APPENDIX A

ROAD TRANSPORT ASSESSMENT

ATLAS-CAMPASPE MINERAL SANDS PROJECT

OPTIMISATION MODIFICATION

APPENDIX A

ROAD TRANSPORT ASSESSMENT

TRONOX

Atlas-Campaspe Mineral Sands Project Optimisation Modification

Road Transport Assessment

Prepared for:

Tronox Mining Australia Limited

12 July 2019

The Transport Planning Partnership

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Atlas-Campaspe Mineral Sands Project Optimisation Modification

Road Transport Assessment

Client: Tronox Mining Australia Limited

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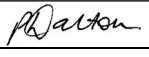
Final	12/7/19	P. Dalton	P. Dalton	

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Austroads (2017), *Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings.*

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1 Introduction

The Atlas-Campaspe Mineral Sands Project (the Project) is being developed by Cristal Mining Australia Limited, which will be renamed Tronox Mining Australia Limited (Tronox) on 25 July 2019. Development Consent (SSD_5012) for the Project was issued under the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* in 2014.

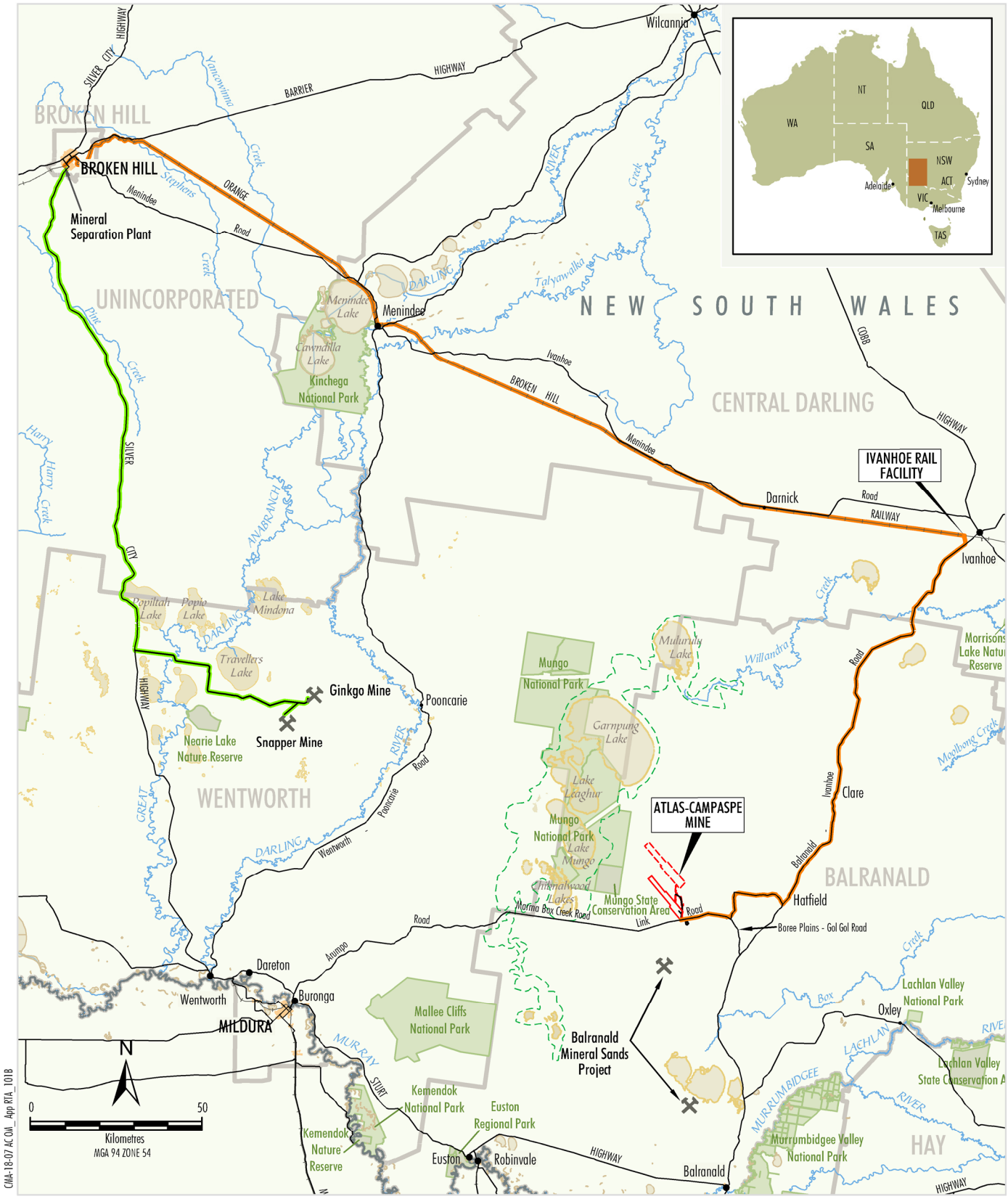
The Project includes the development of a mineral sands mining operation (herein referred to as the Atlas Campaspe Mine), together with the construction and operation of a rail loadout facility located near the township of Ivanhoe (herein referred to as the Ivanhoe Rail Facility).

The Atlas-Campaspe Mine is located approximately 80 kilometres (km) north of Balranald, New South Wales (NSW) and 270 km south-east of Broken Hill (Figure 1.1), and the Ivanhoe Rail Facility is located approximately 135 km north-east of the Atlas-Campaspe Mine.

