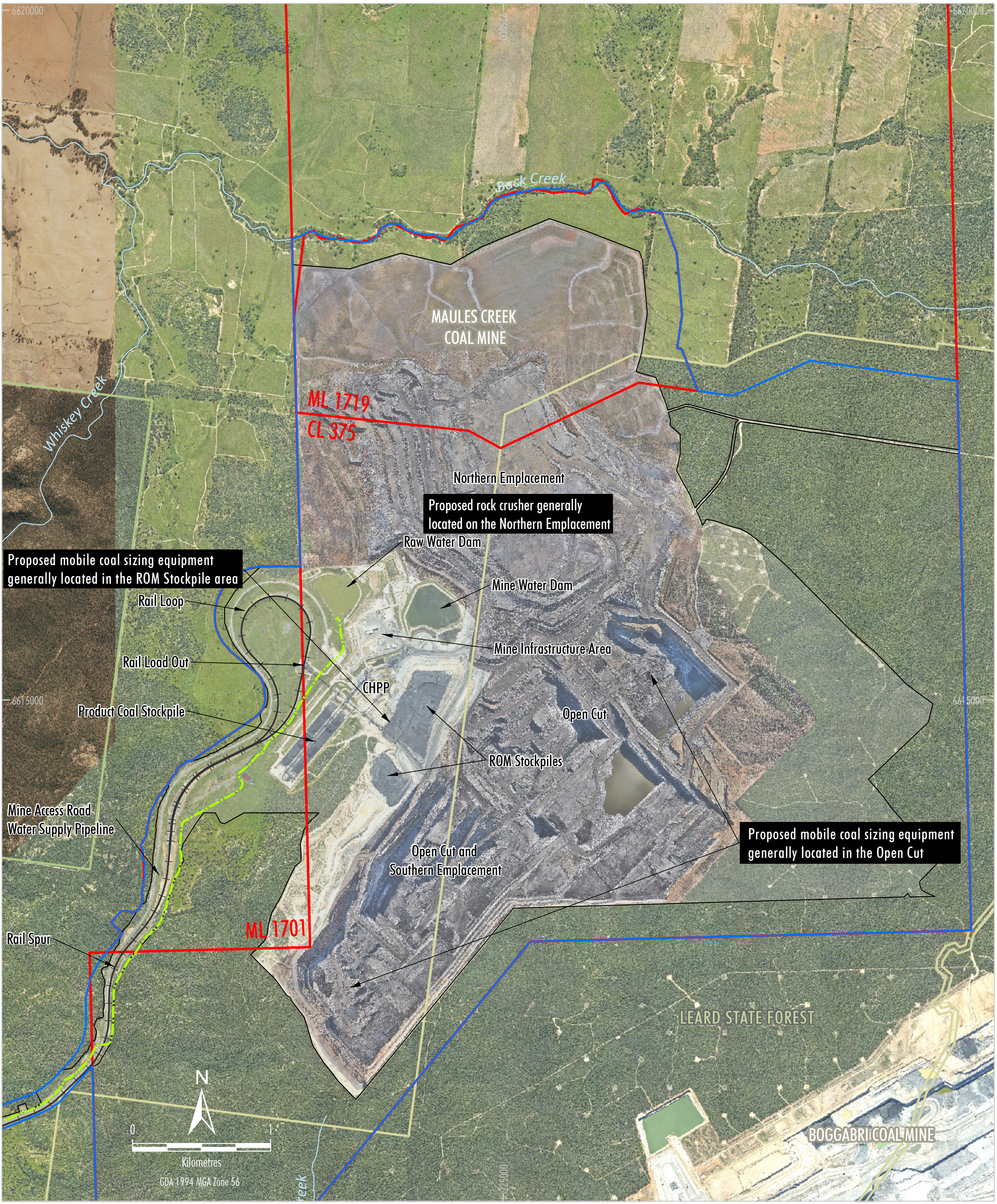
The three mobile coal sizing site general locations are shown in **Figure 1**.

The proposed mobile coal sizing circuit would consist of:

- Existing haul trucks to transport ROM coal to the mobile coal sizing equipment located in the ROM stockpile area or the open cut pit (i.e. the Modification does not involve additional haul trucks).
- Two new mobile coal sizing units and new rehandling equipment (i.e. two 50-tonne excavators and a dozer) which size and rehandle the ROM coal.
- When the mobile coal sizing equipment is located in-pit, existing haul trucks to transport sized coal to the existing ROM stockpile area for rehandling.
- New articulated dump trucks to transport the sized coal to the existing product stockpiles where it is stockpiled using a radial stockpiler, ready to be reclaimed and conveyed to the rail load out and transported from the site.

In addition, the Modification includes the use of a mobile rock crusher located in the Northern Emplacement Area **(Figure 1)** for processing approximately 0.4 Mtpa of waste rock when in use. The crushed waste rock that would otherwise be emplaced would be used on-site for construction, maintaining roads and drainage. Existing mine and ancillary fleet would be used to transport waste rock to the mobile rock crusher where it is crushed and stockpiled before being transported for use at locations across the site. The mobile rock crusher would be operated during day time only.

The Modification does not propose to change the approved MCCM coal extraction or product coal transport rates.



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LEGEND

- MCCM Mining Tenement Boundary (ML and CL)
- MCCM Approximate Extent of Existing/Approved Surface Development
- MCCM Project Boundary
- State Conservation Area, Aboriginal Area
- State Forest
- Rail Line
- Maules Creek Coal Water Supply Pipeline

Source: NSW Spatial Services (2019); Orthophoto: Whitehaven Coal (2021)

WHITEHAVEN COAL

MAULES CREEK COAL MINE

Approved Mine General Arrangement Incorporating the Modification

Figure 1

Project Approval Noise Criteria

Conditions 1 and 2, Schedule 3, of Project Approval (10_0138) specify acquisition and noise mitigation on request rights for property 108 (referred to in this report as receivers 108a and 108b).

Condition 7, Schedule 3, requires MCC to ensure that the operational noise generated by the MCCM does not exceed the criteria in **Table 1** at any residence on privately-owned land, with the exception of receivers 108a and 108b.

Table 1: Operational Noise Criteria

Receiver	Day	Evening	Night	
	$L_{Aeq,15min}$	$L_{Aeq,15min}$	$L_{Aeq,15min}$	$L_{A1,1min}$
108a & 108b	35	39	39	45
All other privately-owned residences	35	35	35	45

Notes: Day: 7:00 am to 6:00 pm; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am.

With regard to cumulative noise, Condition 10, Schedule 3, requires operational noise generated by the MCCM combined with noise generated by other mines in the area not exceed the criteria presented in **Table 2** at privately-owned receivers. Other mines in the area (i.e. Boggabri and Tarrawonga) are also required to ensure that noise generated by their project combined with other mines does not exceed the same cumulative noise criteria at private-owned receivers.

Table 2: Cumulative Noise Criteria

Land	Day / Evening / Night $L_{Aeq (period)}$
All privately-owned land	40

Notes: Day: 7:00 am to 6:00 pm; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am.

Operational Noise Assessment

Low-Frequency Noise Assessment

A low-frequency noise assessment was conducted to ascertain whether any of the identified receivers should be subject to a modifying factor correction due to dominant low-frequency content. The methodology included the use of a site-specific low-frequency spectrum shape and findings that are included in **Appendix C**.

Predicted spectra indicate that it is unlikely that any of the privately-owned receivers surrounding the MCCM would be subject to dominant low-frequency noise with the Modification in place.

Operational Noise Assessment

A quantitative operational noise assessment was conducted for the Modification. The noise assessment considered the incremental change in noise levels due to the additional mobile coal sizing and rock crushing equipment. The noise assessment addressed the closest and potentially most affected privately-owned residential receivers in the vicinity of the Modification. **Appendix A** provides a list and figure of the 79 noise-sensitive receiver locations included the assessment.

The noise assessment methodology and assumptions are included in **Appendix B**. The Modification was assessed using the Year 2021 and Year 2023 operational scenarios previously assessed for the approved MCCM Modification 7 Noise Assessment (Maules Creek Coal Mine – Landform Modification – Noise Assessment, Wilkinson Murray, 2020) as they represent operations with the greatest potential for noise impacts.

Noise results have been compared against the Project Approval Noise Criteria and levels predicted as part of the approved MCCM noise assessment.

The predicted $L_{Aeq,15min}$ operational noise levels are presented in **Appendix C** for all three mobile coal sizing site locations and years 2021 and 2023. Day noise levels reflect the use of the mobile rock crusher in the Northern Emplacement Area.

When considering the maximum noise emissions across both years, the findings can be summarised as follows:

- For the MCCM incorporating the Modification, up to 23 receivers would be subject to a negligible increase of 1 dB at night when compared with the approved MCCM with the mobile coal sizing equipment located in the ROM stockpile area. With the mobile coal sizing equipment located in the northeast in-pit area, up to 15 receivers would be subject to a negligible increase of 1 dB at night when compared with the approved MCCM. Coal sizing equipment located in the southwest in pit area would result in up to 10 receivers being subject to a negligible increase of 1 dB at night when compared with the approved MCCM. Most of the receivers subject to noise level increases would remain compliant with the Project Approval Noise Criteria under noise-enhancing conditions without the use of pro-active noise mitigation measures (i.e. relocating mine fleet, or partially shutting down mine fleet).

- With the mobile coal equipment located in the ROM stockpile area, four additional 1 dB night exceedances would be expected when compared with the approved MCCM (i.e. receivers 33a, 37, 38 and 89a), all of which would be 'negligible' (between 1-2 dB) according to the *VLAMP* and *NPfI*. Such 'negligible' exceedances would not be discernible by the average listener in accordance with the *VLAMP* and *NPfI*.

- With the mobile coal equipment located in the northeast in-pit area, three additional 1 dB night exceedances would be expected due to the Modification (i.e. receivers 37, 38 and 89a), all of which would be considered 'negligible' (between 1-2 dB) and not be discernible by the average listener according to the *VLAMP* and *NPfI*.

- No additional exceedances over the Project Approval Noise Criteria are expected with the mobile coal equipment located in the southwest in-pit area.

- With the mobile coal equipment located in the ROM stockpile area, five night exceedances and one day exceedance that are part of the approved MCCM are found to increase by 1 dB (i.e. receivers 44, 74, 105, 108a and 225 at night; 108a during the day). All those exceedances would remain 'negligible' (between 1-2 dB) according to the *VLAMP* and *NPfI*, except for receiver 108a. Such 'negligible' incremental increases are not discernible by the average listener in accordance with the *VLAMP* and *NPfI*.

- With the mobile coal equipment located in the northeast in-pit area, four night exceedances that are part of the approved MCCM are found to increase by 1 dB (i.e. receivers 44, 74, 108a and 225). All those exceedances would remain 'negligible' (between 1-2 dB) according to the *VLAMP* and *NPfI*, except for receiver 108a. Such 'negligible' incremental increase would not be discernible by the average listener in accordance with the *VLAMP* and *NPfI*.

- With the mobile coal equipment located in the southwest in-pit area, two night exceedances that are part of the approved MCCM are found to increase by 1 dB (i.e. receivers 108a and 225). The exceedance at receiver 225 would remain 'negligible' (between 1-2 dB) according to the *VLAMP* and *NPfI*. The exceedance at receiver 108a would remain greater than negligible in 2021 and 2023. Such 'negligible' incremental increase would not be discernible by the average listener in accordance with the *VLAMP* and *NPfI*.

- It is noted that receiver 108a is eligible for acquisition and noise mitigation on request rights in accordance with Conditions 1 and 2, Schedule 3, of the Project Approval.

Cumulative Noise Assessment

Cumulative noise predictions from the operation of the MCCM incorporating the Modification, Boggabri Coal Mine and Tarrawonga Coal Mine have been considered in the assessment (**Appendix C**).

The assessment results indicated that night cumulative noise levels would comply with the relevant Cumulative Noise Criterion at all privately-owned receivers.

Maximum Noise Level Event Assessment

A maximum noise level event assessment conducted for the Modification (**Appendix C**) has shown that night $L_{A1,1min}$ noise levels would comply with the $L_{A1,1min}$ Project Approval Noise Criterion of 45 dBA at all privately-owned receivers.

Mitigation Scenarios and Noise Levels with Proactive Management Measures in Place

Mitigation measures were investigated and modelled as part of the Noise Assessment to ensure all noise exceedances can be reduced to achieve compliance. Such mitigation measures would be integrated in the proactive management system, which Whitehaven have successfully implemented over the MCCM life and would maintain for the Modification.

It was found that for most of the noise-enhancing meteorological conditions, mitigation measures involving turning off the most exposed rehabilitation and waste emplacement area CAT D11 dozer(s) would suffice to address identified potential exceedances at the closest privately-owned receivers. **Table 3** presents the most typical mitigation scenarios anticipated during the life of the Modification and required during the day and night periods.

Table 3: Typical Mitigation Scenarios During Noise-Enhancing Meteorological Conditions

Description of Typical Mitigation Scenario	Approximate Noise Reduction at Key Receivers
Shutdown one to two rehabilitation and/or waste emplacement area dozers	0.5 - 1 dB
Shutdown three to four rehabilitation and/or waste emplacement area dozers	1 - 2 dB

During the most adverse noise-enhancing conditions, more extensive mitigation measures will be required to achieve compliance at the closest privately-owned receivers. Modelling results indicate, however, that compliance would be achieved under the most adverse noise-enhancing meteorological conditions even with the continued operation of a number of coal and waste fleets and all CHPP operations (including the coarse rejects circuit). It should be noted that when required, such measures have been applied successfully in the past to achieve compliance at the MCCM.

Conclusion

An environmental noise assessment was conducted for the proposed Mobile Coal Sizing Modification. The assessment has considered the incremental change in potential noise impacts of the MCCM due to the Modification. The assessment considered mobile coal sizing and associated equipment located generally in the ROM stockpile area or within parts of the open cut pit (i.e. southwest in-pit area or northeast in-pit area) and the use of a mobile rock crusher in the Northern Emplacement Area during the day.

The incremental noise impacts due to the Modification can be summarised as follows:

- Up to four additional 1 dB night exceedances would be expected when compared with the approved MCCM, depending on the mobile coal sizing site location. All four exceedances are considered to be 'negligible' (between 1-2 dB) according to the *VLAMP* and *NPfI* and would not be discernible by the average listener in accordance with the *VLAMP* and *NPfI*.

- Up to six exceedances that are part of the approved MCCM are found to increase by 1 dB. All those exceedances would remain 'negligible' (between 1-2 dB) according to the *VLAMP* and *NPfI*, except for receiver 108a. Such 'negligible' incremental increases are not discernible by the average listener in accordance with the *VLAMP* and *NPfI*. Receiver 108a is eligible for acquisition and noise mitigation on request rights in accordance with Conditions 1 and 2, Schedule 3, of the Project Approval

The above noise impacts associated with the Modification would be managed with the continued use of the proactive management system, which Whitehaven have successfully implemented over the MCCM life and would maintain for the Modification.

I trust this information is sufficient. Please contact us if you have any further queries.

Yours faithfully

Roman Haverkamp
Senior Engineer
RWDI

APPENDIX A: NOISE-SENSITIVE RECEIVERS

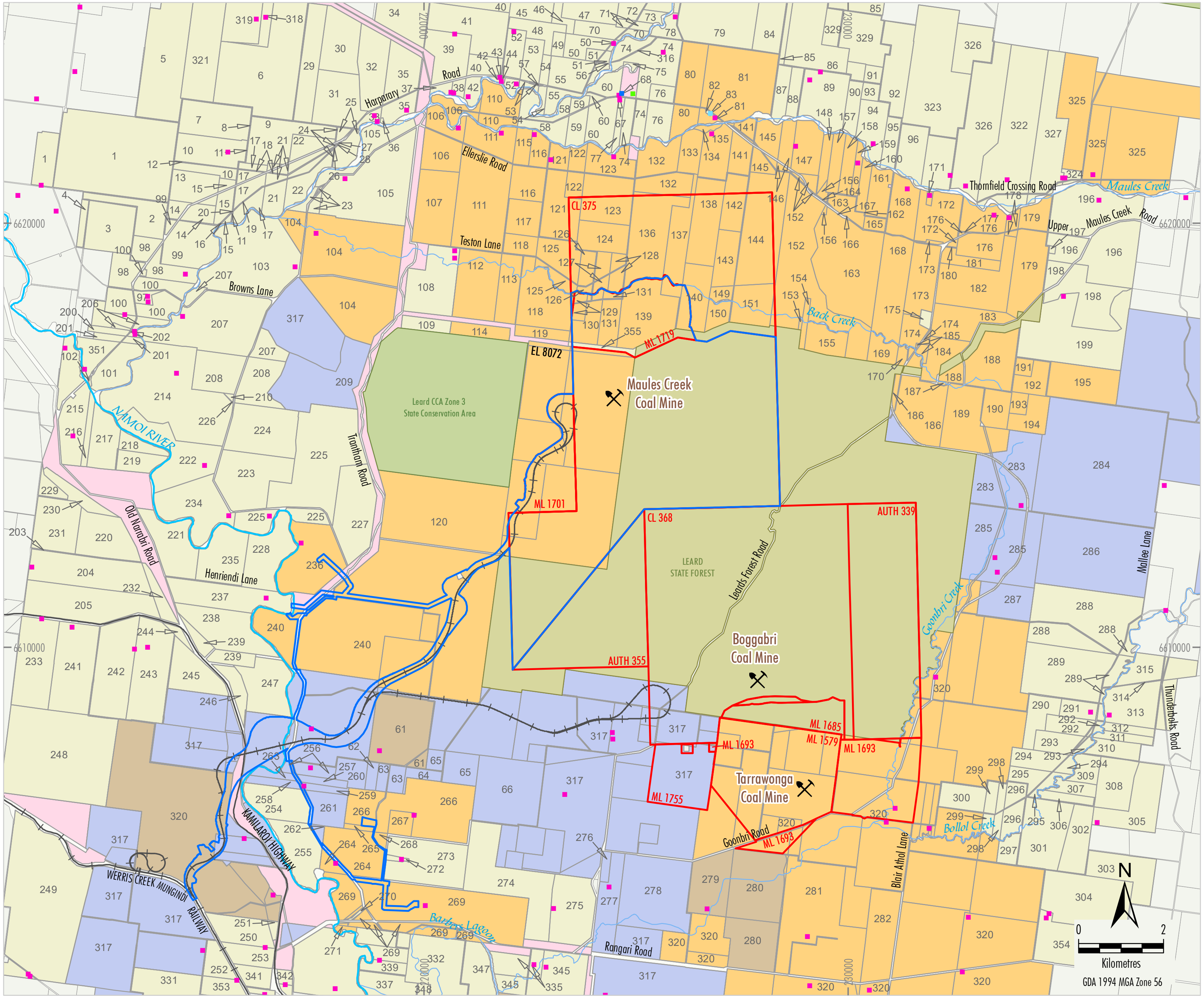
The privately-owned residential receivers considered in the assessment are listed in **Table A1** and shown in **Figure A1**.

Table A1: Receivers Considered in Noise Assessment

Receiver ID	Landholders	Easting	Northing
0b	-	211341	6620286
0c	-	210441	6620646
0d	-	210873	6622921
0e	-	211779	6623573
0f	-	211894	6625092
0g	-	237493	6610870
0h	-	237460	6613814
0i	-	237967	6620606
1	GLENELG COTTON PTY LIMITED	210991	6620883
10	IAN BRUCE NORRIE	215382	6621673
33a	MARTIN SHAW-STUART BECKETT & ZARA NELL	218841	6622532
33b	MARTIN SHAW-STUART BECKETT & ZARA NELL	218907	6622400
35	JOSHUA JAMES SHIELDS & TAYA MAREE THOMPSON	219598	6622663
37	ANNETTE JOY SKILLICORN & ROBERT LINDSAY SKILLICORN	220641	6623080
38	DAVID RODNEY WHAN	220703	6623068
39	JILL MARGARET ISON & RONALD NOEL ISON	220726	6624448
42	DOUGLAS RAYMOND WHAN & JEANETTE JESSIE WHAN	221047	6622982
43	DOUGLAS RAYMOND WHAN & JEANETTE JESSIE WHAN	221799	6623429
44	MATHEW BRIAN SMITH & JASMIN SMITH	221831	6623335
50	ANTHONY MICHAEL NOBILO	224478	6624230
52a	LESLIE DONALD HOLMES	222177	6623274
52b	LESLIE DONALD HOLMES	222124	6624516
67	MINISTER FOR EDUCATION	224599	6623014
74	JOAN BRADSHAW & STEPHEN BRADSHAW	225645	6624020
77	JOAN BRADSHAW & STEPHEN BRADSHAW	224622	6622902
78	RICHARD JOHN LAIRD & TRACEY LEE LAIRD	225935	6624862
89a	ANDREW BRUCE LAIRD & RICHARD JOHN LAIRD	229100	6623372

Receiver ID	Landholders	Easting	Northing
89b	ANDREW BRUCE LAIRD & RICHARD JOHN LAIRD	229351	6623560
94	EAGLE ROCK (NARRABRI) PTY LTD	230597	6621871
97a	CARISSA ELAINE STUBBS & RAYMOND HILTON STUBBS	213499	6618139
97b	CARISSA ELAINE STUBBS & RAYMOND HILTON STUBBS	213492	6618274
98	FRANCIS EDWARD CHISHOLM & ROSEMARY MICHELLE CHISHOLM	214381	6618800
103	GLEN LESLIE HAMBLIN	216974	6618964
105	DEREK MERVYN WILLIAMS	218147	6621039
108a	JEANETTE MARY MORRIS	220728	6619167
108b	JEANETTE MARY MORRIS	220735	6619347
196	JOHN DOUGLAS DUNCAN	235916	6620541
199	JAMES KENNETH DUNCAN	235087	6618265
200a	GEOFFREY HUGH HUNTER & SALLY HUNTER	213180	6617449
200b	GEOFFREY HUGH HUNTER & SALLY HUNTER	213196	6617379
204	OAKEY POINT PTY LTD	210762	6611895
207	HAMBLIN PASTORAL CO PTY LIMITED	214320	6617799
214	OAKCOLT PTY LIMITED	214173	6616450
215	ROBERT ANTHONY MAUNDER	211730	6614981
222	RIVERWAY BOGGABRI PTY LTD	214838	6614287
225	RIVERWAY BOGGABRI PTY LTD	216367	6613093
233	FRANCIS JOHN MAUNDER	211001	6610669
234	BENJIMEN GEORGE BOMFORD & KATE MAREE BOMFORD	215403	6613103
237	PETER JOHN WATSON	216289	6611151
241	ROBERT ANTHONY MAUNDER	211707	6610476
242a	GLEK PTY LIMITED	213187	6609951
242b	GLEK PTY LIMITED	213497	6610002
249a	MARGARET JOAN STOLTENBERG & ROBERT ERNEST STOLTENBERG	210682	6602286
249b	MARGARET JOAN STOLTENBERG & ROBERT ERNEST STOLTENBERG	210717	6602245
253	RICHARD WALTER KEMP & EDWARD JOHN KEMP	216263	6602918
272	DAVID VICTOR GILLHAM	219481	6604997
275	AIDAN NILS RODSTROM	223061	6603835
291	JAMES EDWARD PICTON & ROBYNNE JACQUELINE PICTON	235726	6608475

Receiver ID	Landholders	Easting	Northing
305	JAMES EDWARD PICTON & ROBYNNE JACQUELINE PICTON	235878	6605862
313	JAMES EDWARD PICTON & ROBYNNE JACQUELINE PICTON	236162	6608410
318	GLEN LESLIE HAMBLIN & LYNETTE ETHEL HAMBLIN	216279	6624843
319	IAN GREGORY PEARSON & JEAN MARY PEARSON	216056	6624799
322	KEITH JOSEPH GREENAWAY	233750	6621019
323	COLIN EDWARD GREENAWAY	232409	6621120
324	DONALD WILLIAM STEWART & LILA ENITA STEWART & DONALD RICHARD CHARLES STEWART	235116	6621068
326	COLIN EDWARD GREENAWAY	232772	6620873
327	GUY JAMES THOMAS & PATRICIA CATHERINE THOMAS	235066	6621059
339	KENNETH DAVID GILLHAM	218960	6602617
342	LEE WAYNE HUNT & MARGARET DIANNE HUNT	216733	6602050
344	RICHARD WALTER KEMP & EDWARD JOHN KEMP	216250	6601822
345a	KENNETH DAVID GILLHAM	222883	6602455
345b	KENNETH DAVID GILLHAM	222603	6602516
346	MARILYN FRANCES HART, PENELOPE FRANCES RICE, TIMOTHY THOMPSON HART, SOPHIE LOUISE HART	217911	6601948
349	NEALE RICHARD STUART BURGESS	211546	6617052
350	FRANCIS EDWARD CHISHOLM & ROSEMARY MICHELLE CHISHOLM	212951	6617838
351	FRANCIS EDWARD CHISHOLM & ROSEMARY MICHELLE CHISHOLM	212011	6616553
353	PAUL JAMES BELL	215590	6602142
354a	AMY ISABEL MYER	234674	6603617
354b	AMY ISABEL MYER	234744	6603716



LEGEND

- NSW National Parks and Wildlife Services (NPWS) Estate
- State Forest
- Crown Land
- Whitehaven Coal
- Whitehaven Coal/Boggabri Coal
- Boggabri Coal
- Relevant Landholder
- Landholder not Referenced
- Railway
- Mining Tenement Boundary
- Maules Project Approval Boundary
- 150 Landholder Reference Number *
- Dwelling
- School
- Church
- Community Hall

* Refer to Land Ownership List

Source: Department of Land and Property Information - Land Tenure (2020); NSW Spatial Services (2019); Whitehaven Coal (2020)

N

0 2

Kilometres

GDA 1994 MGA Zone 56

WHITEHAVEN COAL

MAULES CREEK COAL MINE

Land Ownership

WHC-21-86 LT_201A 8/09/2021

APPENDIX B: NOISE ASSESSMENT METHODOLOGY & ASSUMPTIONS

Noise Modelling Methodology

Operational noise levels at nearby receivers have been calculated using the Environmental Noise Model (ENM) (a proprietary computer program from RTA Technology Pty Ltd). This modelling software is compatible with the *NPfI* and has been previously accepted by the EPA and the Department of Planning Industry and Environment (DPIE) for use in environmental noise assessments. Factors that were addressed in the noise modelling are:

- equipment noise level emissions and locations;
- shielding from ground topography and structures;
- noise attenuation due to geometric spreading;
- ground absorption;
- atmospheric absorption; and
- meteorology.

The assessment models the total noise at each receiver from the operation of the MCCM incorporating the Modification. Total predicted operational noise levels are then compared with the Project Approval Noise Criteria.

Noise levels were predicted for each of the three identified mobile coal sizing site locations (ROM stockpile area, northeast in pit, and southwest in pit). For each location, the use of the mobile rock crusher was assumed during the day.

As the proposed mobile coal sizing equipment would be operated 24 hours per day, noise predictions are provided for the day (7:00 am - 6:00 pm), evening (6:00 pm – 10:00 pm) and night (10:00 pm – 7:00 am) assessment periods which are subject to different meteorology.

Assessment Years

Years 2021 and 2023, previously assessed as part of the approved MCCM noise assessment (Maules Creek Coal Mine – Landform Modification – Noise Assessment, Wilkinson Murray, 2020) have been selected for modelling as they represent operations with the greatest potential for noise impacts.

Meteorology

Fact Sheet D of the *NPfI* defines standard and noise-enhancing meteorological conditions to be considered in noise assessments.

Analysis of local meteorological data obtained from the MCCM meteorological station for the period 1 December 2018 to 10 March 2020 establishes a number of noise-enhancing meteorological conditions during the day and night periods. The noise-enhancing meteorological conditions relevant to the assessment are summarised in **Table B1** along with the standard meteorological conditions. These are consistent with the meteorological conditions assumed for the Landform Modification noise assessment.

Table B1: Relevant Meteorological Conditions

Time Period	*NPfI* Meteorological Conditions	Description of Meteorological Parameters
Day	Noise-enhancing meteorological conditions	3 m/s wind in SSE and S directions; stability categories A-D
	Standard meteorological conditions	0.5 m/s wind in source-to-receiver direction; stability categories A-D
Evening	Standard meteorological conditions	0.5 m/s wind in source-to-receiver direction; stability categories A-D
Night	Noise-enhancing meteorological conditions	2 m/s wind in source-to-receiver direction; stability category F
	Standard meteorological conditions	0.5m/s wind in source-to-receiver direction; stability categories A-D

Notes: Day: 7:00 am to 6:00 pm; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am.

For each assessment period, only the highest noise predictions under the relevant *NPfI* meteorological conditions presented in **Table B1** (including both standard and noise-enhancing meteorological conditions as described in Fact Sheet D) are reported.

Equipment List

Table B2 presents a schedule of equipment associated with the Modification. Other equipment and infrastructure items operating on site and included in the noise model are consistent with the approved MCCM noise assessment for years 2021 and 2023.

Table B2: Indicative Fleet List Associated with Modification

Equipment		No. of Equipment	Location/Function	Time Period
Mobile coal sizing circuit	550SR mobile crusher	2	Sizing of ROM coal at mobile coal sizing site	Day, evening, night
	50-tonne excavator	2	Rehandling of ROM coal at mobile coal sizing site	Day, evening, night
	CAT D9T dozer	1	Rehandling of ROM coal at mobile coal sizing site	Day, evening, night

Equipment		No. of Equipment	Location/Function	Time Period
	Radial stockpiler	1	Unloading of sized coal at product stockpile area	Day, evening, night
	Rigid dump truck*	3	Transportation of ROM coal to mobile coal sizing site located in ROM stockpile area or open cut pit. For in-pit mobile coal sizing site locations, rigid dump trucks would transport sized coal to the existing ROM stockpile area for rehandling.	Day, evening, night
	Articulated dump (Moxi) trucks	6	Transportation of sized coal from ROM stockpile area to product stockpile area	Day, evening, night
Mobile rock crushing	Mobile rock crusher	1	Crushing waste rock in Northern Emplacement Area	Day

* Rigid dump trucks used for the proposed mobile coal sizing circuit would consist of trucks already included in approved operation.

Indicative Sound Power Levels

Table B3 presents sound power levels (SWLs) for the additional equipment associated with the Modification.

The nominated SWLs included in **Table B3** are generally indicative of leading practice mining equipment (for noise performance). Equipment would be selected as part of the detailed modification design; however, it is expected SWLs would be generally consistent with those presented in **Table B3**.

MCC recognises the importance of input data such as SWLs as a source of variability in noise predictions and understands the importance of consistent SWLs in order to maintain the noise footprint of the Modification estimated as part of the assessment. As such, MCC has committed to implement and manage proper care and maintenance of the equipment to reduce any deterioration and/or damage of noise attenuation components (Maules Creek - Noise Management Plan, WHC, 2014).

Details regarding SWLs of other equipment and infrastructure items operating on site and included in the noise model are described in the approved MCCM noise assessment.

Table B3: Sound Power Levels of Additional Equipment

Equipment		Sound Power Level per Item (dBA)	Reference
Mobile coal sizing circuit	550SR mobile sizer	119	Manufacturer specifications
	50-tonne excavator	108	Manufacturer specifications
	D9T dozer	114	Manufacturer specifications
	Radial stockpiler	105	Manufacturer specifications

Equipment		Sound Power Level per Item (dBA)	Reference
	Articulated dump (Moxi) trucks	110	Wilkinson Murray (2020)
Mobile rock crushing	Mobile rock crusher	113	Wilkinson Murray (2020)

APPENDIX C: NOISE ASSESSMENT

Low-Frequency Noise Assessment

A low-frequency noise assessment was conducted to ascertain whether any of the identified receivers should be subject to a modifying factor correction due to dominant low-frequency content. If applicable, such corrections would be applied to the predicted noise levels before comparing to the relevant Project Approval Noise Criteria.

The *NPfI* provides a method for assessing low frequency noise based on:

- overall 'C' weighted and 'A' weighted predicted or measured levels; and
- one-third-octave predicted or measured levels in the range 10–160 Hertz (Hz).

Unbalanced Frequency Spectra

A C-weighted noise level minus A-weighted noise level assessment was carried out to determine the potential presence of unbalanced spectra containing major components within the low-frequency range of the spectrum at receivers surrounding the Project. The assessment was conducted for a selection of receivers representative of catchment areas potentially affected by the Modification. The low-frequency noise profile in other catchment areas is expected to be consistent with that of the approved project. The assessment was based on the relevant night *NPfI* meteorological conditions (**Table B1**) resulting in the highest predicted noise levels.

Table C1 lists the receivers considered in the low-frequency noise assessment.

Table C1: Low-Frequency Noise Assessment – Assessed Receivers

Direction	Receiver	Distance to MCCM
North-West	52a	6960 m
North-East	199	8743 m
West	214	9614 m

Note: m = metre

Table C2 summarises the C-weighted noise level minus A-weighted noise level assessment results for all three mobile coal sizing site locations and both assessment years. Levels highlighted in red show differences of 15 dB or more, indicating receivers exposed to unbalanced spectra containing major components within the low-frequency range of the spectrum.

Table C2: C- Minus A-Weighted Noise Levels

Assessed Receiver	$L_{Ceq,15min}$ Noise Level – $L_{Aeq,15min}$ Noise Level (dB)					
	2021			2023		
	ROM	SW	NE	ROM	SW	NE
52a	14.1	14.3	14.3	13.4	13.6	13.6
199	16.3	16.1	16.0	16.0	15.8	15.7
214	16.4	16.0	16.2	16.0	16.0	15.8

Notes: ROM = ROM stockpile location; SW = southwest in-pit location; NE = northeast in-pit location

Assessed receivers expected to be subject to unbalanced spectra were further considered and compared with the relevant one-third octave low-frequency noise threshold levels provided in Table C2 of the *NPfI*.

Low Frequency Noise Thresholds

All predicted operational noise levels reported in the assessment are based on octave band noise predictions ranging between 31.5 Hz to 16 kilohertz (kHz). As such, predictions do not provide third octave band levels and do not include frequency bands between 10 Hz and 160 Hz as required for comparison with the relevant low-frequency noise threshold levels. In order to estimate levels at those lower frequencies, the 63 Hz third octave band level (generally considered to be a relatively reliable component of a source spectrum) was interpolated from the predicted octave band spectra and used as the basis for the normalisation of a site-specific low-frequency spectrum shape. Details regarding the site-specific spectrum shape are provided in the responses to government agency submissions on the Landform Modification (*Maules Creek Coal Mine – Landform Modification – Response to NSW EPA Submissions*, RWDI, April 2021).

Results showing the normalised low-frequency spectrum at the assessed receivers for all three mobile coal sizing sites and both assessment years are shown below in **Figures C1** and **C2**.

All normalised low-frequency spectra were found to be below the *NPfI* low-frequency noise threshold levels. As such, it is unlikely that any of the receivers surrounding the Project would be subject to dominant low-frequency noise and no modifying factor correction for low-frequency noise is warranted for the Modification.

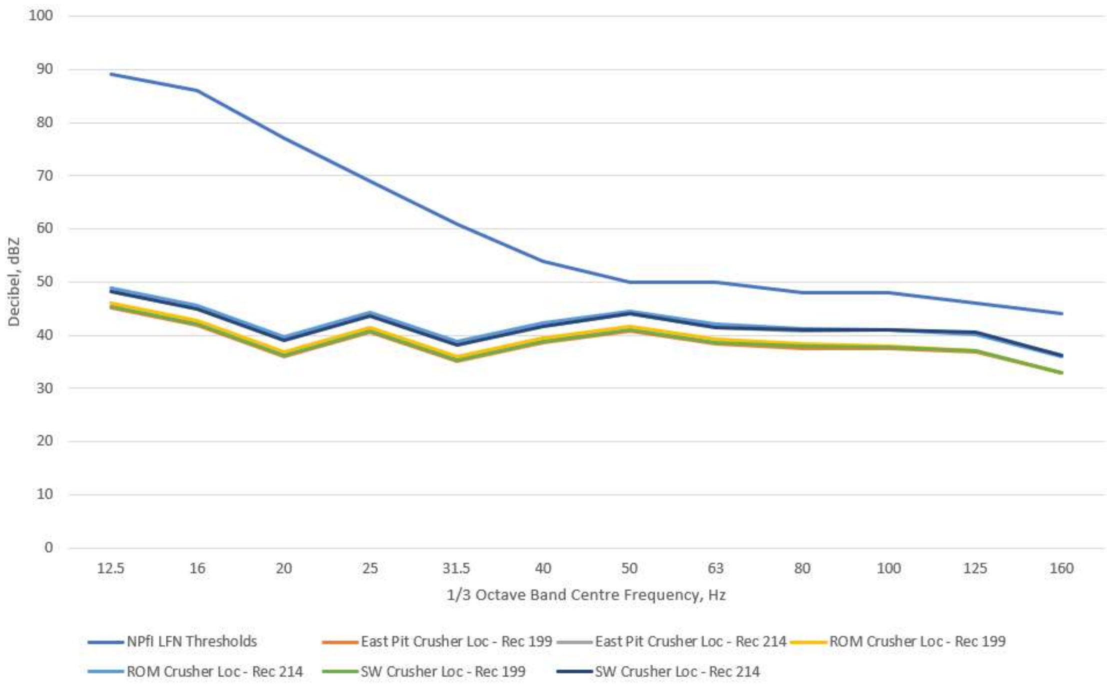


Figure C1: 2021 Normalised Third-Octave Low-Frequency Noise Predictions

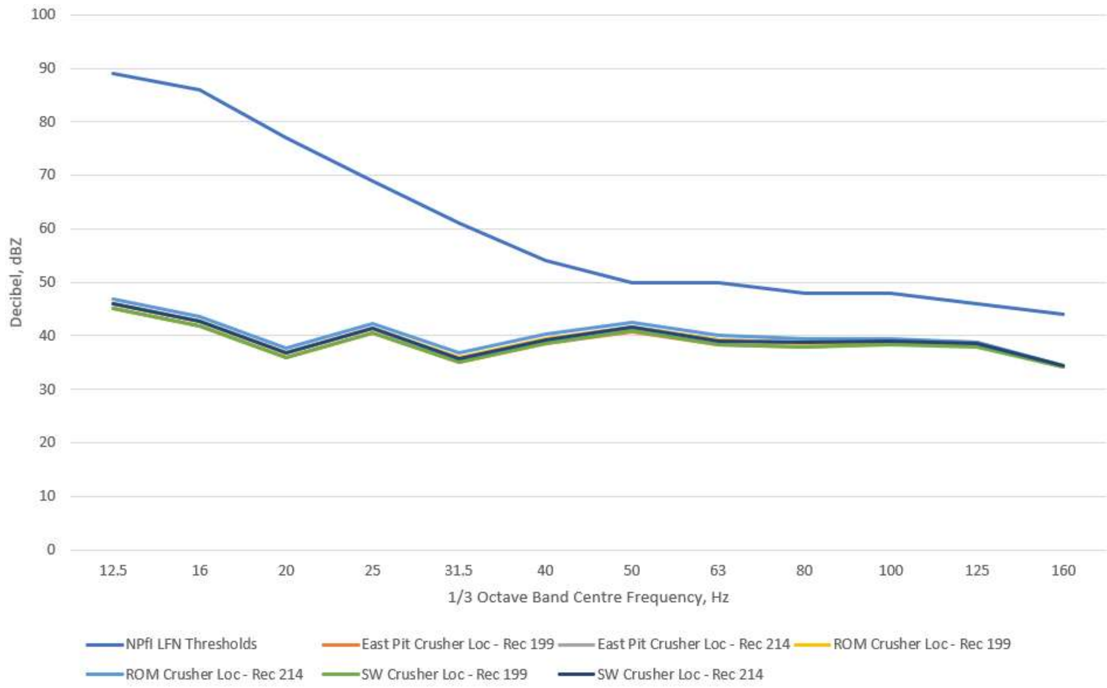


Figure C2: 2023 Normalised Third-Octave Low-Frequency Noise Predictions

Operational Noise Assessment

The predicted $L_{Aeq,15min}$ operational noise levels at each privately-owned residential receiver are presented in **Tables C3** and **C4**. Results are presented for all three mobile coal sizing site locations and years 2021 and 2023. Levels highlighted in red indicate predictions in exceedances of the Operational Noise Criteria (**Table 1**).

Table C3: Predicted $L_{Aeq,15min}$ Operational Noise Levels from Modification - 2021

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
0b	24	22	27	24	22	27	24	22	27
0c	23	21	26	23	21	26	23	21	26
0d	23	21	26	23	20	26	23	20	26
0e	24	21	26	24	21	26	24	21	26
0f	23	21	25	23	20	25	23	20	25
0g	21	21	29	20	20	29	20	20	29
0h	16	16	26	16	16	26	16	16	26
0i	23	20	27	23	20	27	23	20	27
1	24	21	26	24	21	26	24	21	26
10	28	26	31	28	25	31	28	25	31
33a	33	29	35[1]	33	29	35	33	29	35
33b	33	29	35[1]	33	29	35[1]	33	29	35[1]
35	34	29	35[1]	34	29	35[1]	34	29	35[1]
37	33	28	35[1]	32	27	35	33	27	35[1]
38	33	28	35[1]	33	28	35	33	28	35[1]
39	31	26	34	31	26	34	32	26	34
42	33	28	35[1]	33	28	35[1]	33	28	35[1]
43	34	29	35[1]	33	28	35[1]	34	29	35[1]
44	34	29	35[1]	34	29	35[1]	34	29	35[1]
50	33	28	35[1]	33	28	35[1]	33	28	35[1]
52a	34	29	35[1]	34	28	35[1]	34	29	35[1]
52b	32	27	35	32	26	35	32	26	35

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
67	35[1]	30	35[1]	35[1]	30	35[1]	35[1]	30	35[1]
74	34	28	35[1]	34	28	35[1]	34	28	35[1]
77	35[1]	30	35[1]	35[1]	30	35[1]	35[1]	30	35[1]
78	32	27	35	32	27	34	32	27	35
89a	32	28	35[1]	32	28	35	33	28	35[1]
89b	32	28	35	32	28	35	32	28	35
94	32	27	35[1]	32	27	35[1]	32	26	35[1]
97a	26	22	30	26	21	30	26	21	30
97b	26	22	30	26	21	30	26	21	30
98	27	24	31	27	23	31	27	23	31
103	31	27	35	31	26	34	31	26	34
105	33	30	35[1]	33	29	35[1]	33	29	35[1]
108a	35[1]	37	39[1]	35[1]	36	39[1]	35[1]	36	39[1]
108b	35[1]	36	39[1]	35[1]	36	39[1]	35[1]	36	39[1]
196	27	24	30	27	24	30	27	23	31
199	21	21	29	21	21	29	21	20	29
200a	26	23	30	26	22	30	26	22	30
200b	26	23	30	26	22	30	26	22	30
204	22	21	28	21	21	28	21	21	28
207	27	21	31	26	20	31	26	20	31
214	28	22	32	28	22	32	27	22	32
215	25	22	29	25	22	29	25	22	29
222	28	25	34	28	24	34	27	24	34
225	23	24	35[1]	23	23	35[1]	23	23	35[1]
233	21	21	28	21	21	28	21	21	28
234	24	24	35	24	24	35	24	24	35
237	23	24	35[1]	23	23	35[1]	23	23	35[1]
241	21	22	29	21	21	29	21	21	29

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
242a	22	22	30	22	22	30	22	22	30
242b	22	22	31	22	22	31	22	22	31
249a	10	10	21	9	9	21	9	10	21
249b	10	10	21	9	10	21	9	10	21
253	21	21	28	21	21	28	21	21	28
272	20	20	33	20	20	33	20	20	33
275	22	22	33	22	22	33	22	22	33
291	15	16	26	13	13	26	13	13	26
305	15	15	25	15	15	25	15	15	24
313	14	14	26	13	13	25	13	13	25
318	28	24	30	28	24	30	28	24	30
319	27	24	30	27	24	30	27	24	30
322	27	24	32	27	24	32	27	23	32
323	28	25	34	28	25	33	28	24	33
324	27	24	31	27	24	31	28	24	31
326	28	25	33	28	25	33	28	24	33
327	27	24	31	27	24	31	28	24	31
339	20	21	29	20	20	29	20	21	29
342	11	11	21	11	11	21	11	11	21
344	18	18	26	18	18	26	18	19	26
345a	21	21	31	21	21	31	21	21	31
345b	21	21	31	21	21	31	21	21	31
346	7	7	14	7	7	14	7	7	14
349	25	22	29	25	22	29	25	22	29
350	26	22	30	26	21	30	26	21	29
351	26	23	29	26	22	29	25	22	29
353	20	21	27	20	21	27	21	21	27
354a	17	17	26	17	17	26	17	17	26

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
354b	17	17	26	16	16	26	16	16	26

Note 1: Result includes implementation of proactive management system.

Table C4: Predicted $L_{Aeq,15min}$ Operational Noise Levels from Modification - 2023

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
0b	23	21	26	23	20	26	23	20	26
0c	22	20	25	22	19	24	22	19	25
0d	22	19	25	22	19	25	22	19	25
0e	23	20	25	23	19	25	23	19	25
0f	22	18	24	22	18	24	22	18	24
0g	20	20	28	20	20	28	20	20	29
0h	18	18	27	18	18	26	18	18	27
0i	23	21	27	23	20	27	23	20	27
1	23	20	25	23	20	25	23	20	25
10	28	24	30	27	24	30	27	24	30
33a	31	28	34	31	27	34	31	27	34
33b	32	28	35	32	27	35	32	27	34
35	33	28	35	32	28	35	32	28	35
37	32	28	35	32	28	35	32	28	35
38	32	28	35	32	28	35	32	28	35
39	31	26	33	31	26	33	31	26	33
42	33	28	35[1]	33	28	35	33	28	35[1]
43	33	29	35[1]	33	28	35[1]	33	28	35[1]
44	33	29	35[1]	33	29	35[1]	33	29	35[1]
50	33	28	35[1]	33	27	35[1]	33	27	35[1]

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
52a	34	29	35[1]	34	29	35[1]	34	29	35[1]
52b	32	27	34	32	26	34	32	26	34
67	36	29	35[1]	36	29	35[1]	36	29	35[1]
74	33	26	35[1]	33	26	35[1]	33	26	35[1]
77	36	30	35[1]	36	29	35[1]	36	29	35[1]
78	32	26	35	32	25	35	32	25	35
89a	33	26	35[1]	33	26	35[1]	33	26	35[1]
89b	33	26	35[1]	33	26	35[1]	33	26	35[1]
94	33	27	35[1]	33	27	35[1]	33	27	35[1]
97a	24	21	28	24	20	28	24	20	28
97b	24	21	28	24	20	27	24	20	28
98	25	22	29	25	22	29	25	22	29
103	30	26	34	30	26	33	30	26	33
105	32	29	35	32	28	35	32	28	35
108a	40	36	39[1]	40	35	39[1]	40	35	39[1]
108b	40	35	39[1]	40	35	39[1]	40	35	39[1]
196	27	24	31	27	23	31	27	23	31
199	23	23	30	23	22	30	23	23	30
200a	24	21	28	24	20	28	24	21	28
200b	24	21	29	24	21	28	24	21	28
204	20	20	27	19	20	26	19	20	26
207	25	22	30	25	21	29	25	21	29
214	26	21	31	25	20	30	25	20	30
215	24	21	28	23	21	27	23	21	28
222	26	23	32	25	23	32	25	23	32
225	23	23	35	23	23	35	23	23	35
233	20	20	27	19	19	26	19	20	27
234	22	23	34	22	22	33	22	22	33

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
237	23	24	35	23	23	34	23	23	35
241	20	20	28	20	20	27	20	20	28
242a	21	21	29	20	21	29	20	21	29
242b	21	21	30	20	21	29	21	21	30
249a	9	10	20	9	9	20	9	9	20
249b	9	10	20	9	9	20	9	9	20
253	20	21	27	20	20	27	21	21	27
272	20	20	31	19	20	31	20	20	31
275	21	21	32	20	21	31	21	21	31
291	15	15	26	12	12	26	12	13	26
305	14	14	25	14	14	25	14	14	25
313	14	14	26	13	13	25	13	14	26
318	26	22	29	26	22	29	26	22	29
319	26	22	29	26	22	28	26	22	28
322	28	24	33	28	24	32	28	24	32
323	29	25	35	29	25	35	29	25	35
324	27	24	31	27	24	31	27	24	31
326	29	25	34	29	25	34	29	25	34
327	27	24	31	27	24	31	27	24	31
339	20	20	28	19	20	28	20	20	28
342	11	11	21	11	11	20	11	11	21
344	17	17	26	17	17	25	17	17	26
345a	20	20	29	20	20	29	20	20	29
345b	20	20	29	19	20	29	20	20	29
346	6	6	13	6	6	13	6	6	13
349	23	21	27	23	21	26	23	21	27
350	24	21	28	24	20	27	24	20	28
351	24	22	28	23	21	27	24	21	27

Receiver ID	Operational Noise Level (dBA)								
	ROM Stockpile Area			Southwest In-Pit Area			Northeast In-Pit Area		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
353	20	20	26	19	20	26	20	20	26
354a	16	16	25	16	16	25	16	16	25
354b	16	16	25	15	15	25	15	15	25

Note 1: Result includes implementation of proactive management system.

Cumulative Noise Assessment

Cumulative noise from the MCCM and the nearby Boggabri Coal Mine (BCM), Tarrawonga Coal Mine (TCM) have been considered in the assessment. The methodology adopted is consistent with the approved MCCM noise assessment.

The predicted night cumulative noise levels at each privately-owned residential receiver are presented in **Table C5**. Results consider the maximum noise emissions from the three mobile coal sizing sites and across both assessed years.

Table C5: Predicted Night Cumulative $L_{Aeq,Period}$ Operational Noise Levels from the Modification, BCM and TCM

Receiver ID	$L_{eq,9hr}$ Noise Prediction (dBA)				Cumulative Noise Criterion (dBA)
	Modification	TCM (Year 3)	BCM (Year 10)	Cumulative	
0b	24	23	27	30	40
0c	23	23	27	30	40
0d	23	23	27	29	40
0e	23	23	27	30	40
0f	22	23	27	29	40
0g	26	26	32	34	40
0h	24	21	27	29	40
0i	24	22	27	30	40
1	23	23	27	30	40
10	28	23	27	31	40
33a	33	23	27	34	40
33b	33	23	27	34	40
35	33	23	27	34	40

Receiver ID	$L_{eq,9hr}$ Noise Prediction (dBA)				Cumulative Noise Criterion (dBA)
	Modification	TCM (Year 3)	BCM (Year 10)	Cumulative	
37	33	23	27	34	40
38	33	23	27	34	40
39	31	23	27	33	40
42	33	23	27	35	40
43	33	23	27	35	40
44	34	23	27	35	40
50	33	23	27	35	40
52a	34	23	27	35	40
52b	32	23	27	33	40
67	36	23	27	37	40
74	34	23	27	35	40
77	36	23	27	37	40
78	32	23	27	34	40
89a	34	22	27	35	40
89b	33	22	27	34	40
94	34	22	27	35	40
97a	27	23	27	31	40
97b	27	23	27	31	40
98	28	23	27	31	40
103	32	23	27	34	40
105	34	23	27	35	40
108a	42	23	27	42	n/a
108b	41	23	27	42	n/a
196	28	22	27	31	40
199	27	22	27	31	40
200a	27	23	27	31	40
200b	27	23	27	31	40
204	25	23	27	30	40
207	28	23	27	31	40

Receiver ID	$L_{eq,9hr}$ Noise Prediction (dBA)				Cumulative Noise Criterion (dBA)
	Modification	TCM (Year 3)	BCM (Year 10)	Cumulative	
214	29	23	27	32	40
215	26	23	27	30	40
222	31	23	27	33	40
225	34	23	27	35	40
233	25	23	30	32	40
234	32	23	27	34	40
237	33	23	30	35	40
241	26	23	30	32	40
242a	27	23	30	32	40
242b	28	23	30	33	40
249a	18	21	30	31	40
249b	18	21	30	31	40
253	25	25	27	31	40
272	30	27	31	34	40
275	30	31	31	35	40
291	23	31	32	35	40
305	22	32	32	35	40
313	23	31	32	35	40
318	27	23	27	31	40
319	27	23	27	31	40
322	30	22	27	32	40
323	32	22	27	33	40
324	28	22	27	31	40
326	31	22	27	33	40
327	28	22	27	31	40
339	26	28	29	33	40
342	18	11	27	28	40
344	23	20	28	30	40
345a	28	31	31	35	40

Receiver ID	$L_{eq,9hr}$ Noise Prediction (dBA)				Cumulative Noise Criterion (dBA)
	Modification	TCM (Year 3)	BCM (Year 10)	Cumulative	
345b	28	31	31	35	40
346	11	15	27	27	40
349	26	23	27	30	40
350	27	23	27	31	40
351	26	23	27	31	40
353	24	21	30	31	40
354a	23	32	32	35	40
354b	23	32	32	35	40

Table C5 indicates that night cumulative noise levels would comply with the Cumulative Noise Criterion (40 dBA $L_{Aeq,9hr}$) at all privately-owned receivers.

Maximum Noise Level Event Assessment

To assess compliance with the $L_{A1,1min}$ Project Approval Noise Criteria (**Table 1**), the noise model was also used to analyse potential $L_{A1,1min}$ noise levels likely to arise from the Modification's night operations. The instantaneous noise sources associated with the additional equipment from the Modification that have the potential to generate sleep disturbance are summarised in **Table C6**.

Table C6: Maximum Noise Level Event Assessment – Sound Power Levels

Instantaneous Noise Source	Typical $L_{A1,1min}$ SWL (dBA)
Dozer track noise in 1st gear	114-124
Excavator / Loader dumping in empty truck bodies	115-125
Haul truck passbys	<117
Moxi truck dumping into radial stockpiler	115-120
Mobile crusher	120-125

The predicted $L_{A1,1min}$ noise levels at each privately-owned residential receiver are presented in **Table C7**. Results consider the maximum noise emissions from the three mobile coal sizing site locations. The methodology adopted is consistent with the Landform Modification noise assessment.