Construction of the Project is currently being undertaken in accordance with Development Consent SSD_5012, which was granted pursuant to section 89E of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act). Tronox proposes to modify Development Consent (SSD_5012) under Section 4.55(2) of the EP&A Act.

This study examines the road transport implications of the Modification, and is set out as follows:

- Section 2 describes the approved Project;
- Section 3 describes the proposed modification
- Section 4 describes the existing road transport environment;
- Section 5 presents forecasts of the traffic generation of the Modification and its distribution on the road network;
- Section 6 reviews the potential impacts of the Modification on the local road network and identifies the desirable road standards and traffic controls with the Modification;
- Section 7 presents the conclusions of the study.



LEGEND

- National Park, Regional Park or State Conservation Area
- Willandra Lakes Region World Heritage Area
- Local Government Area Boundary
- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Existing Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Approved Mineral Concentrate Transport Route*

Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012)

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OPTIMISATION MODIFICATION

Regional Location

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines.

Figure 1.1

2 Approved Atlas-Campaspe Mineral Sands Project

2.1 Overview

The Project is approved to extract up to approximately 7.2 million tonnes per annum (Mtpa) of mineral sands ore and to transport up to approximately 450,000 tonnes per annum (tpa) of mineral concentrates over an operational life to 2034.

The Project will integrate with other currently existing/approved Tronox operations, including (Figure 1.1):

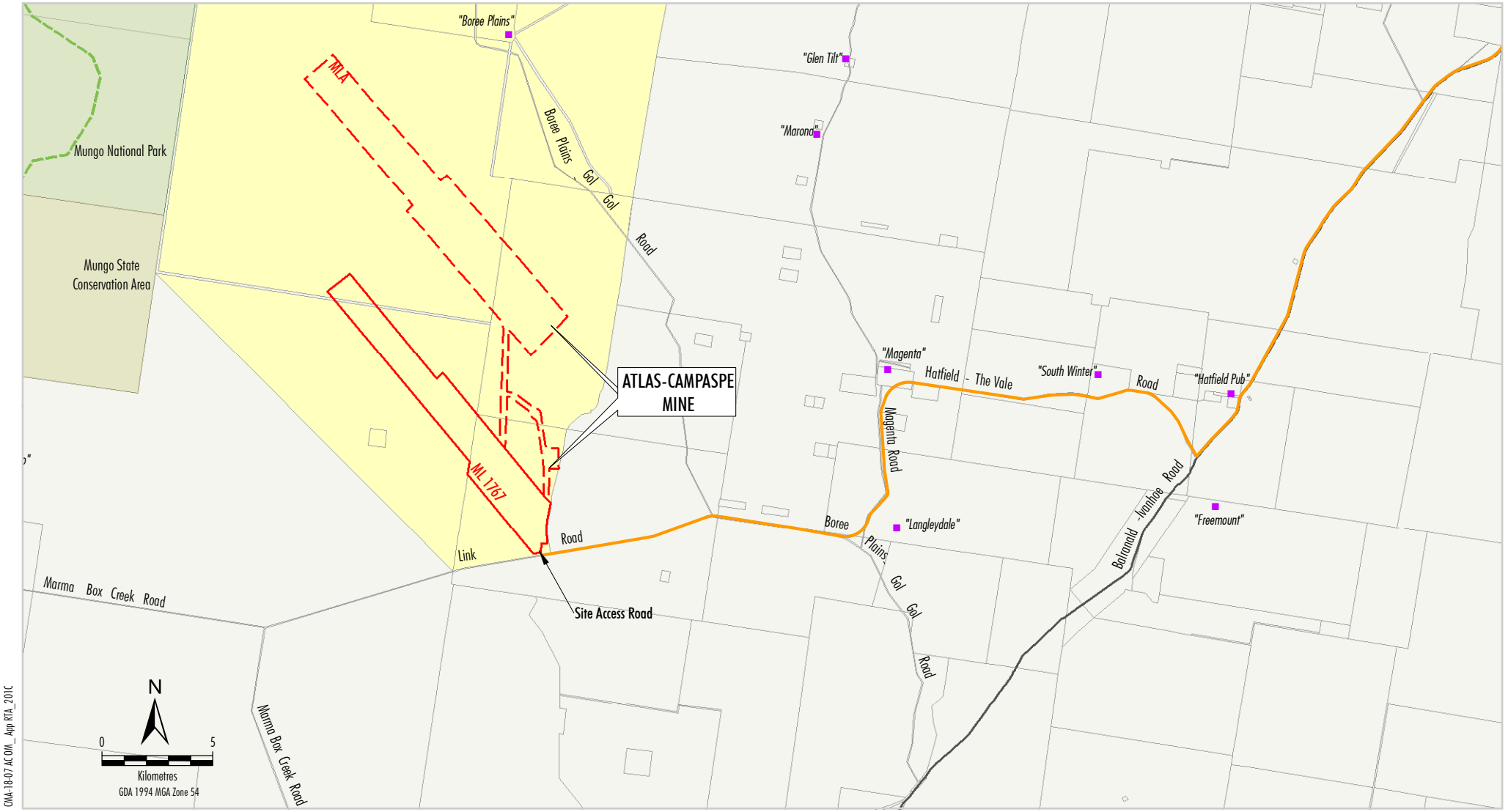
- the Broken Hill Mineral Separation Plan (the MSP) (Development Consent 345-11-02) located approximately 270 km north-west of the Atlas-Campaspe Mine;
- the Snapper Mine (Project Approval 06_0168) located approximately 105 km to the west of the Atlas-Campaspe Mine; and
- the Gingko Mine (Development Consent 251-09-01) located approximately 100 km to the west of the Atlas-Campaspe Mine.