Table C7: Predicted Night $L_{A1,1min}$ Levels from Modification

Receiver ID	$L_{A1,1min}$ Noise Prediction (dBA)		$L_{A1,1min}$ Project Approval Noise Criterion (dBA)
	2021	2023	
0b	27	26	45
0c	26	25	45
0d	26	25	45
0e	26	26	45
0f	26	24	45
0g	30	29	45
0h	27	27	45
0i	28	28	45
1	27	26	45
10	32	31	45
33a	36	35	45
33b	36	35	45
35	37	36	45
37	36	36	45
38	36	36	45
39	34	34	45
42	37	36	45
43	37	36	45
44	37	37	45
50	37	37	45
52a	38	37	45
52b	35	35	45
67	40	39	45
74	37	37	45
77	40	40	45
78	35	35	45
89a	36	37	45

Receiver ID	$L_{A1,1min}$ Noise Prediction (dBA)		$L_{A1,1min}$ Project Approval Noise Criterion (dBA)
	2021	2023	
89b	36	37	45
94	36	38	45
97a	31	29	45
97b	31	29	45
98	32	30	45
103	36	35	45
105	37	36	45
108a	45	45	45
108b	45	44	45
196	31	32	45
199	30	30	45
200a	31	29	45
200b	31	29	45
204	28	27	45
207	32	31	45
214	33	32	45
215	30	28	45
222	35	33	45
225	38	36	45
233	28	27	45
234	36	34	45
237	37	36	45
241	29	28	45
242a	31	30	45
242b	31	30	45
249a	21	20	45
249b	21	20	45
253	28	27	45
272	33	32	45

Receiver ID	$L_{A1,1min}$ Noise Prediction (dBA)		$L_{A1,1min}$ Project Approval Noise Criterion (dBA)
	2021	2023	
275	33	32	45
291	27	27	45
305	25	25	45
313	26	26	45
318	30	29	45
319	30	29	45
322	32	33	45
323	34	35	45
324	32	32	45
326	34	34	45
327	32	32	45
339	30	29	45
342	22	22	45
344	26	26	45
345a	31	30	45
345b	31	30	45
346	14	13	45
349	29	27	45
350	30	29	45
351	30	28	45
353	27	26	45
354a	26	25	45
354b	26	25	45

Table C7 indicates that night $L_{A1,1min}$ noise levels would comply with the $L_{A1,1min}$ Project Approval Noise Criterion of 45 dBA at all privately-owned receivers.

ATTACHMENT B

AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

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8 September 2021

Jorge Moraga
General Manager – Maules Creek
Whitehaven Coal Limited
Off Therribri Rd
Boggabri NSW 2382

RE: Air Quality Assessment – Maules Creek Coal Mine Mobile Coal Sizing Modification

Todoroski Air Sciences has assessed the potential for air quality impacts to arise due to the proposed use of mobile coal sizing and rock crushing equipment at the Maules Creek Coal Mine (MCCM) (hereafter referred to as the Modification). This report investigates the potential change in dust emissions associated with the Modification relative to the approved operations and the potential for dust impacts.

This assessment has been prepared with consideration of the New South Wales (NSW) Environment Protection Authority (EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

Modification description

MCCM is an open cut coal mine operated by Maules Creek Coal Pty Ltd (MCC) and located in the Gunnedah Coal basin approximately 17 kilometres (km) to the northeast of Boggabri and approximately 40km southeast of Narrabri. Project Approval 10_0138 for the MCCM was approved in 2012.

The approved MCCM includes primary, secondary and tertiary coal sizing equipment located in the Mine Infrastructure Area (MIA) which reduces the size of run-of-mine (ROM) coal before it is either processed (washed) in the Coal Handling and Preparation Plant (CHPP) or bypassed to the product stockpile. Through ongoing mine planning, MCC has identified an opportunity to improve operating efficiencies of the MCCM through the use of mobile coal sizing equipment.

MCC is therefore proposing to modify the MCCM Project Approval to allow for the use of mobile coal sizing and associated fleet to process ROM coal. The mobile coal sizing equipment would be located generally in the ROM stockpile area or within parts of the open cut pit and would resize up to 2.2 million tonnes (Mt) of ROM coal per annum (Mt/annum) over the remaining mine life. The Modification does not seek to change the maximum approved extraction rate of 13Mt/annum or product coal export rates for the MCCM.

The proposed mobile coal sizing circuit consists of hauling ROM coal to the mobile coal sizing equipment using existing haul trucks (i.e. no new haul trucks are proposed); resizing of ROM coal using two new mobile sizing units and associated new rehandling equipment (e.g. excavators, dozers); hauling resized coal to the existing ROM stockpile area using existing haul trucks (only when the mobile coal sizers are located in-pit); hauling resized coal with articulated dump trucks to a radial stockpiler for transfer to the product stockpiles.

In addition, MCC proposes to use a mobile rock crusher located in the Northern Emplacement Area for processing approximately 0.4 Mt/annum of waste rock. The resized waste rock that would otherwise be emplaced would be used on-site as needed for the purpose of construction, maintenance of roads, and drainage. Waste rock would be transported to the mobile rock crusher where it is crushed and stockpiled before being transported for use at locations across the site. Construction of roads using better quality materials is a component of the ongoing program of performance improvement and may assist to reduce wheel generated dust, reduce maintenance, and improve safety.

Assessment of potential air quality impacts

To investigate the potential effect the Modification may have on dust levels in the surrounding environment, an analysis was undertaken for the proposed change in dust levels associated with the Modification relative to the dust levels associated with the approved Landform Modification (MOD 7) Air Quality Impact Assessment (**Todoroski Air Sciences, 2020**).

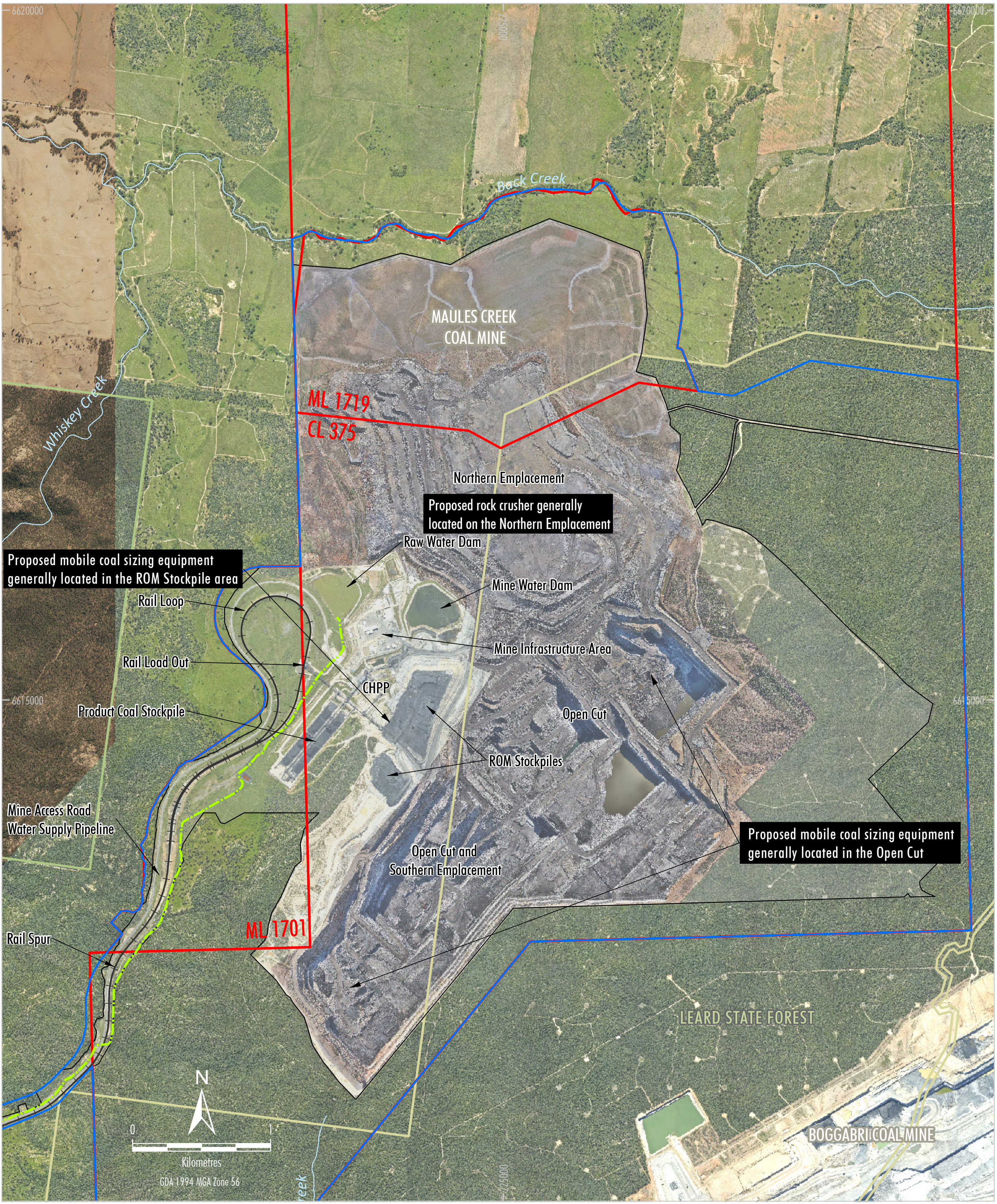
The operational activities associated with the Modification have the potential to generate dust which can affect the quantum of dust emissions generated at MCCM. To consider the potential effect of dust emissions associated with the proposed operational activities (i.e. the incremental impacts of the Modification), the estimated dust emissions are compared with the levels of dust predicted for the MOD 7 Landform Modification.

Three scenarios have been developed and assessed to represent three potential ROM mobile coal sizer locations; the ROM stockpile area (Scenario A), southern open cut pit (Scenario B) and east open cut pit (Scenario C). The mobile rock crusher is located in the Northern Emplacement Area in each of the scenarios. **Figure 1** presents the general location of the activities associated with the Modification.

The influence of the Modification has been assessed using the same detailed air dispersion model developed for the MOD 7 Landform Modification. The air dispersion model was setup identically (apart from adding in the activities associated with this Modification) to allow for a direct comparison with the previous assessment. Full details regarding the air dispersion model setup can be found in the MOD 7 Air Quality Impact Assessment (**Todoroski Air Sciences, 2020**).

The MOD 7 Air Quality Impact Assessment considered three assessment scenarios; operational years 2021, 2023 and 2025. Of these, the Year 2023 scenario includes emplacement occurring on the maximum height of the Northern Emplacement Area and has the highest estimated annual dust emissions and was selected as a generally representative scenario for the Modification.

The modelling scenarios representing the different locations of mobile coal sizing equipment across the site are assessed for the Modification and applied to the modelling predictions for the MOD 7 Year 2023.



LEGEND

- MCCM Mining Tenement Boundary (ML and CL)
- MCCM Approximate Extent of Existing/Approved Surface Development
- MCCM Project Boundary
- State Conservation Area, Aboriginal Area
- State Forest
- Rail Line
- Maules Creek Coal Water Supply Pipeline

Source: NSW Spatial Services (2019); Orthophoto: Whitehaven Coal (2021)

WHITEHAVEN COAL

MAULES CREEK COAL MINE

Approved Mine General Arrangement Incorporating the Modification

Figure 1

The rate of dust emission has been calculated by analysing each step of the primary dust generating activities associated with the Modification which include the handling of material, sizing and screening of coal, rock crushing, dozer activity, vehicle movements and diesel exhaust emissions.

A summary of the estimated dust emissions from the operational activities associated with the Modification is presented in **Table 1**. Detailed dust emission inventories for the operational activities are presented in **Appendix A**. It is noted that the rate of particulate emission is the same for each of the three scenarios as the amount of material handled is identical as is the quantum of hauling of the ROM coal (whether resized or not) to the ROM stockpile would occur at the same rate for the approved project as for the Modification. The data indicate that approximately 97% of the Total Suspended Particulate (TSP) emissions due to the Modification are associated with the ROM coal sizing and 3% are associated with rock crushing.

Table 1: Summary of estimated dust emission rate for the Modification (kg/year)

Activity	TSP emission	PM_{10} emission	$PM_{2.5}$ emission
Coal sizing			
Dozer pushing ROM	64,241	14,565	1,413
Excavator loading ROM to sizing unit	71,809	11,363	1,364
Sizing	5,940	2,640	489
Screening	27,500	9,460	1,752
Unloading to stockpile	71,809	11,363	1,364
Loading to articulated dump truck	71,809	11,363	1,364
Hauling to Product Stockpile	45,161	11,412	1,141
Unloading to radial stockpiler	71,809	11,363	1,364
Radial stockpiler loading to Product Stockpile	287	136	21
Diesel mining equipment	777	777	754
Coal sizing total	**431,143**	**84,441**	**11,027**
Rock crushing			
Loading to rock crusher	521	247	37
Crushing rocks at Northern Emplacement	991	440	82
Unloading from rock crusher	521	247	37
Loading crushed rock to truck	521	247	37
Hauling crushed rock	7,533	1,904	190
Unloading crushed rock	521	247	37
Rehandling crushed rock	521	247	37
Diesel mining equipment	204	204	197
Rock crushing total	**11,335**	**3,781**	**656**
Total emissions (coal sizing + rock crushing)	**442,477**	**88,221**	**11,683**

A comparison of the estimated total annual dust emissions for the Modification compared with the estimated annual dust emissions for the approved MOD 7 is presented in **Table 2**.

Table 2: Comparison of estimated TSP emission rate for the proposed Modification

Activity	Modification	Year 2023 – MOD 7 operations [1]
Total TSP emissions (kg/yr)	442,477	8,473,525
% Change of Total TSP emissions	-	5%

[1] **Todoroski Air Sciences (2020)**

It is calculated that the total annual dust emissions associated with the Modification would increase dust emissions by approximately 5% from the approved MOD 7 Year 2023 operations. The small increase in total annual dust emissions due to the Modification primarily arises from the additional sizing and handling of the ROM coal. The rock crushing activity represents a negligible increase in TSP emissions.

Dispersion modelling predictions

Table 3 presents a summary of the highest maximum predicted level at any privately-owned receptor assessed for the MOD 7 Year 2023 and each of the Modification scenarios.

The results indicate that the predicted dust levels are unlikely to change significantly at the most impacted privately-owned receptors as a result of the proposed Modification in comparison with the MOD 7 Year 2023 results. The predicted increase due to the Modification is approximately <1 to 1μg/m^3 for the assessed dust metrics and is unlikely to be discernible. The results show that the predicted air quality levels at the receptor locations would remain below the relevant criteria for all assessed dust metrics for the approved MCCM incorporating the Modification, and that no additional exceedances of the relevant assessment criteria are predicted to arise for the Modification scenarios.

Table 3: Summary of modelling predictions for all scenarios – highest maximum predicted level at any privately-owned receptor

Pollutant	Impact	Period	Criteria (μg/m³) ^	Modelling predictions (μg/m³)				Change relative to approved MCCM (MOD 7) (μg/m³)		
				MOD 7 [1]	MOD 7 + Scenario A	MOD 7 + Scenario B	MOD 7 + Scenario C	Scenario A	Scenario B	Scenario C
$PM_{2.5}$ (μg/m³)	Modification in isolation (Incremental)	24-hr ave.	25*	7	7	7	7	<1	<1	<1
		Ann. ave.	-	1	1	1	1	<1	<1	<1
PM_{10} (μg/m³)		24-hr ave.	50*	36	37	37	37	1	1	1
		Ann. ave.	-	6	6	6	6	<1	<1	<1
TSP (μg/m³)		Ann. ave.	-	10	10	10	11	<1	<1	1
Deposited dust (g/m²/mth)		Ann. ave.	-	0.3	0.3	0.3	0.3	<1	<1	<1
$PM_{2.5}$ (μg/m³)	Total impact (Cumulative)	Ann. ave.	8	5	5	5	5	<1	<1	<1
PM_{10} (μg/m³)		Ann. ave.	25	22	22	22	22	<1	<1	<1
TSP (μg/m³)		Ann. ave.	90	52	52	52	52	<1	<1	<1
Deposited dust (g/m²/mth)		Ann. ave.	4	2.8	2.8	2.8	2.8	<1	<1	<1

^ Criteria per the NSW EPA Approved Methods (2017). Note that in Project Approval 10_0138, the annual average PM_{10} criterion is 30μg/m^3 and there are currently no criteria for $PM_{2.5}$.

* Note that cumulative 24-hour average criteria also apply.

[1] **Todoroski Air Sciences (2020)**

The incremental modelling predictions for MOD 7 Year 2023 scenario overlaid with the predicted air quality levels due to the proposed Modification (MOD 7 + Modification) are presented in **Appendix B**. Overlaying these contours allows for a direct comparison of the potential change associated with the proposed Modification to be clearly seen.

The isopleth results show that there is minimal difference between the three modification scenarios and the MOD 7 Year 2023 impacts. This therefore indicates that the proposed Modification would have a negligible effect at the privately-owned receptor locations and that all three potential mobile sizing locations have a comparable level of impact.

Greenhouse gas assessment

The potential change in greenhouse gas (GHG) emissions associated with the Modification has been considered. The additional fleet associated with the Modification would have additional diesel usage and the exhaust emissions would generate additional GHG emissions. The additional GHG emissions have been calculated for the Modification using the National Greenhouse Accounts Factors (**DISER, 2020**).

The additional diesel usage for the fleet have been estimated based on the expected hourly diesel fuel consumption for the equipment and the annual operational hours. An estimated additional 1,299 kilolitres per annum of diesel is estimated for the additional fleet.

A comparison of the average estimated annual GHG emissions for the approved mining operation (**PAEHolmes, 2011**) and the Modifications is presented in **Table 4**. It is calculated that the additional GHG emissions associated with the Modification would result in an increase in the annual average GHG emissions by approximately 0.01% relative to the approved MCCM operations.

Table 4: Comparison of estimated annual average GHG emissions (t CO_2-e)

	Total
Annual average GHG emissions for the approved operations [1]	30,028,092
Modification	3,686
% Change of annual average GHG emissions	**0.01%**

[1] **PAEHolmes (2011)**

Summary and conclusions

This study has examined the likely air quality effects which may arise from the proposed Modification.

The study estimates that the potential increase in dust generated from the Modification is approximately 5% of the approved MOD 7 Year 2023 operations.

Direct modelling of all mining activities at MCCM including the Modification was conducted and compared with the predicted levels for MOD 7 Year 2023. The comparison shows the difference between the MOD 7 Year 2023 and incorporating the Modification impacts are very minor and that the predicted air quality levels due to the Modification at the receptor locations would remain below the relevant criteria for all assessed dust metrics.

The increase in GHG emissions due to the Modification is minimal with an estimated 0.01% increase in annual emissions due to the operation of the Modification.

It is concluded that the Modification would not result in any discernible change in impact relative to the impact presented in MOD 7 Year 2023.

Please feel free to contact us if you need to discuss (or require clarification on) any aspect of this report.

Yours faithfully,
Todoroski Air Sciences

Katie Trahair

Philip Henschke

References

DISER (2020)

"National Greenhouse Accounts Factors" Australian Government Department of Industry, Science, Energy and Resources (DISER), October 2020.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

PAEHolmes (2011)

"Air Quality Impact Assessment Maules Creek Coal Project", prepared by PAE Holmes on behalf of Hanson Bailey, July 2011.

Todoroski Air Sciences (2020)

"Air Quality Assessment Maules Creek Coal Mine Landform Modification", prepared by Todoroski Air Sciences on behalf of Whitehaven Coal Limited, December 2020.

Appendix A – Emission Inventory

Table 5: Emissions inventory for the proposed Modification (kg/year)

Activity	TSP emission (kg/yr)	PM10 emission (kg/yr)	PM25 emission (kg/yr)	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 1	Units	Var. 2	Units	Var. 3 - TSP / PM10 / PM2.5	Units	Var. 4	Units	Var. 5	Units	Var. 6	Units
Loading to rock crusher	521	247	37	366,989	t/yr	0.00142	0.00067	0.00010	kg/t	1.2	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
Crushing rocks at Northern Emplacement	991	440	82	366,989	t/yr	0.0027	0.0012	0.0002	kg/t												
Unloading from rock crusher	521	247	37	366,989	t/yr	0.0014	0.0007	0.0001	kg/t	1.2	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
Loading crushed rock to truck	521	247	37	366,989	t/yr	0.00142	0.00067	0.00010	kg/t	1.2	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
Hauling crushed rock	7,533	1,904	190	366,989	t/yr	0.137	0.035	0.003	kg/t	37	tonnes/load	2	km/return trip	2.5/0.6/.01	kg/VKT	4.6	% silt content	46.5	Ave weight (tonnes)	85	% Control
Unloading crushed rock	521	247	37	366,989	t/yr	0.0014	0.0007	0.0001	kg/t	1.2	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
Rehandling crushed rock	521	247	37	366,989	t/yr	0.0014	0.0007	0.0001	kg/t	1.2	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
Dozer pushing ROM	64,241	14,565	1,413	5,908	hrs/yr	10.9	2.5	0.2	kg/h	5	silt content in %	11	moisture content in %								
Excavator loading ROM to sizing unit	71,809	11,363	1,364	2,200,000	t/yr	0.033	0.005	0.001	kg/t	11	moisture content in %										
Sizing	5,940	2,640	489	2,200,000	t/yr	0.0027	0.0012	0.0002	kg/t												
Screening	27,500	9,460	1,752	2,200,000	t/yr	0.013	0.004	0.001	kg/t												
Unloading to stockpile	71,809	11,363	1,364	2,200,000	t/yr	0.033	0.005	0.001	kg/t	11	moisture content in %										
Loading to articulated dump truck	71,809	11,363	1,364	2,200,000	t/yr	0.033	0.005	0.001	kg/t	11	moisture content in %										
Hauling to Product Stockpile	45,161	11,412	1,141	2,200,000	t/yr	0.137	0.035	0.003	kg/t	37	tonnes/load	2	km/return trip	2.5/0.6/.01	kg/VKT	4.6	% silt content	46.5	Ave weight (tonnes)	85	% Control
Unloading to radial stockpiler	71,809	11,363	1,364	2,200,000	t/yr	0.033	0.005	0.001	kg/t	11	moisture content in %										
Radial stockpiler loading to Product Stockpile	287	136	21	2,200,000	t/yr	0.00013	0.00006	0.00001	kg/t	1.2	average of (wind speed/2.2)^1.3 in m/s	11	moisture content in %								
Diesel mining equipment	980	980	951																		
Total emissions (kg/yr.)	**442,477**	**88,221**	**11,683**																		

Appendix B – Isopleth Diagrams

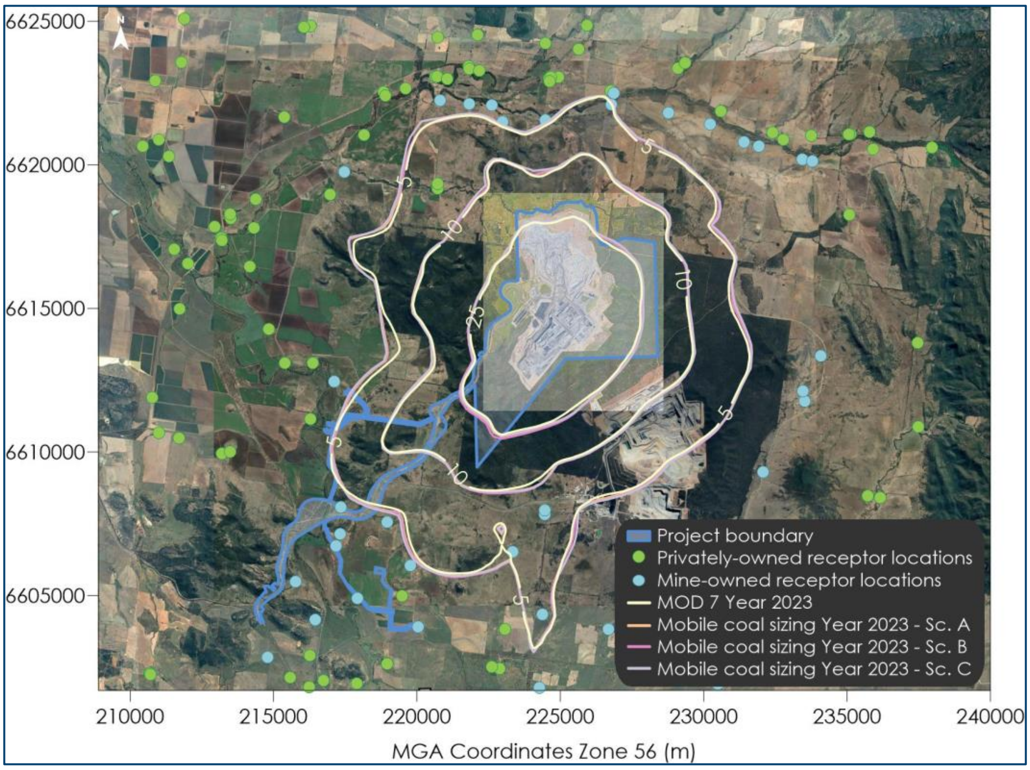


Figure 2: Predicted maximum 24-hour average incremental $PM_{2.5}$ concentrations (µg/m³)

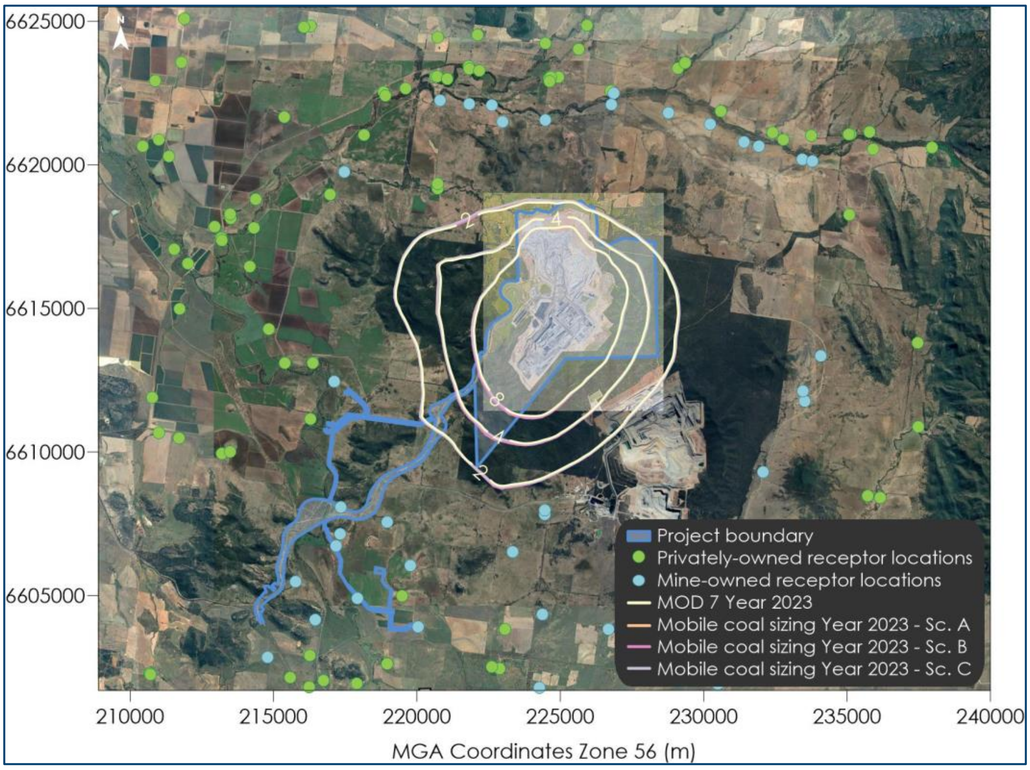


Figure 3: Predicted annual average incremental $PM_{2.5}$ concentrations (µg/m³)

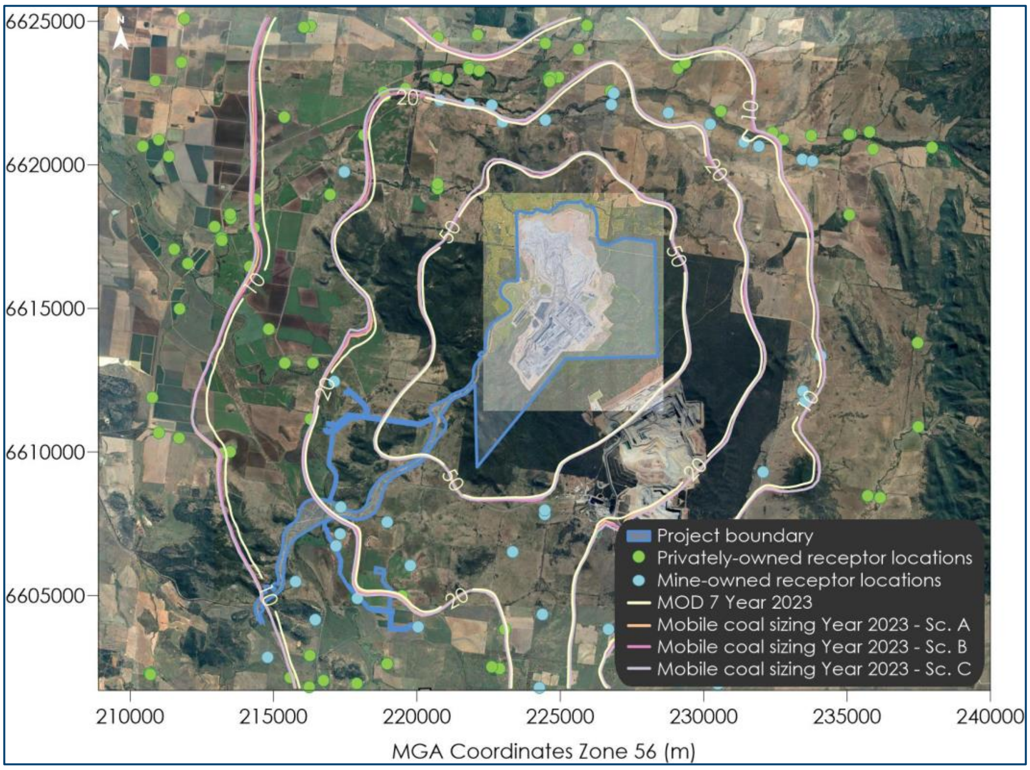


Figure 4: Predicted maximum 24-hour average incremental PM_{10} concentrations (µg/m³)

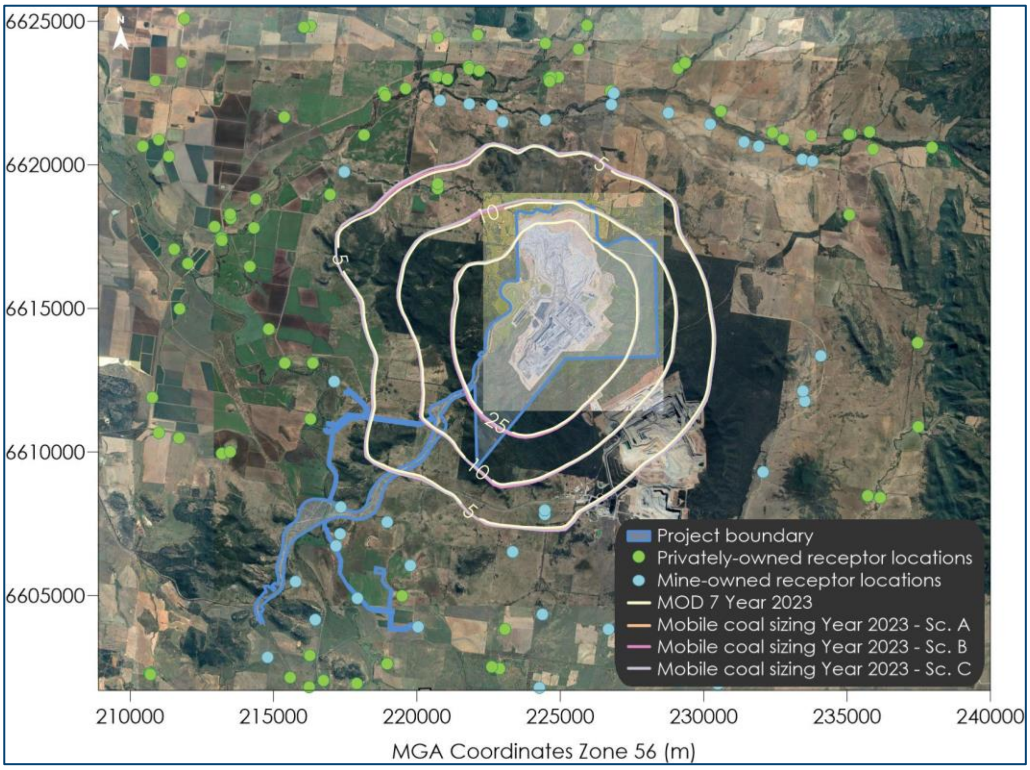


Figure 5: Predicted annual average incremental PM_{10} concentrations (µg/m³)

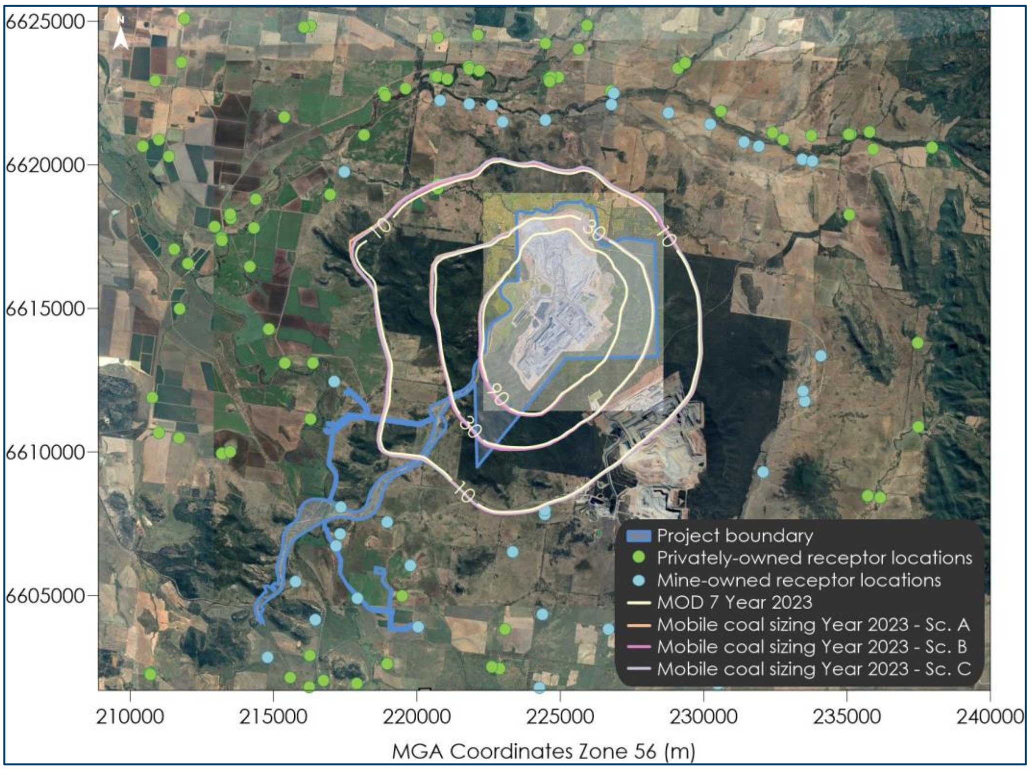


Figure 6: Predicted annual average incremental TSP concentrations (µg/m³)

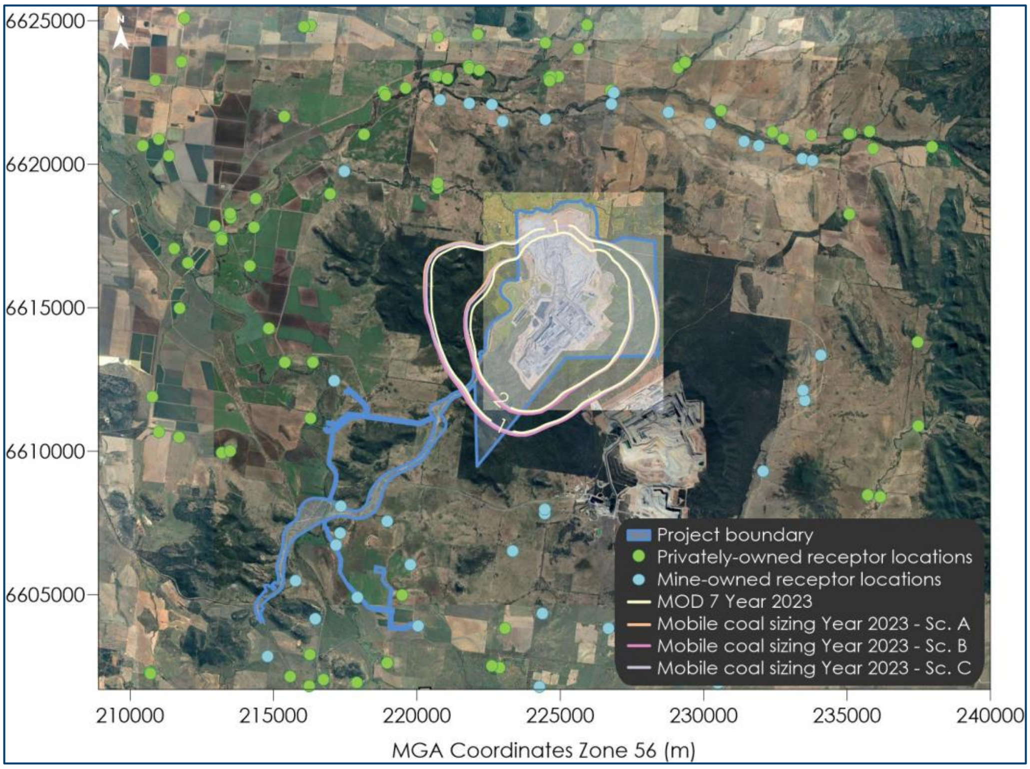


Figure 7: Predicted annual average incremental deposited dust concentrations (µg/m³)

ATTACHMENT C

SUPPORTING INFORMATION ON WASTE TYRE DISPOSAL

Operational policy

Mining

Disposal and storage of scrap tyres at mine sites

Operational policies provide a framework for consistent application and interpretation of legislation by the Department of Environment and Science. Operational policies will not be applied inflexibly to all circumstances. Individual circumstances may require an alternative application of policy. This policy concerns mining activities as defined under s. 110 of the Environmental Protection Act 1994*.*

1 Policy issue

Best practice environmental management for scrap tyres generated by mining activities follows a waste management strategy according to the following hierarchy in decreasing order of preference and desirability: avoidance, recycling, waste-to-energy, and disposal. Adoption and implementation of this hierarchy reflects the economic cost of handling and transporting large mine tyres in Queensland and the considerable energy and material resource embedded in the tyres.

2 Determination

For new applications, environmental authority conditions for scrap tyre management on mine sites should adhere to the following waste management strategies in decreasing order of preference and desirability:[1]

2.1 Avoidance

When negotiating purchase agreements with new tyre suppliers, seek take-back clauses to maximise freight backloading opportunities.

2.2 Recycling

Explore opportunities to recycle scrap tyres on-site and locally through use in impact-absorbing surfaces, bitumen and road construction, pastoral and agricultural use, and civil engineering applications.

2.3 Waste-to-energy

Use existing opportunities in Queensland to recover the intrinsic energy value through waste-to-energy options.

2.4 Disposal

(a) Tyres stored awaiting disposal—or transport for take-back and, recycling, or waste-to-energy options – should be stockpiled in volumes less than 3m in height and 200 square metres in area. Additional fire precautions should be taken, including removal of grass and other materials within a 10m radius of the scrap tyre store. Tyres should be stored in a manner that prevents water retention and minimises mosquito breeding events. Options may include holing side-walls, covering with tarpaulins, spraying with a non-persistent insecticide, or reducing the stockpile during rain events.

[1] Information contained in the guideline 'Application requirements for activities with waste impacts' (available from www.qld.gov.au using ESR/2015/1836 as a search term) should also be considered.

(b) Disposing of scrap tyres in underground stopes is acceptable provided this practice does not cause an unacceptable fire risk or compromise mine safety.

(c) Disposing of scrap tyres in spoil emplacements is acceptable, provided tyres are placed as deep in the spoil as possible but not directly on the pit floor. Placement should ensure scrap tyres do not impede saturated aquifers and do not compromise the stability of the consolidated landform.

(d) Disposing of scrap tyres (and other wastes) on mine sites is a notifiable activity under Schedule 3 of the *Environmental Protection Act 1994*, and the locations of the disposal sites need to be recorded on the Environmental Management Register.

3 Other issues to consider

Scrap tyre management issues that arise under ERA 16 (extractive and screening activities) should also follow this operational policy when establishing conditions for new environmental authority applications.

Approved:

5 December 2014

Enquiries:

Permit and Licence Management

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Version History

Version	Effective date	Description of changes
1.00	5 December 2014	First published version of the guideline.
2.00	5 December 2014	Minor changes.
2.01	18 November 2016	General administrative updates.
2.02	17 May 2018	The document template, header and footer have been updated to reflect current Queensland Government corporate identity requirements and comply with the Policy Register.

ACARP

Australian Coal Association Research Program

FINAL REPORT

Management of Waste Tyres in the Mining Industry

C8037

July 2000

ACARP

Management of Waste Tyres in the Mining Industry

FINAL REPORT

Australian Coal Association Research Program
Project No. C8037

M.H Corbett
Centre for Mined Land Rehabilitation

THE UNIVERSITY OF QUEENSLAND

ACARP
Australian Coal Association Research Program

CMLR

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CONTENTS

EXECUTIVE SUMMARY

The disposal of large off-the-road (OTR) tyres generated by the mining industry has generally been by landfill or a stockpile in a registered waste area on-site. Their size, construction and invariably remote location make them very difficult and expensive to handle and process. This Australian Coal Association Research Program (ACARP) project aims to identify opportunities to *Reduce, Reuse and Recycle* scrap mine tyres and to identify cost-effective alternatives for managing waste OTR tyres at remote mining operations.

Tyre recycling technology and literature is focussed on passenger tyres. The legislative impetus overseas and in Australia to ban whole tyres to landfill is more likely to be designed to conserve urban landfill space and to promote recycling rather than to prevent contamination or because tyres tend to 'float' in landfill. The technological and economic limitations in processing OTR tyres currently restrict any alternative uses to those that use whole or sectioned tyres or steel-containing shreds.

While in the context of Best Available Technology, the use of Tyre Derived Fuel (TDF) in cement kilns appears the most appropriate alternative, the high energy and cost input required to process, transport and 'dispose' OTR tyres suggests that this option is more appropriate for the utilisation of passenger tyres.

On-going dialogue with the mining industries and regulatory organisations has constituted a considerable component of this project and is difficult to detail in a report such as this. However, the input of this industry-funded research in policy development is evident in both the Scrap Tyre Task Force Strategy as well as the Queensland Environmental Protection Agency's (QEPA) Draft Operational Policy (ERA21) directing disposal and storage of scrap tyres on mine sites under the *Environmental Protection Regulation 1998.*

This project has demonstrated that recycling or reuse is extremely difficult to apply efficiently in relation to OTR tyres on remote mine sites. This conclusion is reflected to some extent in recent legislative developments indicating that the disposal option, although not preferable, is acceptable. Our findings do concur with those of the QEPA in that, while potentially the highest consumer cost option, the *Extended Producer Responsibility Principle* would result in the greatest likelihood that scrap OTR

management would move up the waste management hierarchy, probably through recycling. Failing the successful instigation of this process, the most appropriate scrap OTR management option will be site specific and depend largely on the proximity of the site to facilities that can process and utilise the waste. For remote sites, whole tyre on-site burial at depth according to the relevant policy directions is currently the next best option. A significant step forward has been made in that previously, uncertainty of the legislative and environmental issues associated with scrap OTR tyres meant that the worst option, that is perpetual above ground stockpiling, was invariably adopted.

1.0 Introduction

A tyre is engineered and constructed with durability in mind. When a tyre wears out, it remains a virtually indestructible parcel of rubber, chemicals, fabric and steel. At the end of it's service life, an estimated 80% of it's original resources remained trapped in the tyre (Duffy, 1996). In the United States, largely as a result of legislation banning the disposal of whole tyres to landfill, over 70% of the estimated 253 million scrap tyres generated annually are utilised in some form of energy reclamation, recycled rubber manufacture or civil engineering application (Blumenthal, 1997a). In Australia, approximately 10 million tyres expire annually, their most probable destination is currently in landfill, either in shredded or whole form (Anon., 1997). Legislative change in Australia banning tyres to landfill is stimulating the development of retreading, reprocessing and energy reclamation technology (Mills 1993).

From the outset of this report, it is important to differentiate between passenger[1] and large off-the-road (OTR) tyres[2]. OTR tyres are larger, will typically have a higher proportion of natural rubber and may contain steel beads measuring up to 100mm in diameter (Brewer, 1997). The disposal of OTR tyres generated by the mining industry has generally been in landfill or a stockpile in a registered waste area on-site. Their size, construction and invariably remote location make them very difficult and expensive to handle (Carter, 1996). Also, OTR tyre piles are not visible to the public and thus, there is a dearth of information and opportunity with respect to their reuse options.

The vast majority of the literature and developing tyre-recycling technology is focused on passenger tyres. Passenger tyres are much smaller and typically stockpiled in large numbers in populated areas, so they are easier and cheaper to access, transport, handle and process. However, the higher proportions of natural rubber found in OTR tyres is much more valuable than the synthetic rubber used in passenger tyres (Brewer 1997). The economics of rubber reclamation, the legislative trend banning tyres in landfill and

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[1] Passenger vehicle and light truck tyres

[2] Tyres which are larger than 1400X24, but which can be up to 3.5 metres in diameter and weighing over 2 tonnes. Hereafter refered to simply as OTR tyres.

the opportunity to reduce waste and recycle valuable resources could stimulate the recycling of OTR tyres.

This report details work completed for the Australian Coal Association Research Program (ACARP) project C8037, 'Management of Waste Tyres in the Mining Industry'. The project aims to identify opportunities to 'Reduce, Reuse and Recycle' waste tyres employing best available technology and to deliver a cost effective alternative for managing waste OTR tyres at remote mining operations.

The report is divided into two sections, which represent two distinct phases in the project. The first section presents a review of the literature, current industry practise, developing technology and regulatory policy and makes recommendations on which the second phase of the project was based. Section two analyses the various options identified, in terms of practicality and cost, as well as presenting a summary of more recent policy developments, which have largely coincided with this project.

SECTION 1 – State of the art and identification of options

2.0 How does the mining industry currently manage expired OTR tyres?

Although the mining industry accounts for less than 1% of all scrap tyres, the typically large size of scrap tyres generated by the industry accounts for 15% of scrap tyre weight (Carter 1996). Some 20,000 OTR tyres, as well as an additional 3500 giant earthmover tyres[3] are replaced annually in Queensland mines alone (Weinzel, *pers. comm.*; Managing Director: Link Recycling Technology). Currently, the uses for such tyres are very limited. Companies with the technology to process them in Australia are non-existent and the cost to transport them for destruction are prohibitively high[4]. Most significantly, legislation in both Queensland and N.S.W currently allows for mine tyres to be disposed to landfill. A preliminary survey of coal mines in the Bowen Basin in Queensland and the Hunter Valley in N.S.W suggests that, apart from a few limited alternative end uses, such as feed troughs for farmers or road safety barriers on site, scrap tyres are either stockpiled in numbers allowable under the regulations or are monofilled[5]. In some cases, the tyres are quartered[6] to reduce their volume and also to prevent the risk of tyres ‘floating’[7] in the landfill. Some mining operations are shallow filling tyres to allow the option for recovery at a later date, should the technology become available too economically process them. In all cases, stockpiling or monofilling of scrap tyres was a decision driven by cost and regulation. Stockpiles at mining operations surveyed contained between 50 to 750 tyres, with the rates of addition to the stockpiles ranging from 60 to 300+ tyres annually. BHP Coal mines alone generated 937 scrap OTR tyres in the 97-98 financial year (Anon, 1998).

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[3] Tyre >1.5 tonnes
[4] Approximately 24cents/tyre/km for transportation and $300/tyre for high temperature incineration.
[5] A single waste type, or homogenous, landfill
[6] Cut into four pieces using hydraulic, backhoe-mounted shears.
[7] Refer to section 3.3

3.0 Problems associated with the stockpiling and landfilling of tyres

3.1 A Wasted Resource

The average tread depth remaining on a scrapped OTR tyres on a BHP Coal mine can be as high as 45% (Anon, 1998). A $30,000 giant earthmover tyre may be scrapped with 97% tread, or over 1 tonne of tread rubber remaining (Anon, 1998). The average scrap OTR tyre may have as much as 0.7 cubic metres of high quality natural rubber remaining in the tread area alone. An additional 0.5 cubic metre of rubber and 200 kilograms of steel may be present in the sidewall and bead. Based on these figures[8], it is estimated that 16,200 cubic metres of high quality rubber and 2700 tonnes of steel are buried or dumped each year in Queensland alone.

Queensland Environmental Protection (Waste Management) Policy (1997) encourages management of wastes in accord with the waste management practices hierarchy. However, the policy does state that ‘the use of a practice not in accord with the order of the hierarchy is acceptable where it can be established that less environmental harm will result from the use of that practice than any other practice’.

Figure 3.1.1 Waste Management Hierarchy.

The hierarchy sets out the management practices that should be employed in the order of most preferred to least preferred.

[8] Authors calculations based on Michelin specifications for an ‘average’ OTR tyre size

3.2 Potential for Contamination

When considering management options for scrap tyres and the relative advantages and disadvantages of current and proposed disposal (or reuse) options, the first step should be to assess tyres' chemical composition and their potential toxicity/leachability in landfill or stockpiles.

Tyre manufacturing companies are very reluctant to provide information about the ingredients of tyre manufacture. Several studies, however, have investigated the composition of tyres. Tyres are manufactured from natural or synthetic rubber, carbon black, sulfur, zinc stearate, a variety of antioxidants and other additives (Masterton & Slowinski, 1977). The vulcanisation reaction involved in tyre manufacture combines natural rubber with sulfur under heat. Styrene-butadiene rubber (SBR) is made by copolymerising 75% Butadiene and 25% Styrene and is the most important synthetic rubber used by the tyre industry (Edil, 1989). An analysis of tyres by the US EPA (1995) outlines the compounds used in the manufacture of tyres. It is important to note that this analysis is of passenger tyre manufacture but it can be assumed that OTR tyres are manufactured from similar components but will contain higher proportions of more valuable natural rubber (Brewer, 1997). It should also be noted that each tyre design often has a different composition. The list of the major chemicals used in rubber compounding (US EPA, 1995) is included as appendix 1 of this review.

The biodegradation of tyres has been estimated to take 50-80 years (Baglioni et al, 1994). Studies of tyre leachate suggest that shredded or whole tyres do not pose a risk to ground water. In an analysis of tyre leachate, Park et al (1989) concluded that shredded tyres do not release any significant amounts of priority pollutants. In a comparison of leachate from shredded and whole tyres, Burnell and McOmber (1997) found iron[9], zinc and sulfur[10] were released and were in higher concentrations in leachate from shredded tyres but were well below drinking water standard concentrations. An assessment of leachate from waste rubber products using the US EPA (1990) Toxicity Characterisation Leaching Procedure (TCLP), which assesses the

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[9] Resulting from the oxidisation of reinforcing steel beads

[10] Released through an ion exchange process.

[11] 205kg/m^3 for rubber compared to 1344kg/m^3 for glass (EPA, 1990)

leaching potential of over 40 different volatile and semi- volatile organics and metals, showed that none of TCLP regulatory levels were exceeded. In areas retaining water, continued leaching can increase concentrations of barium, iron, manganese and zinc (Getz & Teachey, 1992).

3.3 Landfill Volume and Stability

There is a common perception that whole tyres disposed to landfill ‘float’ upward and may surface over time. There are numerous theories as to the reason for this ‘floating’ but this review has been unable to identify any case study or experimental evidence of this phenomenon. The often vague explanations of the ‘floating’ theory relate to passenger tyres and include; (1) methane gas generated in municipal landfills captured in whole tyres causing them to rise, (2) air trapped in tyres causing them to rise in saturated landfill, (3) partially compressed tyres flexing in landfill and rising to the surface and (4) tyres vibrating to the surface as heavy machinery travels over the surface. The US EPA (1995) states that “when buried, tyres tend to work their way back to the surface as casings compressed by the dirt slowly spring back into shape and “float” the tire upward”. The rigid nature of large OTR tyres, their weight, the depth at which they are generally monofilled and the nature of the overlying material, however, may preclude any threat of ‘floating’.

The deposition of whole tyres in landfill is a very inefficient use of landfill space. Tyres are 85% air space (Weinzel, *pers. comm.*) and so have a very low landfill density[11]. Tyres disposed in landfill can prevent satisfactory compaction (Levitzke, 1996). The legislation governing disposal of tyres to landfill is most likely aimed at preserving urban landfill space although this is generally not a concern for mining operations. A common misconception, however, is that shallow monofilling of tyres will allow for recovery at a later date, should the technology to reprocess them become available. Most existing tyre processing technology requires a clean tyre so in reality, the economics of tyre recycling are so marginal that the additional cost of recovery and cleaning the tyres is most likely to prevent any recycling of buried tyres (Brewer, 1997).

3.4 Health Risks

There is a wealth of literature discussing the public health and the environmental risks associated with the open stockpiling of tyres (Webb, 1996; Vickers, 1996; Lemieux and Ryan, 1993; Dorer, 1978). The two major risks associated with an open stockpiling of tyres are:

(1) The potential to provide a breeding ground for mosquitoes and vermin which provide a vector for disease and
(2) The potential fire hazard causing extreme radiant heat, toxic gas emissions and water and soil contamination.

Aedes aegytpi and *Aedes notoscriptus* are two species of mosquito that are known to transmit disease, namely Dengue Fever and Ross River Virus respectively. These mosquitoes are present in Queensland and breed readily in water collected in waste tyres (Webb, 1996). The Public Health Act (1937) and the Mosquito Prevention and Destruction Regulations (1982) directs the prevention and destruction of mosquito breeding grounds. The required treatment of each tyre in a stockpile with a suitable larvicide every 5-7 days, however, is impractical and the treatment poses health risks to personnel in itself.

A typical tyre stockpile fire will burn for days, weeks or even months (Vickers, 1996). Incomplete combustion of tyres in a stockpile fire results in an extremely hazardous emission of gases and particles which present a serious health risk upon inhalation (Webb, 1996). Intense radiant heat inhibits fire fighting efforts and the resulting toxic slurry will have a significant impact on soil, groundwater and waterways (Webb, 1996).