2.2 Mineral Concentrate Transport

Product (mineral concentrates) generated as a result of operations at the Atlas-Campaspe Mine will be trucked to the Ivanhoe Rail Facility for transfer to train wagons, which will then be railed to the MSP (Figure 1.1).

The approved road haulage route between the Atlas-Campaspe mine and the Ivanhoe Rail Facility consists of (Figures 1.1, 2.1 and 2.2):

- the Atlas-Campaspe Mine access road;
- Link Road;
- Boree Plains-Gol Gol Road;
- Magenta Road;
- Hatfield-The Vale Road;
- Balranald-Ivanhoe Road; and
- Ivanhoe Rail Facility access road.



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LEGEND

- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Willandra Lakes Region World Heritage Area
- National Park
- State Conservation Area
- Tronox Owned Land
- Private Landholder
- Dwelling
- Approved Mineral Concentrate Transport Route

Source: © NSW Department of Finance, Services & Innovation (2018)
Cristal Mining Australia (2012)

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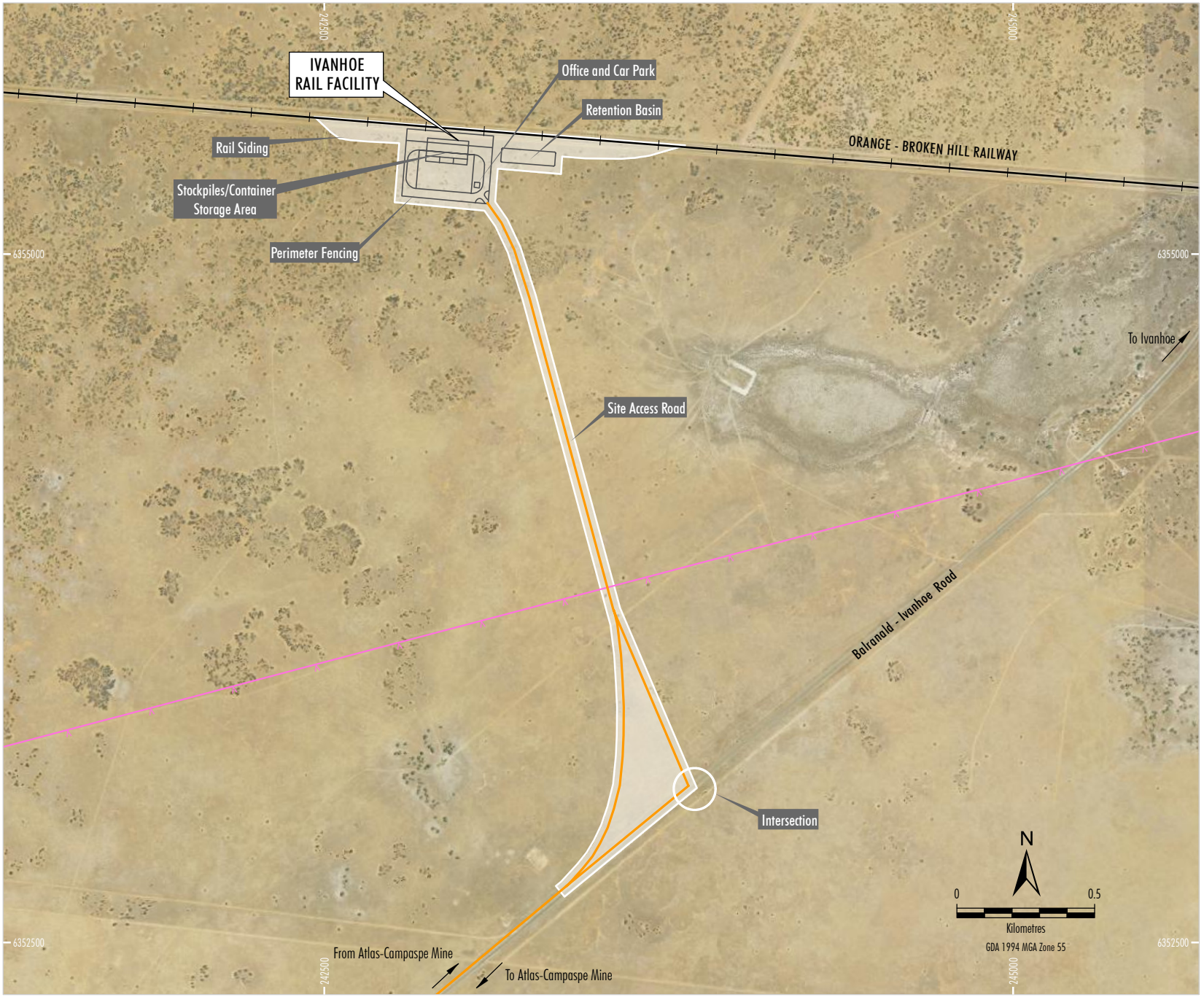
OPTIMISATION MODIFICATION

Atlas-Campaspe Mine
- Local Roads

Figure 2.1



LEGEND

Extent of Approved Surface Development - Ivanhoe Rail Facility

Mineral Concentrate Transport Route*

Existing Electricity Transmission Line

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012)
Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

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OPTIMISATION MODIFICATION

Approved Ivanhoe Rail Facility General Arrangement

Figure 2.2

CMA-18-07 AC OM_ App RTA_205B

Mineral Concentrate Transport Limits

Conditions 7 to 10, Schedule 3 of Development Consent SSD_5012 include the following mineral concentrate transport limits for the Project:

> ***Transportation Limits***
>
> 7. *The Applicant shall not transport more than 450,000 tonnes of mineral concentrate from the site in any calendar year.*
>
> 8. *The Applicant shall ensure that all mineral concentrate is transported in RMS approved vehicles via the haulage route (as shown in Appendix 3).*
>
> 9. *The Applicant shall ensure that no more than 24 haulage vehicle trips (48 vehicle movements) of mineral concentrate are dispatched from the site in any 24 hour period.*
>
> 10. *The Applicant shall restrict train movements to and from the Ivanhoe rail facility to:*
>
> *(a) a maximum of 6 train movements per week; and*
>
> *(b) a maximum of 2 train movements in any 24 hour period.*

Road Haulage Route Road Upgrades

Condition 1, Schedule 3 of Development Consent SSD_5012 requires road haulage route road upgrade works to be implemented prior to the haulage of mineral concentrate, to be to an acceptable standard for Type 1 road trains, and to the satisfaction of the relevant roads authority, being Roads and Maritime Services (RMS), Balranald Shire Council (BSC) or Central Darling Shire Council (CDSC). The required road upgrade works are presented in Table 2.1.

Table 2.1: Project Road Upgrade Works

Measures	Applicable Roads Authority
Upgrade existing Balranald-Ivanhoe Road and Hatfield-The Vale Road intersection	RMS, BSC
Road widening and associated drainage works along: ▪ Hatfield-The Vale Road (14.5 km section); ▪ Magenta Road (3 km section); ▪ Boree Plains-Gol Gol Road (5.5 km section); ▪ Link Road (8 km section)	BSC
Construction of unsealed two lane road between: ▪ Hatfield-The Vale Road and Boree Plains-Gol Gol Road intersections (2 km section); and ▪ Magenta Road and Boree Plains-Gol Gol Road intersections (2 km section).	BSC
Construction of new intersections at: ▪ Hatfield-The Vale Road and Magenta Road; ▪ Magenta Road and Boree Plains-Gol Gol Road; and ▪ Link Road and Atlas-Campaspe site access road.	BSC
Construction of a new intersection at Balranald-Ivanhoe Road and Ivanhoe rail facility access road	RMS, CDSC
Seal and undertake drainage works along Magenta Road (2 km section)	BSC

Road Maintenance Contributions

Tronox will also make financial contributions to the BSC and CDSC to contribute to the maintenance of the road haulage route in accordance Conditions 3 and 4, Schedule 3 of Development Consent SSD_5012.

In addition, Tronox will make financial contributions to the BSC and CDSC to rectify the "high risk" road safety deficiencies along Balranald-Ivanhoe Road in accordance with Condition 5, Schedule 3 of Development Consent SSD_5012.

2.3 Local Road Usage

Condition 6, Schedule 3 of Development Consent SSD_5012 requires that no Project-related traffic, including employees and contractors, is permitted to use local roads to access the site, other than the local roads which form part of the road haulage route (Figure 1.1), except in an emergency to avoid the loss of life, property and/or to prevent environmental harm.

2.4 Transport Management Plan

Tronox has prepared a Transport Management Plan (TMP) (Cristal Mining Australia [CMA], 2018) for the construction phase of the Project in accordance with Condition 9, Schedule 3 of Development Consent SSD_5012. The TMP (for operations) will include:

- a program to monitor and report on the amount of mineral concentrate and MSP process waste transported;
- the measures to be implemented to address the relevant requirements in the Code of Practice for the Safe Transport of Radioactive Materials (ARPANSA, 2001, or its latest version);
- a Road Transport Protocol for all drivers transporting materials to and from the site with measures to ensure:
  - heavy vehicles adhere to the designated road haulage route;
  - all vehicles transporting mineral concentrate are completely covered whilst in transit;
  - the staggering of heavy vehicle departures to minimise impacts on the road network, where practicable;
  - no disruption to school bus timetables;
  - the management of worker fatigue during trips to and from the site;
  - appropriate driver behaviour including adherence to speed limits, safe overtaking and maintaining appropriate distances between vehicles (i.e. a Driver Code of Conduct);
  - adherence to drug and alcohol policies;
  - appropriate vehicle maintenance and safety;
  - contingency plans when the road haulage route is disrupted due to low visibility or closed due to wet weather;
  - emergency response plans;
  - the safe transportation MSP process wastes; and
  - compliance with and enforcement of the protocol.

Tronox received no road transport-related complaints in relation to the Project during the period to 31 December 2018 (CMA, 2019).