3.5 Legislative Constraints

In 1992, overseas experiences with tyre disposal prompted the Australia New Zealand Environment Conservation Council (ANZECC), made up of state and federal environment ministers, to ban whole tyres to landfill and to introduce a disposal levy (Mills, 1993). This initiative, slowly being implemented around Australia, is largely designed to conserve landfill space in urban centres, where 10 million passenger tyres may be disposed of annually (Anon., 1997). The Queensland Environmental Protection (Interim Waste) Regulation 1996 makes no differentiation between passenger and OTR tyres, which may be landfilled currently, while the N.S.W Waste Minimisation and Management Regulation 1996 only covers the disposal of tyres less than 1.2 metres diameter. The NSW EPA has indicated OTR tyres may be buried on-site after removal of the bead and cutting the sidewall and tread into <250mm sections. The Queensland EPA has recently established a Scrap Tyre Task Force to produce a strategy for scrap tyre management for the state. Their strategy is due December 1999. Currently, tyres are a regulated waste in both states and are subject to the relevant licensing and limitations. In Queensland, a mine depositing more than 10% tyres by weight in a general waste area on site must be a licensed facility. The Queensland Waste Management Legislation Public Consultation Document (Department of Environment, 1997) states that;

'The disposal of whole tyres to landfill is banned from a date to be declared. Such ban may be declared for a specific region or region or may apply to the whole state ...'

While it is likely that this ban is designed to preserve urban landfill space, it is unclear if the proposed change will be applicable to remote mine sites. In 1995, after tyres were banned from landfill in South Australia, Western Mining Corporation received dispensation from the legislation after it was shown that the technology did not exist in Australia to otherwise process large OTR tyres.

4.0 Alternative Disposal/Reuse option.

The traditional tyre swing or cleverly carved white painted tyre swan are no longer the only alternative use for a scrap tyres. In the United States, the three major markets for scrap tyres[12] are (1) Tyre Derived Fuel (TDF) for cement and brick kilns and power stations, (2) civil engineering applications and (3) recycled rubber products (Blumenthal, 1997a). It should be noted that, in terms of the Waste Management Hierarchy, the most appropriate option is 'AVOID'. This could be achieved through strategies designed to maximize tyre life or through retreading. Retreading OTR tyres

[12] The number of scrap passenger tyres having markets has increased from 11% in 1990 to 75% in 1996

is also becoming more popular in the United States (Brodsky, 1998). Before critical analyses of these reuse options for scrap tyres is attempted, it is essential to understand the construction of an OTR tyre and the particular problems they pose in reprocessing due to their size, durability and typically remote location.

A tyre is made up of a rubber tread, steel belts or nylon breakers (depending on a radial or bias ply construction), a sidewall and a steel wire bead. A Bias tyre is manufactured with multiple nylon carcass plies running diagonally from bead to bead. A radial tyre is manufactured with a single ply of high strength steel cord running at right angles to the bead. The bead of a tyre may be a package of a number of steel cords or a single large diameter cord. The characteristics of an OTR tyre differ dramatically according to the type of vehicle to which it is fitted and the type of function it performs, however they are all designed to resist cutting, tearing, heat and wear.

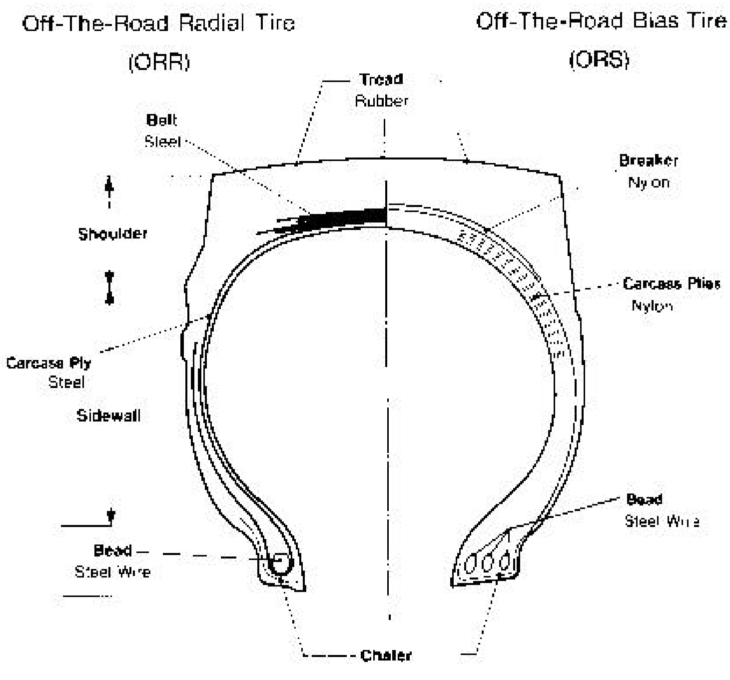

Figure 4.0.1 OTR Tyre Construction (Source: Bridgestone OTR technical data)

4.1 Retreading

While there are no facilities for retreading OTR tyres in Australia, viable retreading occurs in both the United States and Europe (Cummins, *pers. comm.*; Chairman: Independent Retreaders Division, Australian Tyre Dealers and Retreaders Association) In terms of the Waste Management Hierarchy (set out in section 3.1), retreading is the most acceptable option for expired tyres which are suitable for retreading. The American Tire Retread Information Bureau claims that a US$28,000 giant loader tyre can be retreaded for US$18,000 and will provide wear at least equal to the original tyre (Brodsky, 1998). The feasibility of OTR retreading is currently being investigated in Australia (Cummins, *pers. comm.*) and may provide a cost-effective alternative to tyre disposal. It is likely, however, that retreading will be restricted to smaller (<1400X25) OTR tyres.

4.2 Volume Reduction

While shredding, grinding or granulating scrap tyres is not a management option in itself (other than volume reduction in landfill which is a requirement in some states of Australia and most of the United States) it is regarded as a pre-requisite for many processing routes. As already discussed, up to 85% of a tyre's volume is air space, representing an enormous waste of landfill, storage and transportation space. The high cost associated with the transportation of OTR tyres from mine sites may be reduced substantially by shredding scrap tyres on site. The problems associated with the volume reduction of scrap tyres have been summarised (Sive, 1996) as;

- Separation of the components into rubber, fibre and steel.
- Production of components in a form which is suited to a specified market, which has a significant market value and which can be varied in accordance with market demand.
- Handling, transport and processing costs

Additional problems associated with processing OTR tyres include the availability, mobility and durability of equipment and the lack of markets for OTR tyre components.

Four primary techniques for the volume reduction processing of scrap tyres may be considered (Sive, 1996)

- **Shredding** which produces tyre chips by mechanical cutters**.**
- **Grinding** which forces tyre chips between two rollers, as in a cracker mill.
- **Granulation** utilises shearing and chopping; and
- **Impaction** relies on a two stage process of cryogenic cooling and then shattering using a hammermill.

There are typically three stages in producing crumb rubber (Getz & Teachey, 1992). In the first stage, whole tyres are reduced to 50-200mm size chips by a slow speed shear shredder. In the second stage, the pieces are further reduced to smaller than 10mm pieces by cracking and grinding and screening processes. The final stage, producing a final product 99.5% free of steel and fabric, utilises a series of grinders, aspirators and powerful magnets. Alternately, tyres can be cryogenically frozen using liquid nitrogen and smashed in a mill. The cryogenic method liberates almost all steel and fibre from the rubber (Klingensmith & Barnwal, 1998). Rubber particle size and the degree of steel and fabric remaining in the final product are inversely proportional to cost of processing (Blumenthal, 1997a).

A prospective tyre processor should first determine what their end uses are and the size requirement of the market they are targeting (Bruenig, 1994). The existing markets for scrap OTR tyres, however, are extremely limited. While summaries of tyre processing equipment designed to process passenger tyres are numerous (Klingensmith & Baranwal; 1998; Bruening, 1994; Klingensmith, 1991; Sive 1996), this review identified only two mobile machines capable of processing OTR tyres.

The Diamond-Z™ 1463-T has twin 800 horsepower Caterpillar engines, is fully mobile and is capable of reducing 3300mm diameter tyres to 50mm chunks. Bridgestone/Firestone's OTR division mobilises one of these shredders to mines across the western United States, reducing stockpiles of OTR tyres to 50-200mm chunks which are then transported to plants utilising tyre derived fuel (TDF) or landfill. The cost of one of these shredders is approximately US$750,000 ex Idaho (Sept. 1998 estimate). The second machine is a custom built shredder operated by Northern Tyre Salvage in Townsville.

Figure 4.2.1 The Diamond-Z 1463-T mobile shredder

Almost all recycled rubber products utilise a steel and fabric-free rubber crumb. The high price of liquid nitrogen, the wear on machinery caused by the heavy steel beading and the cost and lack of mobility of the plants are factors which currently preclude the economic recovery of pure rubber crumb from OTR tyres. There is potential, however, to reclaim pure rubber relatively simply and inexpensively through a process known as 'buffing'[13]. If this method was to be adapted to reclaim rubber from large OTR tyres, the sidewall rubber could also be buffed, with the potential to produce hundreds of kilograms of high quality, steel-free natural rubber from just one tyre. This method of rubber reclamation, however, does leave a carcass of steel and rubber and so it may be that a combination of processing methods must be employed, depending on the intended

[13] To prepare a tyre for retreading, rubber is first removed from the tread area (the tyre is buffed). The tyre is mounted on an expandable chuck and spun while a cutting tool is passed across the surface of the tread (in the fashion of a lathe) producing a good uniform surface for retreading and a quantity of high-quality rubber compound free of steel or fabric reinforcement. On average, about 10kg of these buffings are produced from a light truck tyre as it is prepared for retreading (Sive, 1996).

end uses of various components of the tyre. An Italian firm manufacture buffing machines which are capable of processing tyres up to 3000mm in diameter.

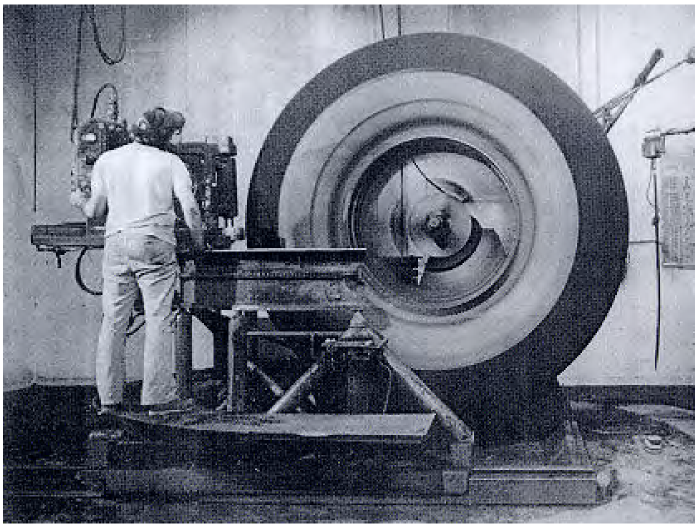

Figure 4.2.2. A large OTR Tyre Buffer

4.3 Waste to Energy/Resource Reclamation

The number of scrap tyres being utilised as a fuel source has increased steadily[14] in both the United States and Australia. Tyre derived fuel (TDF) is by far the most common alternative end use for scrap tyres.

4.3.1 Tyre Derived Fuel (TDF)

In 1996 in the United States, 152 million of the 202 million reused scrap tyres were subject to energy recovery (Blumenthal, 1997a). Electric utilities, pulp and paper mills and cement and brick kilns have all utilised shredded or whole passenger tyres as a fuel source (Farrell, 1996). In Australia, Blue Circle Southern Cement in Geelong, Victoria burn almost all that States' scrap tyres[15] which totals approximately 2 million tyres. This comprises 27% of the plants total fuel consumption (Woods, *pers. comm.*; Business development manager, Queensland Cement Limited).

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[14] In the United States, 75% of all scrap passenger tyres are used as fuel (Blumenthal,1997), while 20% of all scrap passenger tyres are used as fuel in Australia (Woods, *pers. comm*)
[15] tyre sizes up to 1200x20
[16] Ironstone, lime and silica are fired between 1450 C and 2000 C to produce cement 'clinkers'

The cement industry discovered that the addition of tyre chips to their kiln actually increased the energy value of coal and that the steel beading and belt material within a tyre could serve as a replacement for iron oxide[16]. Studies have shown that the high temperature combustion in kilns can preclude products of incomplete combustion (black smoke and odours) and that TDF can have lower emissions than conventional fossil fuels (Palmer, 1996; Carter, 1996). Getz and Teachey (1992) state that TDF can emit less sulfur dioxide and nitrogen oxide than most types of coal on a net energy output basis but depending on the combustion system, can result in a net increase in particulate emissions. Initial results from a recent trial conducted at Queensland Cement Ltd.'s Gladstone kiln, firing 60,000 passenger tyres in one week, suggests that NO_x gas emissions were 20% lower than coal and that other emissions were comparable or lower (Woods, pers. comm.). Carter (1996) states that tyres have a high calorific value, contain less than 1% moisture, generate low amounts of ash and have been demonstrated to lower emissions. He further states that 'it is not unreasonable to assume that virtually every cement kiln in the western United States will be using TDF within the next five years'. One hundred and fifty kilns globally currently utilise TDF (Woods, *pers. comm*).

The availability of passenger tyres in large numbers close to plants that can utilise TDF and the relative ease of handling smaller tyres has precluded the use of OTR tyres. This review failed to identify any cases of whole or shredded OTR tyres being used as TDF. However, a new cement kiln at Gladstone will be capable of utilising 50,000 tonnes of TDF annually (about 25% of its coal consumption) (Woods, *pers. comm.*). The kiln will be able to utilise a 100-200mm clean cut section of tyre. For this option to be viable, shredding would have to be carried out on-site (mobile) to reduce transport costs. Disposal costs charged by the plant (if any) would also have to be assessed[17]. The advantage of this option for scrap tyre management is that no component separation is required after the tyres are shredded (ie the steel may be left bound in the rubber) and that the shreds can be transported with coal from the mine to the plant, provided the customer is willing to accept the additive. The abundance of OTR tyres in concentrated mining areas may also make contracting with a waste manager to shred and transport tyres economical. The limitations are that TDF cannot be used in conjunction with pulverised coal (unless a separate fuel feeding mechanism exists) and is limited to use with low sulfur coal[18] (Carter, 1996).

Another form of TDF which should be considered is the use of shredded rubber as a bulking agent/fuel source in the mine blasting process[19]. Rio-Tinto Zinc have developed and patented a product called ANRUB™ which is a rubber crumb designed to partially replace diesel as a fuel source and act as a bulking agent in the blasting process. Currently however, the process utilises crumb rubber obtained from passenger tyres and so while providing potential savings in diesel and ammonium nitrate consumption, this process does not attempt to solve the scrap OTR tyre problem. The use of rubber in the blasting process is reported to facilitate a ‘soft’, more controllable blast (Kirsch, pers. comm.; Environmental Officer, BHP Coal, Norwich Park mine.). An advantage of using rubber shred, as opposed to sawdust, as a bulking agent is that is can act as a waterproofer. The requirement for rubber used in this process is that the rubber be free of any steel reinforcement. The only economical way to obtain this from OTR tyres may be through buffing the rubber from the tread area of the tyre.

4.3.2 Pyrolysis

Pyrolysis involves the breaking down of scrap tyres to their constituent components, principally softening oil, carbon black, fuel oil, steel and hydrocarbon gas using the controlled application of heat in an oxygen-free atmosphere (Mills, 1993). Carbon black has a wide range of uses in the manufacture of belts, hoses, plastics, inks and toners but by far the greatest user is the tyre industry. Extender or softening oil is used in the plastics and rubber manufacturing industry, again predominantly in tyres. The steel can be sold as scrap and the hydrocarbon gas is used as fuel for the pyrolysis process (Glazebrook, 1996). The literature suggests that the economics of pyrolysis are marginal (Mills, 1993; Powell, 1997) and that the use of the technique is declining in the United States (Farrell, 1996). It is therefore unlikely to able to be applied to the recovery of resources from OTR tyres.

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[17] Disposal costs charged by TDF users to tyre disposers globally range from 0-$70/tonne, the average being $25/tonne (Woods, 1998). Blue Circle Southern Cement in Victoria make no charge to disposers but require clean tyres to be delivered to the plant

[18] TDF contains 1.2% to 1.5% sulphur.

[19] a controlled explosion created with a mixture of ammonium nitrate and diesel

4.4 Civil Engineering Applications

About 12 million scrap passenger tyres, or 8% of all tyres scrapped annually in the United States are utilised in civil engineering applications (Farrell, 1996). Included is a summary of uses for scrap tyres in civil engineering applications and comments on their potential applicability to the mining industry.

4.4.1 Asphalt/rubber road construction

The main use for crumbed rubber is in road construction and paving applications (Getz & Teachey, 1992). In 1991, regulators in the United States legislated for the use of recycled material in federally funded highways which lead to a rapid expansion of the production of rubber modified asphalt (RMA), which consumes 41% of the total ground rubber produced (Blumenthal, 1997b). Asphalt rubber crack sealant, asphalt rubber seal coating, asphalt rubber stress absorbing membrane inter-layers, asphalt rubber concrete and rubber modified asphalt rubber concrete are all products which utilise waste tyres. Rubberised asphalt can cost between two and four times more than conventional concrete (due largely to the high cost of tyre processing) but can significantly improve road life, lower maintenance, increase crack and chip resistance, increase passenger comfort and improve antiskid properties (Mills, 1993). Road making has the potential to consume very large numbers of processed scrap tyres. The availability of rubber 'buffings' from the retread industry[20] and the extra costs associated with producing a steel-free rubber crumb from OTR tyres will limit the applicability of this option to the mining industry. Steel-free tread rubber buffed from tyres and used in road building or repair on-site may be viable.

4.4.2 Sewage sludge composting

The use of tyre chips has been investigated as a bulking agent in sewage sludge composting with and as a substitute for wood chips. After each composting cycle tyre chips are removed from the compost and reused while wood chips decompose after about three composting cycles, representing a significant saving to treatment facilities

[20] Australia is the largest retreader of any OECD nation

(Getz & Teachey, 1992). Tyre chips have also been used in municipal waste disposal facilities. Farrell (1996) further discusses the advantages of the reusability and longevity of rubber as a bulking agent in the composting process.

4.4.3 Oil and heavy metal absorbent

Surface modified rubber[21]will absorb up to three times its weight in crude oil within minutes of being applied to an oil spill. If left for more than a day, the rubber will absorb up to 8 times its weight in oil (Getz & Teachey, 1992). After it is used, the oil can be extracted from the rubber or the chips used as a fuel. Studies have also demonstrated the potential for tyre rubber in the absorption of heavy metals and the mitigation of volatile organic compounds (Park et al, 1997; Meng et al, 1998; Mead et al, 1997). Rowley et al (1984) demonstrated that shredded tyre rubber will absorb cadmium, mercury and lead using a mechanism involving the ion exchange of zinc[22]. This option may have potential applicability to the mining industry in that the final use for reprocessed tyres could be largely on-site. Surface modification technology is still developing. However, unmodified shredded rubber is used in the absorption of heavy metals.

4.4.4 Drainage Layers/Soil Amendments

Both tyre chips and half tyres have been shown to be effective replacements for stone as a drainfield aggregates in septic systems (Burnell & McComber, 1997) sewage treatment plants and landfill cells (Getz & Teachey, 1982). Research also indicates the addition of rubber particles to soil can dramatically reduce soil compaction and improve drainage (Riggle, 1995). A patented soil amendment process in the United States known as Rebound™[23] is gaining popularity for use on sports fields, golf courses and other high traffic areas. This process utilises steel-free fine crumb rubber and so the economics of production favour passenger tyres. Tyre chips used as drainfield aggregate, however, can be larger and can contain steel and so this may be an option for shredded OTR tyres.

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[21] An emerging technology improving the reuse potential of rubber crumb involving the treatment of rubber particles with chlorine gas (Smith et al, 1995), discussed further in section 4.5.

[22] zinc can comprise 5% of a tyre (Doss et al, 1995)

[23] Rebound™ incorporates crumb rubber and compost in a ratio of approximately 1:5.

4.4.5 Artificial Reefs

Tyres can be strapped together or set in concrete and placed offshore to act as an artificial reef or breakwaters. Construction of artificial reefs offshore using tyres has become less popular after overseas experience has shown fish tend to avoid rather than colonise them and that tyres have repeatedly broken free under the action of tides and waves (Mills, 1993). Collins et al (1995) concluded that while tyre surfaces are colonised by algae, coral and shellfish, poor deployment in the United States led to tyres washing ashore after storms, resulting in the banning of their use in marine applications. It could be argued that this option merely transfers waste from land to sea. Unless a barrier reef surrounding our continent is a management aim, the construction of rubber reefs may not be a sustainable reuse (disposal) option for scrap tyres.

4.4.6 Landscape Stabilisation

Stabilisation of gullies, slopes and banks using tyres has been practised in Australia for many years (Mills, 1993). Tyres can be stacked whole or halved and tied and covered with soil to promote vegetation and prevent erosion. MacGregor and Provencher (1993) discuss the use of truck tyres in portable road building mats. Sidewalls of tyres are fastened together and the 3.2 x 6.2m mats installed on forest construction roads to provide traction. They estimate the cost of production and installation as US$40,000/km but consider the longevity of the mats offsets the high initial cost. These options may have practical applications in minesite safety and mine rehabilitation.

4.4.7 Lightweight Fill

Whole or shredded scrap tyres have been used as clean, lightweight fill for road embankments and road bed support. Scrap passenger tyres can be processed to appropriate specification for less than $60/tonne- approximately the cost of soil and substantially less than some other fill materials (Blumenthal, 1997b). Processing of OTR tyres will be more expensive but this cost may be offset by the saving in transportation costs (of tyre offsite and fill onsite). Processed scrap tyres have been demonstrated to have similar or equal performance of other fill material (Blumenthal, 1997b). During 1994 and 1995 , this application grew rapidly in the United States until two incidences, where thick layers (9 and 15 metres) of rough tyre shreds were overlaid with highly organic cover, resulting in oil discharge and fire (Powell, 1997). Some 75 similar projects were completed successfully and it was believed that the organic matter laid over the 'burning fills' resulted in the excess heat build up (Blumenthal, 1997b). In response to the negative publicity generated by the two fires, the United States Scrap Tyre Management Council (STMC) submitted "Design guidelines to minimise internal heating of tire shred fills" to the Federal Highway Administration which recommended the depth of scrap tyres in fill applications to be less than 3 metres (Blumenthal, 1997b).

4.4.8 Marine fenders, traffic control and feed troughs

Used as fender on docks or tugs, traffic control or safety barriers (along highwalls) and split and used by local pastoralists as feed troughs is probably the most common current alternative use for OTR tyres in Australia. While all these options are useful and inventive, they are not able to consume large volumes of scrap tyres.

4.5 Recycled rubber products

The third major market for scrap tyres is for feedstock to be used in recycled rubber products. These products fall into two categories; (1) Those that are manufactured from crumb rubber[24] and (2) those manufactured by punching or stamping rubber from whole tyres. Recycled crumb rubber to be used in the manufacture of new rubber products may have to undergo some particle surface modification[25] or devulcanization[26] to enable the particle to bond effectively. Without surface modification or devulcanization, crumb rubber can be mixed with resins and glue for some uses but the bonding is physical rather than chemical or molecular and so these products tend to have lower performance specifications (Riggle, 1995). The refinement of

[24] Which may either be a bi-product of the retreading industry or whole tyres extensively and expensively processed to produce steel and fibre free rubber crumbs ranging in size from 6mm down to 0.5mm (Riggle, 1995)

[25] The process of surface modification involves exposure of the particle surface to reactive gases to modify the outer few molecular layers, enabling them to bond with materials like polyurethane, latex and other polymers (Riggle, 1995).

[26] Vulcanisation is a high energy process which facilitates the formation of strong, complex chemical bonds between sulphur and carbon molecules (Sive, 1996). Devulcanization involves the breaking of these sulphur bonds chemically or even microbiologically and allows for the recycled, devulcanized crumb rubber to be chemically bonded with other rubber particles and substances

devulcanization and surface modification processes should see an expansion of crumb rubber markets (Blumenthal, 1997a). The high impact attenuation level of rubber makes it especially ideal for the manufacture of protective surfaces for a wide range of applications (Blumenthal, 1997a).

Because of the expense and difficulty associated with producing steel and fibre free crumbed rubber from OTR tyres, the application of the manufacture of recycled rubber products is unlikely to be suitable to the mining industry. Again, however, the most likely economic method of producing steel and fibre free crumb rubber from large OTR tyres must be by buffing the tyre. A summary of recycled rubber products has been included as Appendix 2 of this review.

5.0 CONCLUSIONS/RECOMMENDATIONS (SECTION 1)

- Tyre recycling technology and literature is focussed on passenger tyres.

- The legislative impetus overseas and in Australia to ban whole tyres to landfill is more likely to be designed to conserve urban landfill space and to promote recycling rather than to prevent contamination or because tyres tend to ‘float’ in landfill.

- Technological and economic limitations currently restrict any alternative uses for mine tyres are to those that use whole or sectioned tyres or steel-containing shreds.

- The most appropriate alternative use is likely to be as TDF. Experience in the United States, which leads the world in the reuse or scrap tyres, supports this.

- If a use is identified onsite or a market develops for high quality, steel free, natural rubber shred, then either the purchase or the construction of a machine capable of buffing the tread rubber from the tyres may be viable.

- The viability and cost of tyre shredding and transport should be investigated on a cost benefit basis, with current management practices.

SECTION 2 – Investigating the options and recent policy developments

Section two analyses various options identified, in terms of practicality and cost and presents a summary of more recent policy developments.

6.0 Investigation of the options

The options that were compared, in terms of practicality, cost and relative benefits, were;

- Extended Producer Responsibility Principle
- Transport off-site and shredded
- On-site storage/burial (sectioned)
- On-site burial (whole)

The outcomes of these trials are presented in the following sections.

6.1 The Extended Producer Responsibility Principle

It is appropriate, given the interest shown by both industry and the QEPA in this approach, to give consideration here to the '*extended producer responsibility principle*' in managing tyres. That is, mining companies negotiating take-back clauses in purchasing agreements with tyre suppliers. Essentially, this implies the tyre is leased and that the responsibility of the waste lies with the producer or supplier. This principle is adopted by most passenger tyre suppliers and adds about 2% to the cost of the tyre. Given the increased freight costs and difficulty of handling and processing, we can assume a higher levy would apply to mine tyres. Table 6.1.1 outlines the cost, advantages and disadvantages of this option

Table 6.1.1. Summary of the 'Extended Producer Responsibility Principle' option

COST / TYRE	≅2-5% of purchase price ($100-$1000)
ADVANTAGES	Greatest likelihood of manufacturer being able to develop the technology/markets to recycle the waste
	Freight costs reduced through backloading after delivery of new tyres to remote sites
	Removes the problem from the mine site
DISADVANTAGES	Transferral of responsibility rather than an 'AVOID' solution of the problem
	On-going mine inputs in maintenance and handling of stockpiles, loading trucks etc.
	Potentially highest cost option

6.2 Shredding (for use as TDF)

Stage one of this project identified the use of TDF in cement kilns as the most appropriate alternative. While passenger tyres are can be fed into QCL's Gladstone kiln whole, large OTR tyres must first be shredded into a 100-200mm clean cut chunk. The aim of this trial was to contrast firstly, the transport logistics and costs of whole or shredded tyres, and secondly the cost of shredding.