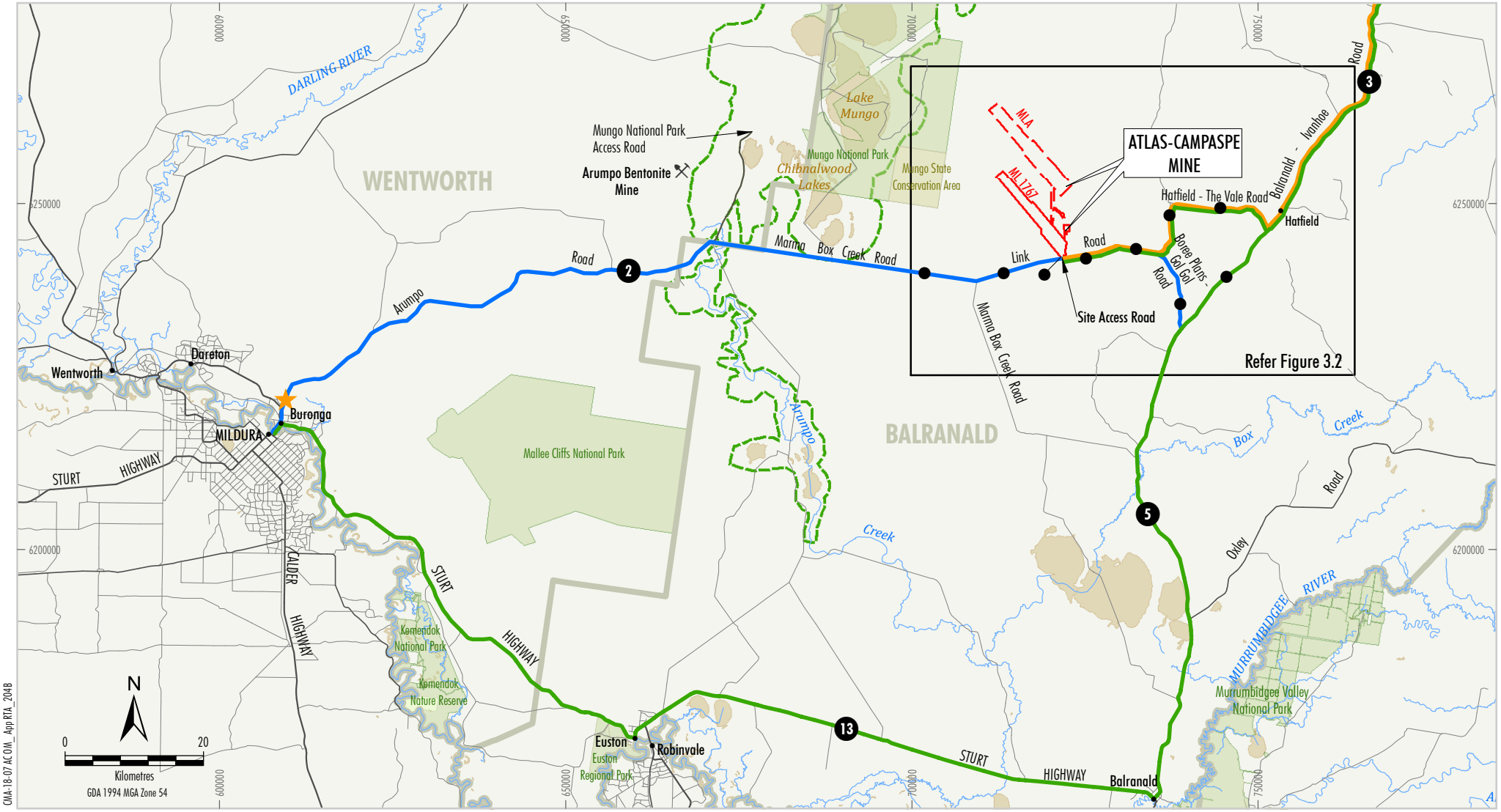
3 Overview of the Modification

The Modification would include:

- the option to use an overland conveyor to transfer overburden in addition to haul trucks;
- increased mineral concentrate production from 546,000 tpa to 665,000 tpa;
- increased mineral concentrate transport from 450,000 tpa to 665,000 tpa;
- increased mineral concentrate transport truck trips from 24 per day to 35 per day;
- increased MSP process waste disposal from 50,000 tpa to 65,000 tpa;
- use of local roads other than the road haulage route by Project-related light vehicles to access site (Figure 3.1 and Figure 3.2);
- the option to develop on-site solar power generation infrastructure at the Atlas-Campaspe Mine to supplement diesel generator sets;
- development of an emergency airstrip at the Atlas-Campaspe Mine;
- construction and operation of a telecommunications tower at the Atlas-Campaspe Mine;
- increased mineral concentrate transport train length from 600 metres [m] to 920 m, and frequency from six to eight train movements per week, i.e. four arrivals and four departures;
- extension of the Ivanhoe Rail Facility hardstand area;
- extension of the Ivanhoe Rail Facility rail siding and addition of a passing siding;
- revised alignment of the Ivanhoe Rail Facility access road and access road intersection (Figure 3.3);
- a groundwater supply bore for the Ivanhoe Rail Facility; and
- relocation of the Atlas-Campaspe Mine accommodation camp.

The proposed Modification would not change the following components of the Project:

- mine path or mine life;
- mining method;
- mineral concentration methods;
- overburden and ore extraction rate;
- sand reside, coarse reject and process waste placement management practices;
- annual maximum water supply/demand;
- rehabilitation works;
- biodiversity offset area; and
- workforce.



LEGEND

- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Willandra Lakes Region World Heritage Area
- Local Government Area Boundary
- National Park
- Nature Reserve
- Regional Park
- State Conservation Area
- Approved Light Vehicle Access Route
- Approved Mineral Concentrate Transport Route
- Proposed Light Vehicle Access Routes
- Traffic Forecast Location
- Traffic Survey Location

Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012); Tronox (2019) and TTPP (2019)

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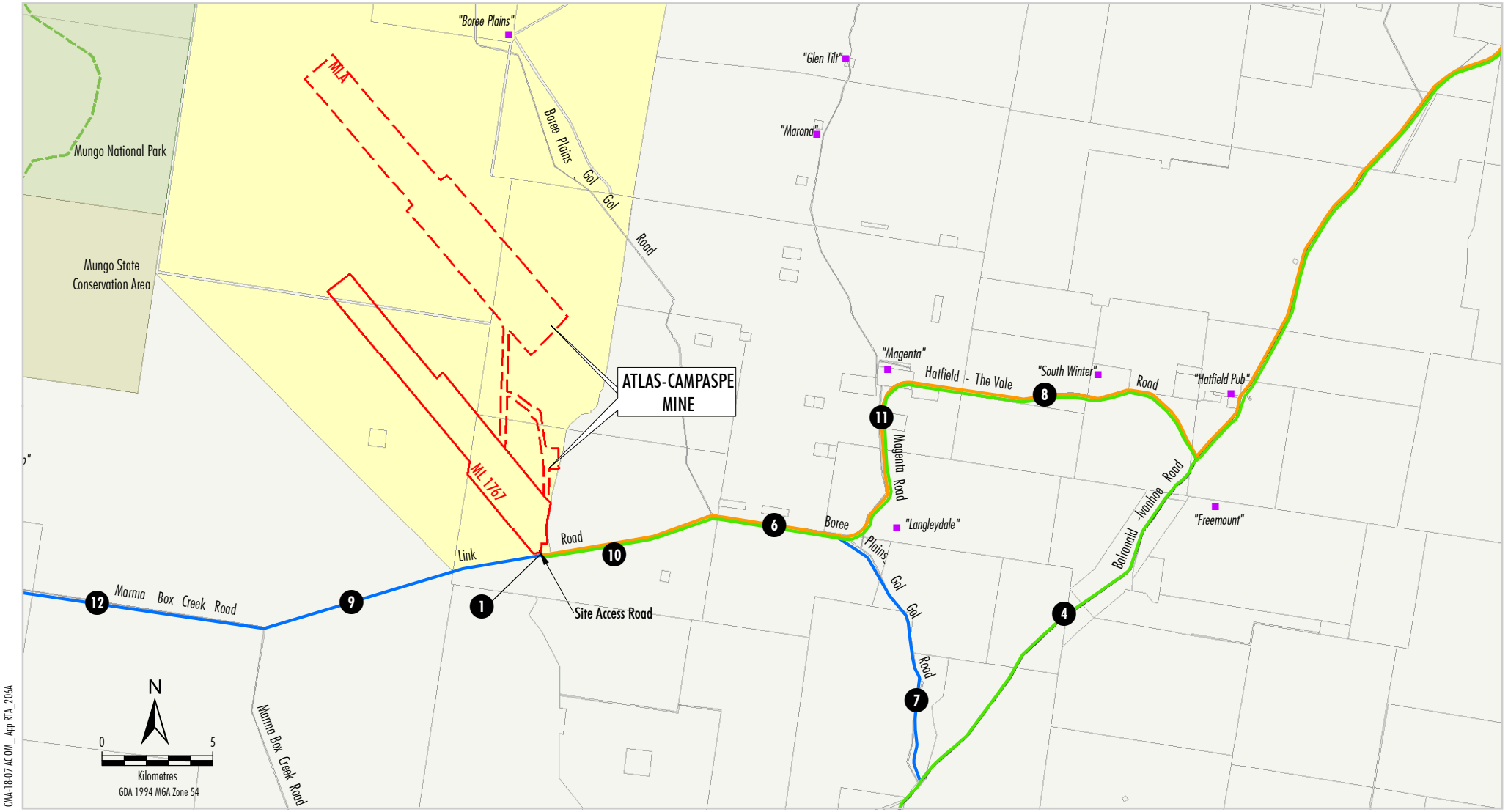
OPTIMISATION MODIFICATION

Project Road Transpot Routes

Figure 3.1



LEGEND

- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Willandra Lakes Region World Heritage Area
- National Park
- State Conservation Area
- Tronox Owned Land
- Private Landholder
- Dwelling
- Approved Mineral Concentrate Transport Route
- Proposed Light Vehicle Access Routes
- Approved Light Vehicle Access Route
- 1 Traffic Forecast Location

Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012); Tronox (2019) and TTPP (2019)