Initially, it was hoped that we would mobilise a Diamond-Z shredder and conduct a large scale, on-site trial, however, the mobilisation and shredding cost was prohibitive given our research budget. Another site issue that became apparent was the need for access by shredders to a water source for cooling cutting surfaces. Thus, if the tyres were not stockpiled near a water source, a water truck would present an additional cost to the process. Additionally, earthworks would be needed to bund an area for the retention and reuse of cooling water. Preliminary investigation of on-site shredding suggests that mobilisation costs (of the shredder, conveyor, loader, shears and escort vehicles, 700 kilometres) of approximately $5000 would apply. This fee is additional to shredding and transport costs. Similarly, correspondence with transport contractors revealed problems associated with transport of shredded tyres. The need for a truck to be on stand-by while tyres are shredded (stockpiling shred on the ground could result in contamination unacceptable to the cement kiln) and special handling requirements (walking platform, or tipping truck, excavators etc) would likely offset the transport cost saving from the resultant decreased volume. It was then decided to transport a small sample of whole large tyres to the two shredders capable of handling them. The first shredder is operated by Northern Tyre Salvage (NTS) in Townsville and the second by Blink's Chop and Chip (BC&C) in Brisbane. The two shredders are very different in that the custom-built plant of NTS shreds at very low RPM but relies on very high torque, while the Diamond-Z tub grinder of BC&C uses high revolution cutting blades. The Diamond-Z shredder would consume approximately 30 litres of diesel/tyre while the custom built model consumes approximately 10 litres/tyre. The tyres that were transported to Blink's Chop and Chip were never shredded. This was probably due to the shredder being tied up with core work of shredding urban refuse and forest waste and highlights the limited capacity for this contractor to currently process the volume of tyres generated on mine sites.

Whole tyre transport costs were calculated and are presented in Table 6.2.1 along with the cost, advantages and disadvantages of whole tyre transport for shredding and use as TDF option. It was found that OTR tyres had to be quartered before shredding, using excavator-mounted hydraulic shears (similar to those used in the Ok Tedi trial), which added about $60/tyre to the original shredding cost estimates. The cost estimates presented here are conservative in that they are *exclusive* of any transport/handling costs of shred to a kiln or of any likely charged applied by the kiln operator to receive the 'waste'.

Table 6.2.1. Summary of the shredding (TDF) option

COST / TYRE	≅$370+* ($0.24/tyre/km transport + ≅$150-250/tyre shredding)
ADVANTAGES	More preferred option under QEPA's waste management hierarchy
	Recovers energy embedded in waste
DISADVANTAGES	Intensive energy usage (diesel) to shred and transport OTR tyres may offset benefit of energy recovery
	High cost

*Based on 700km whole tyre transport, e*xclusive* of shred transport and disposal costs charged by QCL which are unclear.

Figure 6.2.1 Quartered OTR tyre handling at Northern Tyre Salvage (photo Matt Corbett)

Figure 6.2.2 Feeding tyre sections into the shredder (NTS) (photo Matt Corbett)

Figure 6.2.3 2300 RPM are reduced to 2 RPM through a series of gearboxes, producing high torque for shredding (NTS) **(photo Matt Corbett)**

Figure 6.2.4 Shredded OTR tyres (NTS) **(photo Matt Corbett)**

Figure 6.2.5 Northern Tyre Salvages' mobile custom shredder **(photo Matt Corbett)**

6.3 On-site storage and burial (sectioned)

Given the health risks outlined in section 3.4, it is desirable that stockpiling of tyres on-site be minimised. However, some stockpiling will be unavoidable, whether it is while waiting for an appropriate landfill destination on-site or for processing and/or transportation off-site. In order that stored tyres not retain water and to facilitate handling and disposal into landfill cells, a trial was conducted to assess the practicality and cost of storage and burial of sectioned tyres.

A scrap metal contractor used 'hydraulic jaws' fitted to a PC300 excavator to cut tyres (up to 3metres diameter) into 300-400mm chunks that were subsequently disposed of in landfill cells on-site. Table 6.3.1 outlines the cost, advantages and disadvantages of this option

Table 6.2.1. Summary of the on-site sectioned storage and burial option

COST / TYRE	≅$175*
ADVANTAGES	Easily carried out on-site
	Relatively low-cost
	Reduced health risks of stockpile
DISADVANTAGES	Least preferred option in waste management hierarchy = disposal

- ≅$145 cutting cost, ≅$30 disposal cost (transport/labour, adjusted for Australian labour rate)

Figure 6.2.1 Hydraulic shears sectioning tyres **(photo Gary Moffat)**

Figure 6.2.2 Sectioned tyres awaiting landfill **(photo Gary Moffat)**

6.4 On-site burial (whole)

The findings of stage 1 with respect to the (lack of) potential for buried tyres to contaminate or float in landfill and the uncertainty of scrap OTR policy direction led us to seek to quantify the cost of the status quo option. A trial was conducted to assess the practicality and cost of emplacement of tyres for burial on the floor of a disused pit.

Fifty tyres were stacked on a low-loader using a tyre handler and hauled approximately 5 kilometres for burial. The procedure took two personnel approximately six hours to complete. Burial depth was approximately 65 metres. Table 6.4.1 outlines the cost, advantages and disadvantages of this option.

Table 6.4.1 Summary of the on-site burial (whole) option

COST / TYRE	≅$30*
ADVANTAGES	Easily carried out on-site
	Lowest cost
	Quickly eliminates stockpiles
	Low energy input
	Tyres are unlikely to affect landform stability or pose a risk to ground water
DISADVANTAGES	Least preferred option in waste management hierarchy = disposal
	Tyres must still be stockpiled while awaiting burial.

- Includes labour and equipment operators

Figure 6.4.1 Whole tyres in disused pit floor **(photo Bernie Kirsch)**

Figure 6.4.2 Whole tyres in disused pit floor **(photo Bernie Kirsch)**

7.0 Recent policy development

As stated earlier, this project has largely coincided with the development by the QEPA of a strategy, and the formulation of policy, directing the management of scrap OTR tyres on mine sites. On-going dialogue with both the mining industry and the QEPA ensured that the outcomes of this research project were given due consideration in the policy development process. Thus, this project represents an example of research acting as an interface between industry and its regulators, and of providing a sound factual basis on which to make policy decisions. Recent developments (post-stage one of this project) in policy relating to the disposal and storage of scrap OTR tyres at mine sites are summarised in this section.

7.1 The Scrap Tyre Task Force Strategy

In early 1999, in response to requests from many sectors of the Queensland tyre industry (including consumers, producers & distributors and recyclers), the QEPA formed the

Scrap Tyre Task Force (STTF) to produce a strategy to manage the waste tyre problem. While focussing on the tyre industry as a whole, the strategy does make the important separation between passenger and OTR tyres and does give special consideration to the management of the latter in remote locations.

While seeking to promote management of waste tyres according to the Waste Management Hierarchy, the strategy recognises the limitations posed by the nature of OTR tyres and the remoteness of many of the sites where they are stored. It does however tend to underestimate the component costs (diesel, transport and processing) of the waste-to-energy option. The key actions it recommended with respect to mine tyres can be summarised as;

- Develop standard operating criteria guiding the options for disposal of tyres at mine sites, in conjunction with the Queensland Mining Council;
- Undertake a cost/benefit analysis on the current reuse, recycling, waste-to-energy, and disposal options available for OTR tyres on mine sites;
- Investigate the use of a mobile shredder to process OTR tyres on-site;
- Explore markets for rubber recycled from OTR tyres;
- Encourage mining companies to seek return clauses in purchase agreements in line with the *Extended Producer Responsibility Principle* ; and
- Develop transport processes to centralised facilities for OTR tyres.

(Queensland Environmental Protection Agency, 1999)

Many of these actions have been completed by this project.

7.2 Draft operational policy EPREG.ERA 21

An outcome of both the STTF strategy and the ongoing dialogue between industry and the QEPA has been the formulation of a Draft Operational Policy (ERA21) under the *Environmental Protection Regulation 1998, Schedule 1*, directing the disposal and storage of scrap tyres at mine sites (Queensland Environmental Protection Agency, 2000). The draft policy determines that;

For new applications, licence conditions for scrap tyre management on mine sites should adhere to the following principles in decreasing order of effort and acceptability:

- *Avoidance*. When negotiating purchase agreements with new tyre suppliers, seek take-back clauses to maximise freight backloading opportunities.
- *Recycling*. Explore opportunities to recycle scrap tyres on-site and locally through use in impact absorbing surfaces, bitumen and road construction, farm and agricultural use, and civil engineering applications.
- *Waste-to-Energy*. Utilise existing opportunities in Queensland to recover embedded energy through waste-to-energy options.
- *Disposal*.

(a) Tyres stored waiting disposal should be stockpiled in volumes less than 3m in height and $200m^2$ in area. Additional fire precautions should be taken including removal of grass and other materials within a 10m radius of the scrap tyre store. Side-walls should be removed to prevent water retention and mosquito breeding.

(b) Scrap tyres disposed of in underground stopes is acceptable provided this practice does not constitute a fire hazard or compromise mine safety.

(c) Scrap tyres disposed of in spoil emplacements is acceptable provided the tyres are not placed on the pit floor but still placed as deep in the spoil as possible. This practice will ensure scrap tyres are not placed in saturated aquifers while not compromising the stability of the consolidated landform.

(d) Disposing of scrap tyres on mine sites may be regarded as a notifiable activity under Schedule 3 of the Environmental Protection Act and the locations of the disposal sites need to be recorded on the Environmental Management Register.

Perhaps the most important implication of this draft policy to the consideration of management options, is the indication that, while a non-preferred option, on-site burial will be allowable under the *Environmental Protection Regulation 1998*.

8.0 Conclusions

While this project set out with the aim of identifying opportunities to 'reduce, reuse, recycle', it has been shown that this philosophy is extremely difficult to apply efficiently in relation to OTR tyres on remote mine sites. This conclusion is not arrived at lightly and has evolved over the life of the project though a number of realisations. Firstly, realisation of the relatively benign nature of tyres in landfill. Secondly at the lack of technology to recycle OTR tyres and the high energy input and cost required to process and transport them for waste-to-energy and finally, recent legislative developments indicating that the disposal option is acceptable, albeit non-preferable. Our findings do concur with the QEPA in that, while potentially the highest consumer cost option, the *Extended Producer Responsibility Principle* should be implemented. This would result in the greatest likelihood that scrap OTR management would move up the waste management hierarchy in that tyre manufacturers are the sector of the industry most likely to have the infrastructure, knowledge and economic incentives to develop recycling options. Failing the successful instigation of this process, the most appropriate scrap OTR management option will be site specific and depend largely on the proximity of the site to facilities that can process and utilise the waste. For remote sites, whole tyre on-site burial at depth according to the relevant policy directions is currently the next best option. A significant step forward has been made in that previously, uncertainty of the legislative and environmental issues associated with scrap OTR tyres meant that the worst option, that is perpetual above ground stockpiling, was invariably adopted.

BIBLIOGRAPHY

Anon. (1997) Burning Rubber. *Choice* Feb 1997.

Anon (1998) Total Tyre Control BHP Coal tyre loss report. Klinge & Co Pty Ltd. Brisbane, Queensland.

Baglioni A, De-Angelis S, Bernasconi M & Prandoni F (1994) The scrap tire[27] as a building material. In: *Sustainable construction: Proceedings of the First International Conference of Sustainable Construction*, Tampa, Florida 1994.

Blumenthal M (1997a) Scrap Tire Market Analysis. *Biocycle* V38 N2 pp70-72

Blumenthal M (1997b) Growing markets for scrap tires. *Biocycle* V38 N10 pp 53-55.

Bridgestone (1996) Technical Data. Off-The-Road-Tyres. Bridgestone Corporation Off-The-Road tire sales department. Tokyo, Japan.

Brewer J (1997) OTR Tires...Scrap Tires' Market Niche: Presentation at the ITRA World Tire Conference Program. Held April,1997, Kentucky USA.

Brodsky H (1998) Retreading provides monster savings for monster tires. American Tire Retread Information Bureau (TRIB) news release. www.arib.com.

Bruening J.C (1994) Tire equipment education. *Recycling Today*, June 1994.

Burnell B.N & McOmber G (1997) Used Tires as a Substitute for Drainfield Aggregate. In: M.S. Bedinger (Ed) *Site Characterization and Design of On-Site Septic Systems*. American Society for Testing and Materials.

Carter R (1996) When Rubber Tires Leave the Road. *Coal* March 1996.

Collins K.J, Jensen A.C & Albert S (1995) A review of waste tyre utilization in the marine environment. *Chemical Ecology* V10 No3-4, pp 205-216

Department of Environment (1997) Waste management legislation – public consultation document. Department of Environment, State of Queensland.

Duffy M (1996) Waste Tyre Solutions. In*: Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996.

Dorer R.E (1978) Mosquitoes, Fish and Old Tires. *Mosquito News* 38(3) pp418-420.

Doss G.J, Elfving D.C, Lisk D.J (1995) Zinc in foliage downwind from a tire-burning power plant. *Chemosphere* 31:3 pp2901-3

Edil T.B (1989) Waste Characterization or Tire Chips. Letter to Mr. Niemi, University of Wisconsin-Madison dept. of Civil and Environmental Engineering.

[27] tire is the American spelling.

Farrel M (1996) Good year for tire recovery. *Biocycle* V37 N3 pp35-37.

Getz N & Teachey M.F (1992) Options in scrap tire management. *Waste Age*, October 1992.

Glazebrook C (1996) Tyre disposal technologies - Tyre Pyrolysis. In: *Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996.

Klingensmith B (1991) Recycling, production and use of reprocesses rubbers. *Rubber World* 203/6 pp 16-21

Klingensmith B & Baranwal K (1998) Recycling of rubber: An Overveiw. *Rubber World* June 1998. pp41-46

Lemieux P.M & Ryan J.V (1993) Characterization of air pollutants emmitted from a simulated scrap tire fire. *Air and Waste* V43 August 1993 pp1106-1115.

Levitzke V (1996) Waste tyre management in South Australia. In: *Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996.

Macgregor D.T & Provencher Y (1993) *Recycling used truck tyres into road building mats*. Field note: Roads and Bridges Forest Engineering Research Institute of Canada No.33, 2pp.

Masterton W.L & Slowinski E.J (1977) *Chemical Principals, 4th ed*. W.B Saunders Co. Philadelphia. pp612-616.

Mead E, McCash R & Shawn R (1997) Innovative leachate management: options and answers. *Waste Age*. V28 may pp258-60.

Meng X, Hua Z & Dermatas D (1998) Immobilization of mercury (II) in contaminated soil with used tire rubber. *Journal of Hazardous Materials*. V57 Jan. pp231-241.

Mills S (1993) Recycling of Tyres to Start in Ernest. *Engineers Australia* 22 January 1993.

Palmer G (1996) Scrap Tyres: Energy recovery in cement kilns. In: *Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996.

Park L.K, Holsen T.M, Bontoux L, Jenkins D and Selleck R.E. (1989) *Permeation of Plastic Pipe by Organic Chemicals*. Univ. of California, Berkeley, Sanitary Engineering and Environmental Health Research Laboratory, Report No. 89-1.

Park J.K, Kim J.Y, Madsen C.D and Edil T.B (1997) Retardation of volatile organic compound movement by a soil-bentonite slurry cutoff wall amended with ground tires. *Water Environmental Research* V69 N5 Jul-Aug pp 1022-1031.

Powell J (1997) Signs of a maturing industry: the recent growth in scrap tire recovery. *Resource Recovery* March 1997 pp18-27.

Queensland Environmental Protection Agency (2000) Operational Policy (ERA21), *Environmental Protection Regulation 1998, Schedule 1.* Draft for comment. April, 2000

Queensland Environmental Protection Agency (1999) A strategy for managing waste tyres in Queensland - DRAFT. Produced by the Scrap Tyre Task Force, October 1999.

Riggle D (1995) A finer grind for rubber recyclers. *BioCycle* 36(3) pp42-54

Roweley A.G, Husband F.M & Cunningham A.B (1984) Mechanisms of metal absorption from aqueous solutions by waste tire rubber. *Water Research* 18(8) pp981-984.

Sive A (1996) Tyre shredding as a tyre disposal technology. In: *Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996.

Smith F.G, Daniels E.J & Teotia A.P.S (1995) Testing and evaluating commercial applications of new surface treated rubber technology utilizing waste tires. *Resources, Conservation and Recycling*. V15 N2 Nov. pp133-144.

U.S EPA (1990) *Characterization of municipal solid waste in the United States*: 1990 update report No EPA/530-SW-042, 103pp.

U.S EPA (1995) *Profile of the Rubber and Plastics Industry*. EPA Office of Compliance Sector Notebook Project. Office of Compliance, Washington DC.

Webb M (1996) Health and environmental risks associated with open stockpiling of tyres. In: *Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996.

Vickers O (1996) Health and safety issues- the fire service perspective. In: *Waste Tyre Conference '96. The Full Cycle of Responsibility*. Held in Brisbane June 1996

Appendix 1: List of the major chemicals used in rubber compounding (US EPA, 1995)

- Processing Aids - zinc compounds
- Accelerators - zinc compounds
- Activators - nickel compounds, hydroquinone, phenol, alphanaphthylamine and p-phenylenediamine
- Age restorers - selenium compounds, zinc compounds and lead compounds
- Initiator - benzoyl peroxide
- Accelerator Activators - zinc compounds, lead compounds and ammonia
- Plasticizers - dibutyl phthalate, dioctylphthalate and bis(2-ethylhexyladipate)
- Miscellaneous ingredients - including titanium dioxide, cadmium compounds, organic dyes, sulphur compounds and antimony compounds.

Also, as part of the rubber component of tyres (natural or synthetic) a tyre contains high proportions of carbon and oil. In addition to the rubber, a tyre contains steel (approx. 12% but up to 22%) and nylon (approx. 3%) depending on the type of tyre (Blumenthal, 1997a).

Appendix 2: Applications of Recycled Crumb Rubber (from Sive, 1996)

Road and Rail

- Acoustic barriers
- Portable traffic control devices
- Rail crossings, sleeper and buffers
- Ripple strips and speed bumps
- Roadside safety railings

Construction and Industrial

- Adhesive sealants
- Anti-static computer mats
- Carpet underlay
- Plastic Compounds
- Compression moulding compounds
- Conveyor belts
- Flexible foam
- Foundation material
- Industrial flooring and paths
- Membrane protection
- Mounting pads and shock absorber
- Playground surfacing
- Pond liners
- Recycling bins
- Rollers
- Runways
- Shoe soles

Appendix 2: Applications of Recycled Crumb Rubber (from Sive, 1996) (continued...)

- Solid tyres
- Spray-proofing, insulation and waterproofing

Automotive

- Adhesive and anti-corrosive sealants
- Brake and clutch linings
- Bumpers
- Door and window seals
- Filler in new tyre manufacture
- floor mats, mud flaps and protection strips
- Gaskets
- Tray liners
- Sprayable sealant
- Tyre retreads

Marine

- Anti-fouling and anti-corrosive paints
- Floating docks
- Non-slip flooring
- Wharf fender strips

Sporting

- Equestrian surfaces
- Impact absorbing flooring

Appendix 2: Applications of Recycled Crumb Rubber (from Sive, 1996) (continued...)

- Athletic tracks surface
- Tennis court surfaces

Rural and landscaping

- Agricultural pipes and drains
- Animal bedding
- Irrigation hose
- Fencing
- sprayable wear linings in silos and tanks

Bulk Products and Mining

- Erosion control mats
- Filter for landfill leachate ponds
- Wet weather road mats
- Perma-mulches
- Oil spill absorbent.

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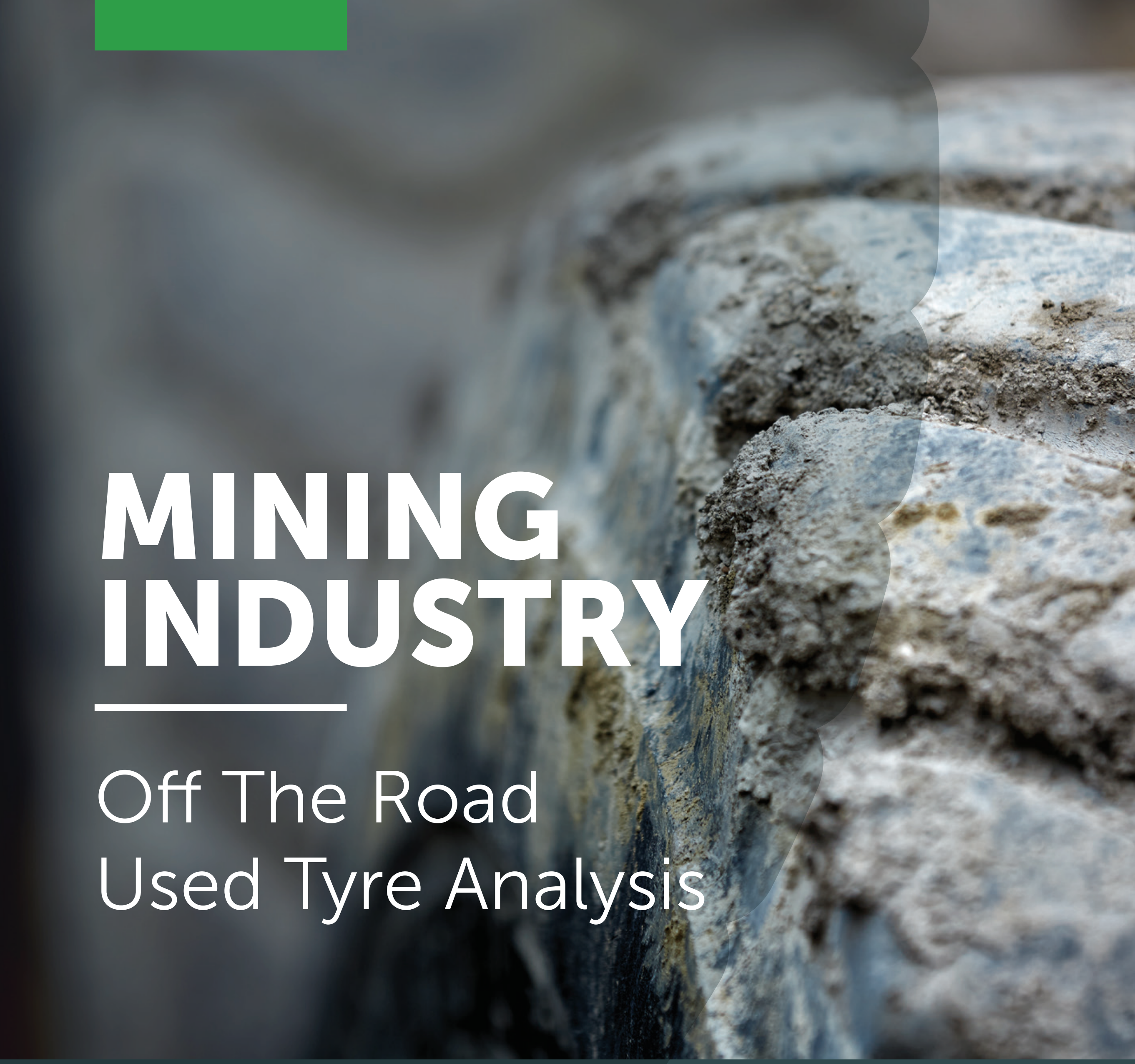


MINING INDUSTRY

Off The Road Used Tyre Analysis

FINAL REPORT
January 2020

Prepared for Tyre Stewardship Australia
by Randell Environmental Consulting
in association with Brock Baker
Environmental Consulting

TyreStewardship AUSTRALIA

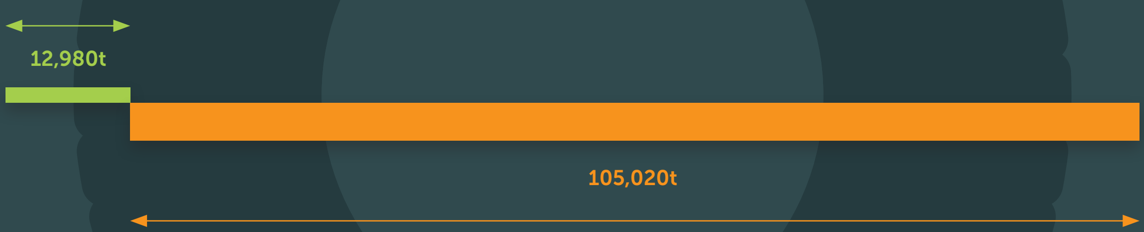
Contents

Introduction

In 2019, Tyre Stewardship Australia engaged Randell Environmental Consulting in association with Brock Baker Environmental Consulting to complete an analysis of the consumption and fate of mining industry Off-The-Road tyres

This analysis followed the completion of the report commissioned by Tyre Stewardship Australia titled ***End-Of-Life Tyres Supply Chain and Fate Analysis*** *(REC 2019)* by Randell Environmental Consulting

REC 2019 identified the need to better understand OTR tyre consumption and fate given the estimated **recovery rate in 2018/19 was just 11%**



The remaining 89% were not recovered (with 81% assumed to be disposed onsite at mining, farming or similar sites)

Basde on 118,000 tonnes of used OTR tyres in 2018/19.

Outline

Section 1 of this report begins by providing a detailed profile of all OTRs in Australia

- The profile includes analysis of OTR types and the industry sectors that generated the estimated 118,000 tonnes of used OTR tyres in 2018/19
- This section also provides analysis of the fate of all types of OTR tyres (i.e. what happens to the used OTR tyres)

Section 2 onwards, provides focused analysis of the mining portion of the used OTR tonnages

The 'deep-dive' into mining includes:

- A profile of the mining industry across Australia, including mine types
- Mapping of the mining industry sites and current used tyre processing sites, that enables analysis of travel times to used tyre processing facilities for different areas of Australia
- The historical and current management and fate of used mining tyres[2]
- Analysis of the technical feasibility of used mining tyre repair, re-treading, recycling or energy recovery
- A discussion of international best practice for used mining tyre management
- Analysis of the financials of used mining tyre recovery versus the current management practices
- Analysis of options to improve the recovery rates of used mining tyres

Project Scope

This report is intended to provide the foundation for further engagement with the mining sector

Much of the analysis is preliminary and intended to provide an understanding of the core issues.

The report does not provide 'the answers' to improved used mining tyre recovery, however, it will enable more informed discussions.

Scope 1

OTR tyre consumption and used tyre generation

- Detailed Material Flow Analysis (MFA) for OTR tyres that will detail OTR consumption, use, used tyre generation and fate by OTR tyre type
- Profile OTR tyre consumption and used tyre generation by industry sector (i.e. mining, agriculture, civil construction, other)

Scope 2

Mining industry sector analysis

- Provide a profile of the mining industry across Australia including mine types to enable analysis of the management of used tyres (based on mine type)
- Provide mapping of the mining industry sites to enable assessment of travel times to used tyre processing facilities for different areas of Australia
- Targeted consultation with state and territory regulators, a few mining companies, and used tyre recycling industry to confirm the historical and current management and fate of used mining tyres

Scope 3

Used mining tyres recovery analysis

- Analyse the technical feasibility of used mining tyre re-treading, recycling or energy recovery
- Analyse the financials of used mining tyre re-use, recycling or energy recovery, compared with current management practices
- Literature review of international best practice for used mining tyre management

Scope 4

Preliminary options analysis to improve recovery of used mining tyre

- Provide analysis of options to improve the recovered rates of used mining tyres
- The options analysis to include discussion of system wide reforms (product stewardship options) and, where appropriate, specific infrastructure investments that need to be implemented to enable used mining tyre recovery
- This options analysis is intended to provide the foundation for further engagement with the mining sector

Off-the-road tyre consumption, used tyre generation and fate

This section provides the detailed Material Flow Analysis (MFA) for all OTR tyres imported into Australia, including OTR tyre consumption, used OTR tyre generation and fate by tyre type and generating industry sector.

OTR tyre consumption

1.1

To profile OTR tyre consumption, OTR imports (both loose and fitment) were categorised by tyre type and then allocated to the assumed industry sector (that uses the OTRs). Table 1 provides the OTR tyre categories and related industry sectors derived for the project analysis.

Table 1. OTR tyre categories and industry sector allocations

OTR tyre category	Industry
Tractor (note 1)	Agriculture
Aircraft	Aviation
Grader, Bobcat and tractor	Construction
Solid and Fork lift	Manufacturing & trade
Earth mover	Mining

Note 1: Tractor small and large were split between Agriculture (80%) and construction (20%)

Table 2 provides the estimated OTR consumption by industry sector from 2014 till 2019 and the five-year average, in tonnes.

Table 2. OTR tyre consumption by industry sector 2014-2019 and five-year average (tonnes)

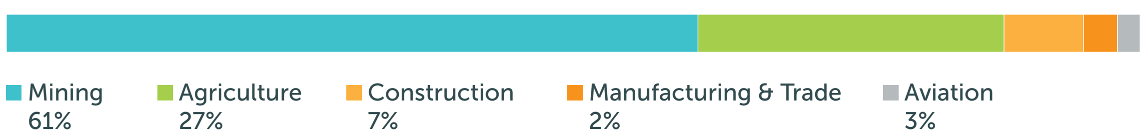
Industry	2014	2015	2016	2017	2018	2019	5-Yr. Ave.
Agriculture	46,300	38,800	36,100	39,000	37,300	33,800	37,000
Aviation[3]	2,200	2,800	2,200	4,500	3,500	3,700	3,400
Construction	14,100	10,600	10,400	10,400	9,300	8,500	9,800
Manufacturing & trade	36,700	55,700	21,700	2,400	8,600	2,900	18,200
Mining	62,200	44,600	58,500	67,600	80,800	76,900	65,700
Total	**161,500**	**152,400**	**128,800**	**123,900**	**139,600**	**125,800**	**134,100**

Over the past five years Australia has consumed an average of around 134,000 tonnes of OTR tyres.

On a tonnage basis, the mining and agriculture sectors have dominated consumption over the past 5 years, representing around 75% of the tonnages of OTR tyre consumption.

Figure 1 includes the 2018-19 OTR consumption by industry sector, in tonnes. It shows mining OTRs made-up 61%, followed by agriculture at 27% and construction, manufacturing and trade at around 10% and aviation tyres which made-up about 3%.

Figure 1. **2018-19 OTR consumption by industry sector (tonnes)**



3. Aviation tyre tonnages are likely to be an over-estimate as a single weight of 100 kgs per new tyre has been applied to all aviation tyre imports (as they are all under one import code) and that weight is too high for smaller aviation tyres.

Used OTR tyre generation

1.2

Following OTR tyre consumption and use, used OTR tyres are generated. The tonnages of used OTR generation relate to the consumption tonnages from the previous years. The tonnages of used tyres are lower than new tyre consumption from previous years due to tyre wear and the weight difference between a new and used tyre.

Table 3 provides the estimated used OTR generation by industry sector from 2014 till 2019 and the five-year average, in tonnes.

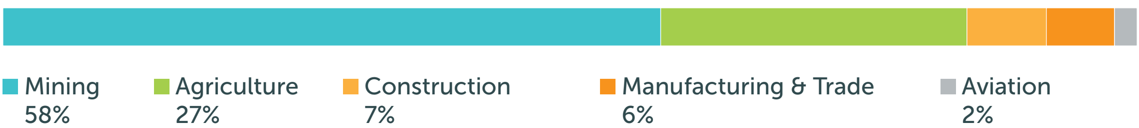
Table 3. **OTR used tyre generation by industry sector 2014-2019 and five-year average (tonnes)**

Industry	2014	2015	2016	2017	2018	2019	5-Yr. Ave.
Agriculture	38,300	39,000	32,700	30,400	32,900	31,400	33,300
Aviation	1,800	1,900	2,300	1,900	3,800	3,000	2,600
Construction	11,700	11,900	9,000	8,800	8,800	7,900	9,200
Manufacturing & trade	30,300	30,900	46,900	18,300	2,000	7,300	21,100
Mining	51,500	52,400	37,500	49,200	56,900	68,000	52,800
Total	**133,600**	**136,000**	**128,400**	**108,500**	**104,400**	**117,600**	**119,000**

Over the past five years an average of around 120,000 tonnes of OTR tyres have been generated.

Figure 2 includes the 2018-19 used OTR generation by industry sector, in tonnes. It shows mining OTRs made-up 58%, followed by agriculture 27% and construction, manufacturing and trade at around 13% and aviation tyres were presented about 2%.

Figure 2.
2018-19 used OTR by industry sector (tonnes)



Used OTR tyre fates

1.3

This section provides analysis of the fate (i.e. what happens to the used tyres) for Australia's used OTR tyres. The fate categories are based on those adopted in *REC 2019*, as listed below. All fate categories apart from 'export overseas for processing' refer to local on-shore fates.

Casings & seconds	Refers to used tyres that are **re-treaded** for reuse. It does not include OTR mining tyres that are repaired due to a sidewall puncture, for example.
Civil engineering	Refers to the use of used tyres in the construction of retaining walls or similar.
Crumb, granules and buffings	Refers to the highly processed rubber products that are made from used tyres for a wide range of uses from improving the performance of asphalt in road construction to tile adhesives.
Pyrolysis	Refers to the heating of tyres in the absence of oxygen to decompose and separate various organic components to generate end products including char, oil, syngas and steel.
Kilns/boilers/ furnaces	Refers to used tyres that are used as a fuel supplement in cement kilns or similar industrial facilities.
Stockpiles (>40 t, 5,000 EPU)	Refers to more than 40 tonnes of used tyres (5,000 equivalent passenger units, EPU) stockpiled for more than 12 months that are untreated and unprocessed to product specification. Stockpiles refer to large, typically illegal, piles of used tyres as opposed to dispersed dumping of tyres in small quantities, or onsite disposal of used tyres at mine sites or similar.
Landfill	Refers to used tyres sent to a legal landfilling site that is permitted by state or territory environmental regulators.
Onsite disposal (mining, other OTR)	Refers to the onsite disposal of OTR tyres (only) within a mining void or onsite on farms or similar.
Dumping dispersed	Refers to small incidental dumps, of several tyres, across Australia
Exported for processing	Refers to the used tyres that are not managed in Australia and are exported for re-treading and reuse, recycling or energy recovery.

Consultation with state and territory regulators and the used tyre recycling industry has been completed to enable analysis of the historical and current management and fate of used OTR tyres.

Table 4 and **Table 5** include the estimated proportions of each OTR tyre category sent to each of the local or export fates, listed above, as a percentage of total used OTR generation detailed in Table 3. Each of the fate category allocations are discussed below.

Table 4. **Used OTR tyres assumed local and export fate proportions by tyre category, 2018-19 (%)**

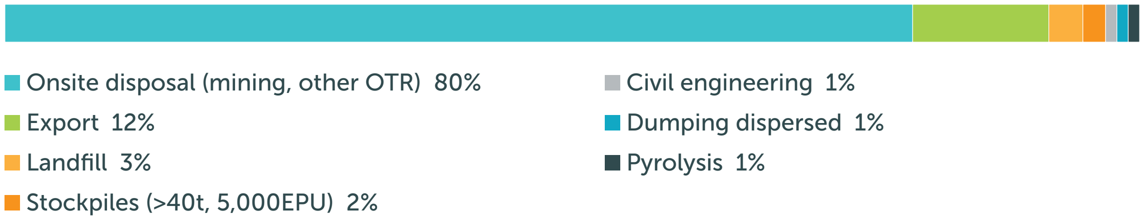
Fate	Agriculture	Aviation	Construction	Manufacturing & trade	Mining
Casings & seconds (re-treading)	–	–	–	–	–
Civil engineering	1%	–	1%	1%	1%
Crumb, granules & buffings	–	–	1%	1%	–
Pyrolysis	–	–	–	–	1%
Kilns/boilers/furnaces	–	–	–	–	–
Stockpiles (>40 t, 5,000 EPU)	2%	–	2%	2%	2%
Landfill	4%	4%	4%	4%	3%
Onsite disposal (mining, other OTR)	90%	10%	10%	10%	93%
Dumping dispersed	3%	3%	3%	3%	–
Export for processing	–	83%	79%	79%	–
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Table 5. **Used OTR tyres assumed local and export fate proportions by tyre category, 2018-19 (tonnes)**

Fate	Agriculture	Aviation	Construction	Manufacturing & trade	Mining	Total	%
Casings & seconds (re-treading)	-	-	-	-	-	-	0%
Civil engineering	300	-	100	100	700	**1,200**	1%
Crumb, granules & buffings	-	-	100	100	-	**200**	0%
Pyrolysis	-	-	-	-	700	**700**	1%
Kilns/boilers/furnaces	-	-	-	-	-	-	0%
Stockpiles (>40 t, 5,000 EPU)	600	-	200	100	1,400	**2,300**	2%
Landfill	1,300	100	300	300	2,000	**4,000**	3%
Onsite disposal (mining, other OTR)	28,300	300	800	700	63,300	**93,400**	79%
Dumping dispersed	900	100	200	200	-	**1,400**	1%
Export for processing	-	2,500	6,200	5,700	-	**14,400**	12%
Total	**31,400**	**3,000**	**7,900**	**7,200**	**68,100**	**118,000**	**100%**

Figure 3.

Used OTR tyres assumed local and export fate proportions, 2018-19 (%)



Onsite disposal (mining, other OTR) – 80%

Stakeholder consultation found that onsite disposal was the main fate for used OTR tyres in Australia, particularly for the mining and agricultural sectors, that generated about 85% of the used OTR tonnage in 2018-19. An estimated total of 93,400 tonnes of used OTRs were disposed onsite in Australia in 2018-19. Across Australia mining sites have been allowed to dispose used OTR tyres into mining voids, see Section 3.2 for further discussion.

Replacement agricultural OTRs are typically fitted on-farm by the tyre retailer. Industry commented that the cost of back loading and disposing of agricultural OTRs (around $120 per used OTR tyre) means that most used agricultural OTRs stay on-farm and are stored, repurposed or dumped on-farm in erosion gullies or similar.

Export for processing overseas – 12%

An estimated 14,400 tonnes of used OTR tyres were exported overseas for processing in 2018-19. Around 2,500 tonnes of aviation tyres were exported. Large aviation tyres would be re-treaded and refurbished and returned to Australia for continued use. Other smaller used aviation OTR tyres, that cannot be re-treaded, would be exported as shredded tyre derived fuel or baled. The remaining, around 12,000 tonnes, of OTR exports would likely be used OTR tyres from the construction and manufacturing and trade sectors that have been sectioned into manageable sized pieces for export.

Landfill – 3%

Most jurisdictions do not allow landfilling of any whole tyres and landfill operators typically would not want to accept large used OTR tyres for landfilling as they are very poor use of airspace and difficult to handle/compact. Landfilling of shredded OTRs is also unlikely given the high costs of shredding an OTR and the additional cost of landfilling gate fees. Some more remote, unmanned or less tightly controlled landfills would have used OTR tyres disposed onsite. A total of 4,000 tonnes of used OTR tyres were estimated to have been sent to these more remote, less controlled landfills in Australia in 2018-19.

Stockpiles _ 2%

Industry consultation found that stockpiling, that excludes onsite disposal, of OTRs in large, typically illegal stockpiles was not common in 2018-19. An estimated total of around 2,300 tonnes of used OTRs were disposed into stockpiles in Australia in 2018-19.

Civil engineering – 1%

Industry consultation found that the use of used OTRs in civil construction is not a significant fate for used OTRs. A total of 1,200 tonnes of used agriculture, construction, manufacturing and trade and mining OTRs were estimated to be used in civil engineering in Australia in 2018-19.

Dispersed dumping – 1%

The mapping and drive-time analysis of all Australian landfills and transfer stations, presented REC 2019, shows that 97% of Australians live within a 30-minute drive of a landfill or transfer station. The remaining 3% of the population are assumed to have no used tyre drop-off service in their area (due to being very remote) and are not likely to drive more than 30 mins to access a disposal point, and therefore the used tyres are likely to be dumped in diffuse small dumping events. For used OTR tyres where onsite disposal is allowed (i.e. mining OTRs) diffuse dumping is unlikely to occur and the used tyres would be kept onsite. Based on the method outlined above, an estimated total of 1,400 tonnes of used OTRs were illegally dumped across Australia in 2018-19.

Pyrolysis – 1%

TSA participants recovered a small amount, around 700 tonnes, of used OTR tyres via pyrolysis in Australia in 2018-19.

Crumb, granules and buffing – >1%

TSA participants processed a very small amount, around 200 tonnes, of used OTRs in Australia in 2018-19.

Cement kilns, industrial boilers or furnaces – 0%

No used tyres of any kind were sent to cement kilns, industrial boilers or furnaces in Australia in 2018-19.

Casing and seconds (re-treading) – 0%

Industry consultation found that re-treading of used OTR is not practiced in Australia, currently, except for aviation OTRs. Larger aviation OTRs (greater than 15 inch in diameter) are commonly re-treaded up to six or seven times once a set number of landings have been completed, to extend the life of the tyre. Australia exports all large aviation OTRs for re- treading off-shore to specialist facilities that provide complete refurbishment of the tyres before sending tyres back for continued use, see tonnages reported under 'export for processing overseas' below.

Key finding:

This report's more detailed used OTR tyre category and fate analysis came to essentially the same conclusion as *REC 2019*, **with an estimated 84% of used OTR tyre tonnages not recovered and 80% being disposed onsite at mining sites, farms or similar.**

Mining industry sector analysis

This section provides a profile of the mining industry across Australia including mine types, mapping of mining sites and used tyre processing facilities for different areas of Australia.

Australian mining sector profile

2.1

Geoscience Australia's OZMIN database (last updated Feb 2015) provides useful information about the profile of mining sites in Australia. Table 6 provides a summary of the number of operational mines in Australia by mine type and jurisdiction. Mining industry consultation has also informed the type of mining voids that are used for each mine type in Australia.

Table 6. Australian mining sites by mine type and by state

Mine type	NSW	NT	QLD	SA	TAS	VIC	WA	Total	%	Void type and % split[4]
Coal	61		52	1	4	5	2	125	31%	Open cut
Gold	10	7	5	2	2	7	74	107	26%	Open cut and underground 50/50
Other	6	4	6	6	6	2	15	45	11%	Rare earth mines mostly open cut 70/30
Iron ore	1	1	1	2	1		38	44	11%	Open cut
Copper	6	2	10	3			6	27	7%	Mostly underground 80/20
Nickel							23	23	6%	Mostly underground 70/30
Zinc	4	1	6	1	3			15	4%	Mostly underground 70/30
Bauxite		1	2				3	6	1%	Open cut
Opal	2			3				5	1%	Underground
Lead	1		1				2	4	1%	Mostly underground 70/30
Uranium		1		2				3	1%	Underground
Total	91	17	83	20	16	14	163	404		

Some 400 mines were operational in Australia in 2015. Coal mines, mostly in NSW and Qld, make up around 30% of mining sites in Australia. Gold mines, mostly in WA, make-up around 26%. Rare earth, iron ore, copper, nickel and zinc make up around 40%.

[4] *Source: mining industry consultation, pers. comm.*

By the number of sites, most of the mines in Australia are open pit mines, that would utilise large ridged and articulated haul truck tyres.

Whilst there will be significant amount of smaller mining OTRs used in underground mining, the above analysis illustrates the need for any used mining tyre recovery program to be able to cater for large bulk haul truck tyres, which will be the main tyre type/tonnages that would require processing.

Used mining OTR tyre disposal practices 2.2

This section analyses the historical and current used mining tyre disposal practices in Australia. The analysis is based on consultation with the key mining jurisdictions WA, Qld, NSW and NT environmental protection agencies and some industry consultation.

Western Australia 2.2.1

In WA used mining tyres are permitted to be disposed onsite in designated areas that are defined in the mining site environmental licence. WA licenses typically contain requirements for used mining tyre storage and onsite burial.

For example, the Newcrest Telfer Gold Mine licence, page 15, requires the following for storage:

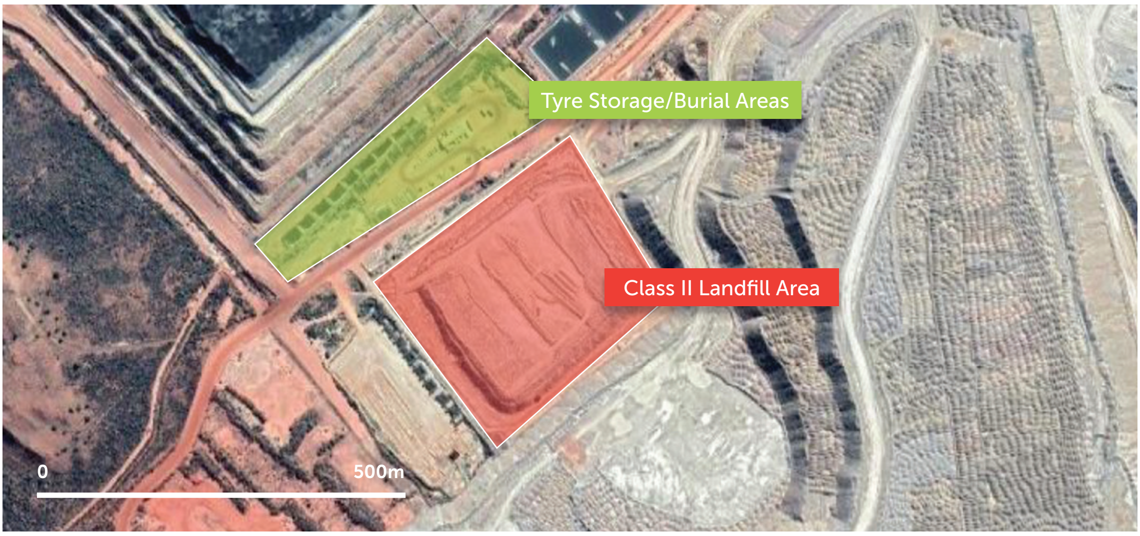
- Storage of tyres shall only take place within the tyre storage/burial areas shown on the Landfill Area Map in Schedule 1 (Figure 3).
- Not more than 30,000 used tyres shall be stored at the premises at any onetime;
- Used tyre stacks shall not exceed 1000 tyres per stack and 5 m in height; and
- Used tyre stacks are to be stored no less than 4 m from any other tyre stacks

The licence also specifies the onsite burial requirements for used mining tyres as follows:

- Burial of tyres shall only take place within the tyre burial areas shown on the Landfill Area Map in Schedule 1 (Figure 3 and Figure 4).
- Tyres shall only be land filled:
    a. in batches separated from each other by at least 100mm of soil and each consisting of not more than 40 cubic metres of tyres reduced to pieces;or
    b. in batches separated from each other by at least 100mm of soil and each consisting of not more than 1000 whole tyres.
- Cell locations where tyres are to be buried will be surveyed and the latitude and longitude recorded.

Figure 4 shows the 'landfill map area' referred to above, extracted from page 23 of the licence. Large storages of used tyres can be seen in separated piles awaiting burial.

Figure 4 **Example of permitted mining tyre storage and burial area at Telfer Gold Mine in WA.**



WA government are currently reviewing the practice of used mining tyre onsite disposal and the current licence allowances with a view to improve recovery rates of used mining tyres.

Queensland

2.2.2

In Qld used mining tyres are permitted to be stored and disposed onsite with no limits on quantities or location. The recently approved Adani Carmichael Coal Mine licence (EPML01470513) includes only the following requirement for used tyre disposal, see page 9:

- Scrap tyres are authorised to be stored awaiting disposal or disposed on the mining lease in a manner that minimises environmental harm. A record must be kept of the number and location of tyres disposed.

The Qld Department of Environment and Science have also published ***Operational policy, Mining, Disposal and storage of scrap tyres at mine sites*** (DES 2014). This policy states that new mining approvals should apply the 'waste hierarchy' in the management of used mining tyres by:

2.1 Avoidance

When negotiating purchase agreements with new tyre suppliers, seek take-back clauses to maximise freight backloading opportunities.

2.2 Recycling

Explore opportunities to recycle scrap tyres on-site and locally through use in impact-absorbing surfaces, bitumen and road construction, pastoral and agricultural use, and civil engineering applications.

2.3 Waste-to-energy

Use existing opportunities in Queensland to recover the intrinsic energy value through waste-to-energy options.

2.4 Disposal

a. *Tyres stored awaiting disposal—or transport for take-back and, recycling, or waste-to-energy options – should be stockpiled in volumes less than 3m in height and 200 square metres in area. Additional fire precautions should be taken, including removal of grass and other materials within a 10m radius of the scrap tyre store. Tyres should be stored in a manner that prevents water retention and minimises mosquito breeding events. Options may include holing side-walls, covering with tarpaulins, spraying with a non-persistent insecticide, or reducing the stockpile during rain events.*
b. *Disposing of scrap tyres in underground stopes is acceptable provided this practice does not cause an unacceptable fire risk or compromise mine safety.*
c. *Disposing of scrap tyres in spoil emplacements is acceptable, provided tyres are placed as deep in the spoil as possible but not directly on the pit floor. Placement should ensure scrap tyres do not impede saturated aquifers and do not compromise the stability of the consolidated land form.*
d. *Disposing of scrap tyres (and other wastes) on mine sites is a notifiable activity under Schedule 3 of the Environmental Protection Act 1994, and the locations of the disposal sites need to be recorded on the Environmental Management Register.*

Qld Department of Environment and Science noted that there has been discussions held at senior level of Government with the Minerals Council of Australia flagging the Department's expectation for the current management practices for used mining tyres to change as new processing options come online and that the Department would consider banning onsite used tyre disposal if industry do not pursue an alternative to onsite disposal.

New South Wales

2.2.3

Consultation with NSW EPA staff found that mining tyres are allowed by EPA to be stored and disposed onsite with no limits on quantities or location.

A review of mining licences such as the Mt Arthur Coal mine licence, one of NSW largest coal mines, found no reference to used tyres and no reference to onsite burial requirements.

EPA noted that if a farmer in NSW was to bury waste tyres on their farm it would be an offence. NSW EPA is likely to review the status of mining tyre onsite disposal in its annual review of regulations.

Northern Territory

2.2.4

Consultation with NT EPA and NT Department of mining staff found that mining tyres are allowed by EPA to be stored and disposed onsite with no limits on quantities or location. NT staff noted that licences in NT do not specify onsite burial requirements.

NT EPA would like to see the tyres recovered but, due to remote locations, on-site burial has always been seen as the only option.

Key findings:

- Any used mining tyre recovery program needs to be able to cater for large bulk haul truck tyres, which will be the main tyre type/ tonnages that would require processing.
- All jurisdiction consulted allow onsite disposal.
- WA is the only jurisdiction consulted with requirements for used mining tyre storage and disposal included in the mine licence (i.e. that are required)
- QLD, NSW, WA are all reviewing the current practice of allowing onsite disposal and Qld government have raised this issue with Minerals Council of Australia
- Historically onsite disposal has been allowed due to there being no alternatives. As this changes, mining companies should expect the allowance of onsite disposal to cease.

Mining sites and used tyre processing locations

This section provides analysis of mining site and used tyre processing locations around Australia and analysis of average travel distances.

Figure 6. **Examples of lower and upper end of processing investment costs.**

Photos by Tyrecycle and Pearl Global

Figure 7, overleaf, illustrates the location of Australian mining and used tyre processing locations. It also includes the 500 km distance 'circle' from each used tyre processor. The green shading for the 500 km distance circle also illustrates the density of processing sites in each 500 km area.

Important! Only a few of Australia's used tyre processors are currently able to receive large mining OTR tyres. **So Figure 7, is simply illustrating the current network of used tyre processing sites that could take used mining OTRs in future and most of these sites would require investment to be able to process large mining OTRs.** The extent of the investment would depend on the level of mining tyre processing to be done onsite. Investments could range from as little as $100,000 for excavator shears to simply section the tyres to allow enable transport or shipping for further processing in Australia or off-shore, through to multi-million-dollar investments to build full OTR tyre processing plants such as those recently established by Pearl Global in Queensland (see example photo above right).

Figure 7. Australian mine sites and current used tyre reprocessors (most without mining OTR capability)

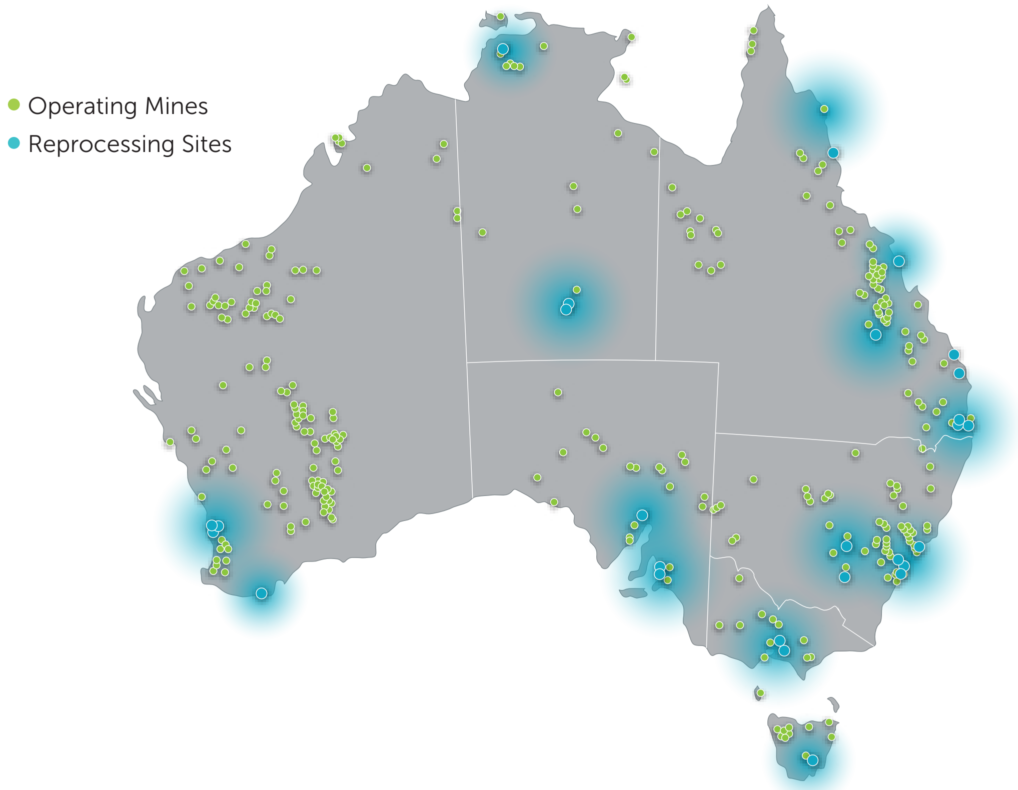


Table 7 provides the results of analysis for the distances between used tyre processors and mining sites.