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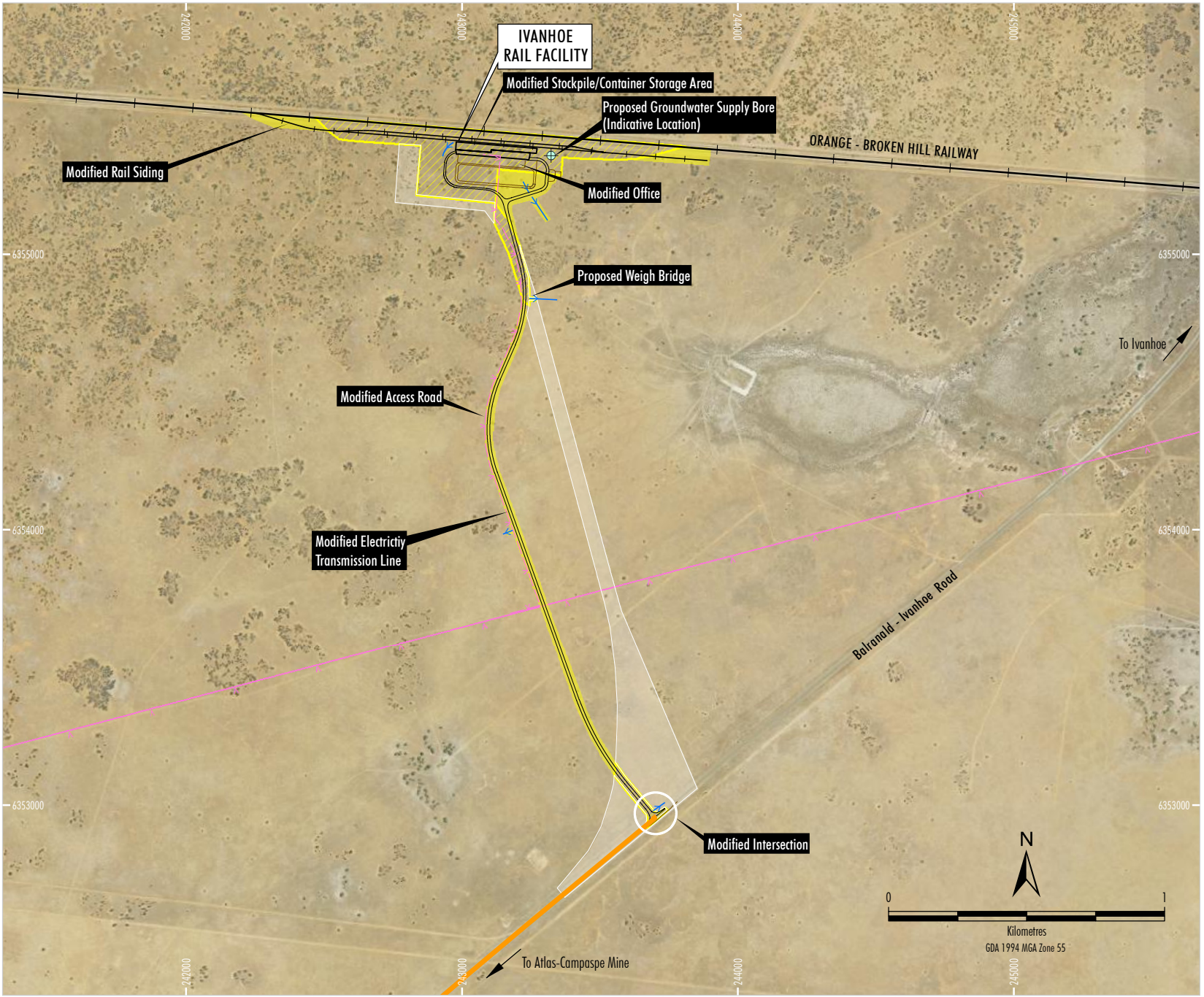
Project Road Transport Routes - Inset

Figure 3.2



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*
- Existing Electricity Transmission Line

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012); Tronox (2019)
Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

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OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility
General Arrangement

Figure 3.3

CMA-18-07 AC OM_ App RTA_202B

Road Transport Aspects of the Modification

With regard to the road transport aspects of the Project, the Modification proposes the following changes:

- increased mineral concentrate transport truck trips from 24 per day to 35 per day;
- use of other local roads other than the road haulage route by Project-related light vehicles to access site (Figure 3.1 and Figure 3.2), including
  - to/from Mildura/Buronga via Arumpo Road, Marma Box Creek Road and Link Road;
  - to/from Balranald-Ivanhoe Road then south via Link Road (as approved) and Boree Plains-Gol Gol Road only; and
- revised alignment of the Ivanhoe Rail Facility access road intersection with Balranald-Ivanhoe Road (Figure 3.3).

4 Existing Road Environment

4.1 Road Haulage Route

The approved road haulage route consists of (Figures 1.1, 2.1 and 2.2):

- the Atlas-Campaspe Mine access road;
- Link Road;
- Boree Plains-Gol Gol Road;
- Magenta Road;
- Hatfield-The Vale Road;
- Balranald-Ivanhoe Road; and
- Ivanhoe Rail Facility access road.

4.1.1 Route Description

A description of the relevant public road sections of the road haulage route is provided below.

Link Road is an unsealed local road which provides a link from Marma Box Creek Road to Boree Plains-Gol Gol Road. The intersection of Link Road with the Atlas-Campaspe Mine access road will be constructed to an appropriate standard for use by Type 1 A-double road trains. Link Road will be widened over an 8 km length between its new intersection with the Atlas-Campaspe Mine access road and its intersection with Boree Plains-Gol Gol Road (Table 2.1).

Boree Plains-Gol Gol Road is an unsealed local road which extends from Balranald-Ivanhoe Road via Boree Plains Station to Gol Gol Road on the eastern side of Garnpung Lake. Between Link Road and Magenta Road, Boree Plains-Gol Gol Road forms part of the road haulage route. The intersection of Boree Plains-Gol Gol Road and Link Road is aligned such that Boree Plains-Gol Gol Road has priority. At its intersection with Balranald-Ivanhoe Road, Boree Plains-Gol Gol Road is the minor road. A new intersection will be constructed with Magenta Road, and Boree Plains-Gol Gol Road will be widened with associated drainage works over 5.5 km between Link Road and the new intersection with Magenta Road (Table 2.1).

Magenta Road is a local road which provides a north-south link between Hatfield-The Vale Road and Boree Plains-Gol Gol Road. The intersections of Magenta Road with Hatfield-The Vale Road and Boree Plains-Gol Gol Road are T-intersections, with Magenta Road as the minor road. Magenta Road will be widened with associated drainage works over 3 km between Boree Plains-Gol Gol Road and the new intersection with Hatfield-The Vale Road (Table 2.1). In addition, a 2 km section of Magenta Road will be sealed (Table 2.1).