Table 7. Distance between mines and used tyre processors by jurisdiction (kilometres)

Distance (kilometres)	NSW	NT	QLD	SA	TAS	VIC	WA
Average distance between mines and processors	183	442	449	327	268	168	832
Closest mine to a processor	7	53	21	49	62	56	101
Furthest mine to a processor	731	1,208	1,244	582	406	422	1,713

Vic, NSW and Tas have similar average distances of around 200 kms between mining and processing sites. Qld and NT both have average distances of around 400 kms. WA has by far the longest average distance of around 800 kms.

Table 8 provides the results of analysis for the proportions of mining sites within distance ranges to used tyre processors by jurisdiction and nationally.

Table 8. Proportions of mining sites within distance ranges to used tyre processors by jurisdiction (%)

Distance from nearest processor	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
Within 500 km	98%	53%	73%	73%	100%	100%	13%	**57%**
Between 500 km and 1,000 km	2%	40%	12%	27%	0%	0%	62%	**30%**
Greater than 1,000 km	0%	7%	15%	0%	0%	0%	24%	**13%**

Key findings:

- Nationally, 57% of sites are within 500 kms of the used tyre processor, 30% are between 500 and 1,000 kms and 13% are more than 1,000 kms away from a processor.
  WA, Qld and NT all have sites that are more than 1,000 kms from a processor site, but WA has by far the largest proportion with 24% of the mines more than 1,000 kms from a processor.

- Only a few of Australia's used tyre processors are currently able to process large used mining tyres. Most used tyre processors in Australia would require investment to be able to process large used mining tyres.

  The extent of the investment would depend on the level of mining tyre processing to be done onsite. Investments could range from as little as $100,000 for excavator shears to simply section the tyres to allow enable transport or shipping for further processing in Australia or off-shore, through to multi-million-dollar investments to build complete mining tyre processing plants.

Section 4

Used mining tyre recovery analysis

This section provides analysis of the technical feasibility of large used mining tyre repair, re-treading, recycling or energy recovery.

Used mining tyre repair 4.1

Repairing of partly worn, but damaged, mining tyres is common in Australia. For example, Bridgestone Mining Solutions Australia (BMSA) have six mining OTR repair service centres located around Australia, as detailed here. Due to the cost of new mining tyres (around $40-50,000 for a large mining tyre) there is a strong financial driver to repair mining tyres where significant tread remains. Apart from repair, mine operators also put chains around worn tyres to get more life out of the tyre before disposal.

Used mining tyre re-treading 4.2

Industry consultation found that re-treading of mining OTRs is currently not happening in Australia and is unlikely to in future. Industry noted that there has been attempts to re-tread mining tyres in the past that have failed. This main cause of failure was wear/damage to the casing making the re-treaded tyre less reliable. The adhesive bond between the casing and the re-tread was not typically the cause of failure.

However, in contrast to this view, Kal Tyre promote a global mining tyre re-treading business that has been operating for over 45 years, here. Kal Tyre re-tread over 10,000 OTR tyres annually in the UK, West Africa, Canada, Chile and Mexico.

Used mining tyre recycling 4.3

Recycling of used large mining tyres by processing the tyres into crumbed rubber and steel is not currently happening in Australia, however, it is technically feasible and there are international examples such as those discussed below.

ELDAN recycling installed a mining tyre recycling plant in at the OK Tedi Mining Limited copper mine in Papua New Guinea. For this plant the mining tyres are pre-cut, and have the bead removed, by a heavy-duty demolition shear into pieces which fit the in-feed of the shredder, which is designed to process mining tyres. The tyre sections are processed into tyre shreds, and free steel wire is liberated and removed from the shreds by a powerful magnet. The tyre shreds are then further processed in a granulation and separation plant. Depending on the customer specific requirements a high-quality rubber granulate and clean steel wire can be produced.

Companies such as Eco Green Equipment are marketing processing equipment purpose built to recycle large used mining OTR tyres, as demonstrated here. This equipment is purpose built to cut the remaining rubber from the three outer sites of the tyre and then remove the steel bead from the mining OTR before sectioning and shredding the casing for rubber and steel recovery.

Tyrecycle are the main company in Australia that are currently marketing the recycling of mining tyres into rubber and steel, as shown here. However, it is understood that all mining OTR processing is occurring at overseas facilities, with only primary size reduction happening onshore.

The recycling of used mining tyres is an energy intensive process that requires multiple stages of size reduction which adds to the processing costs.

Used mining tyre recovery via pyrolysis

4.4

There are several pyrolysis plants that are either built, commissioning, under construction or in the planning stages of establishing in Australia with the intention of targeting used mining tyres as one of the primary feedstocks.

The Pearl Global facility in Stapylton, Qld has recently completed commissioning, is operational and is receiving large mining tyres. The processing units can be housed in a 40-foot ISO frame so it is portable and scalable and can be located in proximity to tyre generating sites.

The stated time to replicate the facility is 16 weeks. With six processing units operating at one site, 18,000 tonnes of tyres could be processed per annum. The processing units require the tyre to be shredded down to two-inch feedstock before processing.

Southern Oil is considering a pyrolysis facility designed to be able to process whole large used mining tyres or baled tyres and will provide oil that can be further refined.

Tytec Recycling is a collaboration between Tytec Group and Green Distillation Technologies Corporation (GDTC) and is planning to build a pyrolysis system for whole used mining tyres processing also to be located in Qld. They anticipate the plant to be operational by mid-2021.

Sister company, Tytec Logistics, currently specialise in delivering new OTR tyres to mining sites in purpose-built trailers, that maximise payload, and service large portions of the mining industry, including remote sites. Tytec Recycling recognise the significant backloading opportunity for used tyres using the same transports, see photos below.

Photos by Tytec

Used mining tyres are also being processed in pyrolysis plants overseas at plants such as the Titan Tyre Recycling Facility in Canada, that started operating in 2016.

Canadian company Kal Tyre are set to open their first major mining tyre pyrolysis facility in Chile, South America to service the vast copper mines. The plant will have two kilns and capacity to process 7,500 tonnes of rubber. Two kilns will enable 24/7 operation of the plant. Similar to the Pearl Global proposition, the Kal Tyre units are to be built close to mine sites and be scalable and relatively easy to replicate.

Used mining tyre energy recovery (TDF) 4.5

The shredding of mining tyres for use as a fuel supplement, or tyre derived fuel (TDF), in industrial kilns is also technically feasible. Tyrecycle is the main company in Australia that is currently marketing the collection of mining tyres to produce TDF, as shown here.

The process for TDF production is the same as the first stages of recycling (i.e. de-beading, tyre sectioning and shredding). Once the material is shredded to the appropriate size, it is exported to kilns located in Asia and used to supplement coal, mostly in cement kiln firing. As noted in Section 1.3, no used tyres are sent to the cement kilns in Australia, that operate in NSW, SA, Qld and Tas.

Key findings:

- The repair of large mining tyres that are partly worn and damaged is a well-established industry in Australia, currently.
- Re-treading of fully worn large mining tyres is not happening in Australia currently and some do not think re-treading is a viable option for large mining tyres. However, companies such as Kal Tyre have an international network of mining tyre re-treading sites.
- The recycling of used large mining tyres into crumbed rubber and steel is technically feasible, however, energy intensive and currently the only reported recycling is by Tyrecycle who cut the tyres into manageable sections and export the tyres for recycling overseas where overhead costs are lower.
- It is technically feasible to produce a TDF from large used mining tyres, however, in Australia this is understood not to be happening in significant tonnages due to the energy intensive processes required to shred large mining tyres for export as TDF.
- Recovery of large used mining tyres by pyrolysis is technically feasible and several pyrolysis plants are either built, commissioning, under construction or are in the planning stages of establishing in Australia with the intention of targeting used mining tyres as one of the primary feedstocks.
- Historically, large used mining tyres have been allowed by regulators to be disposed of into mining voids. With the development of onshore options for recovery by pyrolysis and several providers tyring to establish onshore operations to target large used mining tyres, it is an appropriate time for regulators to review if this practice should be allowed to continue.

Used mining tyre best practice management

This section provides results of the literature review of international best practice for used mining tyre management.

Whilst there are several examples of what could be termed 'best practice' mining tyre **recovery**, that have been discussed above, the literature review found little information on best practice used mining tyre management (i.e. examples of mining tyre governance and resulting recovery rates).

Literature such as ***Investigating global best practice waste tyre management***, L. O'Keefe, 2016, available here, provide detailed review of global approaches to used tyre management. However, the focus of such studies is, understandably, on passenger and truck tyres with limited discussion of mining tyre management best practice.

The review found that onsite disposal of used large mining tyres is wide spread, globally.

The ELDAN recycling system installed at the OK Tedi Mining Limited copper mine in Papua New Guinea, discussed in Section 4.3, provides an example of an onsite solution for large used mining tyres. However, it is unclear how successful the onsite recycling plant has been and what ongoing markets have been established for recycled products.

An example that is worth noting is new legislation in Chile, that includes a ban on the onsite disposal of mining tyres onsite. The *Extended Product Liability and Recycling Promotion* legislation was passed in 2016. The regulation will come into force with the 'supreme decrees' that will establish collection and valorisation goals for each priority product (including tyres). **For used mining tyres, the legislation states that by 2026, 100 per cent of collection and recovery must be achieved.**

The legislation differentiates tyre recycling goals according to their size, above and under 57 inches, projecting that larger mining tyres should be completely reused in 2026, while those less than 57 inches, should attain a 98 per cent recycling rate by 2028. Source: Tyre and Rubber Recycling, New Chilean Plan for Mining Tyres, Jan 2019.

Key findings:

- The review found that onsite disposal of used large mining tyres is wide spread, globally.
- Chile has implemented legislation that requires 100 per cent recovery of mining tyres by 2026. The implementation of this legislation has been key to enabling Kal Tyre to invest in, develop and build their new mining tyre pyrolysis facility.
- While mining companies are allowed to stockpile or dispose of used mining tyres onsite, which they can do at effectively no cost, the recovery of mining tyres is unlikely to be wide spread.

Used mining tyre recovery financials

This section provides analysis of the financials of large used mining tyre recycling or energy recovery compared with current management.

Stakeholder consultation found that onsite disposal was the fate of almost all used large mining tyres in Australia. Whilst there would be some handling involved in shifting and burying the used tyres, this is all assumed to be within normal site operations. There would be no external costs associated with onsite mining tyre disposal. The costs for onsite disposal are therefore assumed to be zero.

The tyre recovery industry has been consulted to inform the analysis below.

The financials presented below are for large used mining tyres with an assumed weight of three tonnes. There are some heavier mining tyres (up to 4.5 tonne) and some lighter. As discussed in Section 2, large bulk haul truck tyres will be the main tyre type/tonnages that would require processing and these are assumed to have an average weight of three tonnes.

Table 9 Estimated cost range for collection of used large mining tyres for offsite processing (total costs to the waste generator) ($/tyre)

Mine site	Lower		Upper		Comments
	$/unit	$/tonne	$/unit	$/tonne	
Regional	$1,000	$333	$1,800	$600	Collection costs vary by distance travelled. 'Regional' collections typically allow for up to 500 kms from processor.
Remote	$1,400	$467	$2,300	$767	Collection costs vary by distance travelled. 'Remote' collections typically allow for up to 1,000 kms from processor.

Table 9 provides the estimated cost range for the collection of used large mining tyres for the off-site processing from regional mines (up to 500 kms from processing site) and remote mines (up to 1,000 kms from processing site).

Mining companies located in regional areas could expect to pay from $1,000 to $1,800 per three tonne used mining tyre (collection and processing costs). Mining companies located in remote areas could expect to pay from $1,400 to $2,300 per three tonne used mining tyre (collection and processing costs).

Assuming an average new tyre cost of $45,000, these costs present 2-4% of a new tyre cost in regional area and 3-5% of a new tyre cost in remote areas.

Table 10 provides the estimated processing cost ranges for a tonne of used large mining tyres. It shows processing costs are highest for recycling back into crumbed rubber, followed by pyrolysis and then energy recovery (via shredding and TDF export). Whilst processing costs are higher for recycling and pyrolysis, it is important to note that these processes will generate revenue from recycled products.

Table 10 Estimated processing cost ranges for used large mining tyre ($/tonne, excluding freight)

Process	Lower $/tonne	Upper $/tonne	Comments
Recycling (crumbed rubber - onshore)	$600	$800	Assumes an additional $200/tonne to process large mining tyres for de-beading and extra size reduction costs. Crumbing costs are typically $400 -$600 per tonne.
Recovery via pyrolysis (oil, syngas, act. carbon - onshore)	$300	$500	Costs are for whole mining tyres processing.
Energy recovery (tyre derived fuel - exported)	$285	$300	Assumes an additional $200/tonne to process large mining tyres for de-beading and extra size reduction costs. Typical costs for TDF exports are around $85 to $100.

Where mining tyre recovery facilities are located very close to mining sites, the collection costs in Table 9 would decrease (due to reduced transport costs) and would be closer to the processing cost ranges listed in Table 10.

Key findings:

- Mining companies located in regional areas could expect to pay from $1,000 to $1,800 per three tonne used mining tyre (collection and processing costs). Mining companies located in remote areas could expect to pay from $1,400 to $2,300 per three tonne used mining tyre (collection and processing costs).

- Assuming an average new tyre cost of $45,000, these costs present 2-4% of a new tyre cost in regional area and 3-5% of a new tyre cost in remote areas.

- For remote sites, where mining tyre recovery facilities are located very close to mining sites, the costs to the mining company could reduce significantly (due to reduced transport costs).

Section 7

Improving recovery of used mining tyres

Considering the analysis that is presented in the sections above, the items below discuss a range of ways to improve the recovery of used mining tyres in Australia. This discussion does not provide 'the answer,' however, it will aid in further engagement with the mining sector.

Mining tyre importers become members of the current Tyre Stewardship Scheme(TSS) 7.1

If mining tyre importers were to join the current TSS, around $100 dollars (per large mining tyre imported and sold into Australia) would be collected, or 0.2% of the sale price for a $45,000 mining tyre.

As the analysis in Section 6 illustrates, the costs to recover large used mining tyres is estimated to be 10-23 times more than the TSS fees that would be collected.

Membership of the scheme would fund TSA to provide support to mining tyre manufacturers, importers and mining companies to:

- Build upon research such as that included in this report to development an industry strategy for mining tyre recovery
- Investigate and identify areas of the country with needs for additional recovery infrastructure, to support industry to make funding applications to Governments (for example)
- Support market development for products derived from used mining tyre recovery.

Co-regulatory or mandatory product stewardship to fund recovery 7.2

The Australia *Product Stewardship Act* is currently under review. It is possible that used mining tyres could be included under a **co-regulatory or mandatory product stewardship** scheme under this review. There are numerous possibilities as to how this could unfold.

If used mining tyres are included under a co-regulatory or mandatory scheme, the key outcome would be the payment of part or all of the recovery costs for used mining tyres (by tyre manufacturers/importers). This would likely see a significant increase in used tyre recovery infrastructure capacity and capability around Australia.

Ban on onsite disposal of mining tyres in all jurisdictions 7.3

Following Chile's lead, jurisdictions around Australia could implement a ban on the onsite disposal of used mining tyres. A lead time of at least several years (Chile gave a 10-year lead time) would allow time for the establishment of the required recovery infrastructure around the country. All states and territories should implement the ban to ensure used tyres are not simple shifted to a mine in another jurisdiction. A will structured national ban for onsite disposal would provide the used tyre recovery industry with the feedstock security that has been lacking historically.

Establishing a network of used tyre processing sites in close proximity to new mining tyre distribution locations 7.4

Transport costs are a significant part of mining tyre recovery costs, especially while used mining tyre processing facilities are not available as a network of sites across the country.

Backloading of used tyres when delivering new tyres may be the best means of reducing transport costs. However, if there is no used tyre processing facility in proximity of the new mining tyre distribution locations, significant additional freight costs would still be incurred.

Establishing a network of used tyre processing sites in close proximity to significant mining areas

7.5

Another approach to reducing transport, and overall recovery costs, could involve establishing a network of used mining tyre processing facilities in close proximity to significant mining areas with a significant tonnage of used mining tyres.

These facilities could be setup to provide full processing of mining tyres, as is proposed by the Pearl Global and Kal Tyre technologies or be a far more basic facility that is set-up to section the tyres and load them for efficient transport to Australian or export markets (Tyrecycle's current model).

Tyre retailers lease mining tyres rather than sell them

7.6

Mining tyre importers/retailers could set-up contracts with miners that include leasing of the tyres rather than purchasing. This would allow for drop-off and pick-up of mining tyres at the same time and build the used tyre processing costs into the leasing fees. This would also allow the mining company to resolve tyre supply, pick-up and processing costs within one contact. It would also provide the mining company with assurance that the used tyre is sent to an appropriate facility for processing.

Develop on-shore energy recovery markets for TDF

7.7

Australia currently exports significant tonnages of shredded used tyres as TDF to Japan and Korea. Currently, no Australian used tyres are sent to local industrial kilns/boilers/furnaces as a fuel (i.e. brown coal) supplement.

There has been very little incentive for Australian coal fired kilns/boilers/furnaces operators to install the required infrastructure to utilise TDF as Australia has access to huge reserves of cheap coal.

Used mining tyres could be processed into TDF and used to offset coal use in future, as pressure increases for the reduction of coal fired energy production.

Glossary of terms / abbreviations

Term / abbreviations	Description
TSA	Tyre Stewardship Australia
BBEC	Brock Baker Environmental Consulting
REC	Randell Environmental Consulting
Material flow analysis (MFA)	MFA is an analytical method to quantify flows and stocks of materials in a well-defined system. MFA is used to study material flows across different industrial sectors. When combined with an assessment of the costs associated with material flows this business-oriented application of MFA is called *material flow cost accounting*. MFA is an important tool in establishing a circular economy.
Stockpile	The following definition of used tyre stockpile was adopted for the report analysis: 1. More than 40 tonnes (5,000 EPUs) in storage onsite 2. More than 12 months storage 3. Untreated, unprocessed to product specification.
Casings	The rigid, inner of a tyre upon which a tread is placed. Typically, tyres good enough for re-tread or resale as seconds are referred to as casings.
Civil engineering	Engineering discipline that deals with the built environment, including works like roads, bridges, canals, dams, and buildings.
Crumb rubber	A highly-refined rubber product, typically less than 1mm in diameter, made from recycled tyres.
Domestic recycling	Activities that occur to recycle or reprocess waste tyres within Australia.
Dispersal to the open environment	The dispersal of rubber from in-use tyres to the open environment (land, waterways, etc.) due to wear of the tyre tread.
Used tyre fates	What happens to Australian used tyres when they reach the end of their useful life (either in Australian or overseas) including re-use, recycling, energy recovery, and disposal fates.
Used tyres	A tyre that is deemed no longer capable of performing the function for which it was originally made.
Energy recovery	The use of used tyres in a thermal process to recover energy for electricity generation or industrial process.
Equivalent passenger units (EPUs)	A standard measure, based on the typical weight of a standard passenger tyre (9.5 kgs).
In-use	Tyres that are in demand for the purpose for which they were originally made.
Off-the-road (OTR) tyre	Tyres for mining sites and heavy industry applications.
Recovery	Broadly refers to used tyres that are collected and either reused, recycled or recovered for embodied energy (energy recovery) either in Australia, or overseas.
Recycling	Process to recover constituent materials from end-of-life tyres and use those materials to manufacture other products either in Australia or overseas.
Resource recovery	Refers to used tyres that are collected and either reused recycled or recovered for embodied energy (energy recovery) either in Australia or overseas.
Re-treading	The preparation of used tyres for reuse by replacing the outer tread.
Reuse	The use of tyres for the purpose for which they were originally made, including use of re-treaded tyres and second-hand tyres.
Rubber granule	A refined rubber product, typically 2mm – 15mm, made from recycled tyres.
tpa	Tonnes per annum
Tyre Derived Fuel (TDF)	Shredded tyres prepared to a specification for use in energy recovery.
Tyre Stewardship Australia (TSA)	The not-for-profit organisation established to deliver the National Tyre Product Stewardship Scheme.
Tyre-derived aggregate (TDA)	Shredded tyres prepared to a specification for use as aggregate in civil engineering applications.
Tyre-derived products (TDPs)	Any product produced from rubber, steel, textiles or other material recovery from the recovery of used tyres.

About TSA

Tyre Stewardship Australia (TSA) was established in 2014 to implement the national Tyre Product Stewardship Scheme (the Scheme) which aims to promote the development of viable markets for end of life tyres. The Scheme's objectives are to:

- increase resource recovery and recycling and minimise the environmental, health and safety impacts of end of life tyres generated in Australia; and
- develop Australia's tyre recycling industry and markets for tyre derived products.

TSA accredits participants, including tyre retailers, manufacturers, recyclers and collectors, who are committed to supporting the objectives of the Scheme. TSA also invests in market development initiatives including research and development, and commercialisation, of new productive uses for end of life tyres.

TSA's work helps to drive the transformation of a waste product into a useful commodity, creating new industries and employment opportunities while also reducing the environmental harm caused by the illegal dumping of old tyres. TSA envisions a circular economy for tyres, where resources from end of life tyres are used and reused, such as through recycling, recovery and/or repurposing, ultimately boosting new industries and eliminating tyres from the waste stream.

TSA's Purpose, Vision and Mission

TSA's purpose is to drive sustainable outcomes for end of life tyres.

TSA's vision is to create a circular economy for end-of-life tyres which contributes to a sustainable society.

TSA's mission is to collaboratively ensure the sustainable management, recycling and productive use of end of life tyres.

TSA aims to build awareness and facilitate the commercialisation of better opportunities provided by end of life tyres, provide accreditation and stimulate innovation, in order to advance circular economy principles within the sector.

Mining Industry Off-The-Road Used Tyre Analysis

Tyre Stewardship Australia

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Report Disclaimer

This report has been prepared for Tyre Stewardship Australia in accordance with the terms and conditions of appointment dated 04/11/2019. Randell Environmental Consulting Pty Ltd (ABN 38 326 653 151) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

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TSA V1:0320

ATTACHMENT D

WHITEHAVEN WASTE TYRE DISPOSAL ENVIRONMENTAL PROCEDURE

MINE TYRE DISPOSAL PROCEDURE

Approval	Position	Signed	Date
Document Owner:			
Authorised by:			

1. DEFINITION

1.1. The reference to waste mining tyre within this Procedure refers to all waste tyres from heavy mining equipment that are generated on-site and unable to continue to be used safely on heavy equipment. These tyres are to be disposed of within the emplacement area and exclude reference to light vehicle / passenger vehicle tyres.

2. PURPOSE

2.1 The purpose of this Procedure is to ensure potential impacts associated with waste tyre disposal on site are managed, monitored and effective control mechanisms implemented.

3. SCOPE

3.1 To provide a standard work practice for the disposal of waste tyres and guidance on the identification and environmental management of risks associated with the disposal of waste tyres. This procedure details how applicable Whitehaven Coal sites will manage and dispose of waste mining tyres generated on site to address environmental requirements in accordance with applicable legislation.

3.2 This is an internal Whitehaven Coal procedure that will be reviewed periodically and amended from time to time, as required.

4. STORAGE

4.1 Heavy vehicle waste tyres will be stored at a designated storage area/s prior to disposal. The site specific logistics and storage of tyres will be managed on an individual site basis to ensure an appropriate site-specific location is selected. The location will consider appropriate distance from ignition sources and ensuring appropriate access for facilitating disposal events.

5. DISPOSAL PREPARATION AND METHOD

5.1 The Maintenance Department (or relevant operational team) will facilitate, in coordination with relevant operational personnel, the disposal of tyres in the operational area as required when adequate numbers of tyres are accumulated to warrant a disposal event.

5.2 Preparation for a disposal event will include identifying relevant hazards (refer Section 6) and controls for the defined area of disposal.

5.3 The generation and disposal of heavy equipment tyres is managed as far as practicable by implementing a number of measures to extend tyre life including:

- Road design, construction and maintenance;
- Implementation of speed limits;
- Tyre inspection and maintenance;

- Repairing tyres in so far as is reasonably practicable without impacting the safe operation of equipment; and
- Where determined as feasible at an operation, waste tyres may be reused for safety bunds, intersection delineation or temporary stabilisation of areas.

5.4 The method of disposal will generally include loading of waste tyres, at the site-specific storage location/s, onto a flat-bed type truck or equivalent piece of heavy equipment suitable for transporting large heavy equipment tyres.

The loaded truck will be guided by a light vehicle escort to the pre-determined designated disposal area to ensure the correct disposal location of the waste tyres within the operational area. Tyres will be unloaded and placed at the disposal location prior to encapsulation and coverage by overburden material.

5.5 Instances where individual or a small number of waste mining tyres require disposal (ie an equipment maintenance event in the pit, or other related unplanned or planned tyre changing occurrence), the disposal register will be updated accordingly, together with ensuring disposal at the pre-determined disposal location.

5.6 The relevant site safety procedures will apply to a disposal event and a pre-task risk assessment completed to assess hazards and controls relevant to the activity. Disposal controls will also be implemented to ensure locations, disposed tyre details, and location prior to coverage is recorded.

6. HAZARD AND ASSESSMENT

6.1 Disposal of waste tyres in the operation will consider potential safety hazards such as proximity of active dumping, slope and geotechnical stability, weather conditions and relevant site operational conditions.

6.2 A safety risk assessment will be undertaken as noted in section 5.6.

6.3 Environmental assessment of identified disposal areas will consider key aspects as described in the Environmental Assessment, including:

- Ensuring there is at least 20 metres of material available to enable compliant coverage of waste tyre disposal areas.
- Identifying whether potential to impede any saturated aquifers, or compromise the stability of the consolidated final landform or have any long-term effects on rehabilitation;
- Considering presence of any PAF material or coal rejects to ensure the emplacement is not within 15 metres proximity to the disposal area to mitigate risk of spontaneous combustion;

7. WASTE TYRE TRACKING

7.1 A register will document all heavy equipment tyres disposed and buried. Key information to be included in the register will include:

- Serial number of disposed tyres.
- Type/make and quantity.
- Disposal date.
- Surveyed co-ordinates of the disposal site area (Eastings, Northings, RL); and
- Summarised description of the disposal area.

At the completion of each disposal event, the register will be updated by the relevant operational personnel.

8. MONITORING AND REPORTING

8.1 Monitoring of stockpiled tonnage of waste heavy vehicle tyres from mining equipment will occur to identify when a disposal event is required, and ensure any applicable maximum annual disposal limits are complied with.

8.2 Monitoring of disposed waste tyres will occur as part of establishment of the final landform for rehabilitation. Monitoring will assess the final shaped grade and stability prior to topsoil placement to ensure no up-rising of waste tyres has occurred, and that at least twenty metres of emplacement material is over the disposed waste tyre area. Rehabilitation monitoring required under respective Mining Operation Plan's and applicable site management plans will assess slope stability and identification of any effects related to historical waste tyre disposal.

8.2 The reporting of relevant information within the waste tyre tracking register of the disposal of waste tyres from inception of this Procedure will be supplied, where required, to relevant agencies.