Hatfield-The Vale Road is a local road which provides an east-west link between Balranald-Ivanhoe Road and Magenta Road, then turns northwards west of Magenta Road to form part of a north-south link via Dockerty Road and Ivanhoe Road to Ivanhoe-Menindee Road west of Ivanhoe. Hatfield-The Vale Road is the minor road at the T-intersection formed with Balranald-Ivanhoe Road, and is the major road at the T-intersection formed with Magenta Road. Hatfield-The Vale Road will be widened with associated drainage works over 14.5 km between Magenta Road and the upgraded intersection with Balranald-Ivanhoe Road (Table 2.1).

Balranald-Ivanhoe Road (MR67) is a Regional Road which links from the Sturt Highway at Balranald, generally north-south via Hatfield to the Cobb Highway (HW21) at Ivanhoe. It is also known as Ivanhoe Road (near Balranald), Hatfield Penarie Road and Balranald Road (near Ivanhoe). North of Hatfield The Vale Road, it forms part of the road haulage route. This road is an approved route for A-double and modular B-triple road trains and 4.6 m high vehicles. Balranald-Ivanhoe Road is a two-lane road, and has a sealed surface between Balranald and a point 71 km north of its intersection with Hatfield-The Vale Road. North of this point, the road is generally unsealed, with short sections of sealed road.

4.1.2 Road Conditions

As outlined in Section 2.2, Tronox will undertake road upgrade works along the road haulage route prior to the haulage of mineral concentrate, to be to an acceptable standard for Type 1 road trains, in accordance with Condition 1, Schedule 3 of Development Consent SSD_5012. The road upgrade works will be undertaken to the satisfaction of the relevant road authority, being RMS, BSC or CDSC.

4.1.3 Traffic Volumes

Traffic surveys undertaken on Balranald-Ivanhoe Road in May 2012 (GTA Consultants, 2012) indicate that at that time, Balranald-Ivanhoe Road carried an average of 35 vehicles per day south of the Orange Broken Hill Railway, and an average of 32 vehicles per day north of Hatfield-The Vale Road. Surveys of other local roads included in the road transport route were not possible due to road surface conditions, however, are expected to be lower than those recorded on Balranald-Ivanhoe Road.

It is not expected that background traffic volumes on the approved road transport route have changed significantly since the surveys were conducted in 2012, as the most significant changes are expected to be directly related to the Project. The GTA (2012) assessment applied a background growth rate of one percent per annum, which would suggest an increase of two to three vehicles per day between 2012 and 2019. This small increase would have negligible impact on the operation of the roads.

Anecdotally, it is noted that a site inspection conducted by TTPP on 26 March 2019 found that traffic volumes along sections of the approved road transport route (specifically Link Road and Boree Plains Gol Gol Road) were very low, recording some four vehicles over a two-hour period between 2.30 pm and 4.30 pm. No vehicles were recorded along Balranald-Ivanhoe Road between 3.45 pm and 4.15 pm.

EMM (2015) examined the road transport implications of the Balranald Mineral Sands Project, and identified the routes to be used by traffic generated during the construction and operational stages of that project. The access routes for the Balranald Mineral Sands Project require all vehicles to approach and depart to and from the south, using Balranald-Ivanhoe Road only south of its intersection with Marma Box Creek Road. Traffic generated by the Balranald Mineral Sands Project would therefore not use the approved road transport route.

4.1.4 Road Safety History

Validated crash data was obtained from RMS covering the period from 1 January 2014 to 31 December 2018, noting that data for the latest nine months of that period is preliminary and subject to change. The data includes those crashes which conform to the national guidelines for reporting and classifying road vehicle crashes based on the following criteria:

- The crash was reported to the police.
- The crash occurred on a road open to the public.
- The crash involved at least one moving vehicle.
- The crash involved at least one person being killed or injured or at least one motor vehicle being towed away.

Crash data was reviewed on the approved road transport route including:

- Link Road between Atlas-Campaspe Mine Road and Boree Plains-Gol Gol Road;
- Boree Plains-Gol Gol Road between Link Road and Magenta Road;
- Magenta Road between Boree Plains-Gol Gol Road and Hatfield-The Vale Road;
- Hatfield-The Vale Road between Magenta Road and Balranald-Ivanhoe Road; and
- Balranald-Ivanhoe Road between Hatfield-The Vale Road and the Orange Broken Hill Railway.

The data indicates that two crashes were reported on those roads over that period, both of which occurred on Balranald-Ivanhoe Road:

- Thursday 25 May 2017 at 10.00 am in fine weather and on a wet unsealed road surface. An eastbound motorcycle on Balranald-Ivanhoe Road travelling at 80 km/h lost control on the carriageway and rolled over. The rider was moderately injured, and neither speed nor fatigue were nominated as contributing factors to the crash. The crash occurred in the Balranald Shire approximately 5.5 km travel distance along Balranald-Ivanhoe Road south west of the boundary with the Central Darling Shire (and approximately 40 km travel distance from Ivanhoe).
- Tuesday 10 June 2017 at 4.00 pm, in fine weather and on a wet sealed road surface. A northbound motorcycle on Balranald-Ivanhoe Road travelling at 90 km/h skidded/slid and lost control, left the carriageway to the right and rolled over. Two people were seriously injured, and neither speed nor fatigue were nominated as contributing factors to the crash. The crash occurred near Katabritoi Lake, 25 km travel distance south west of Cobb Highway at Ivanhoe.

The two crashes on Balranald-Ivanhoe Road occurred at different locations, one on the sealed portion and one on the unsealed portion, and each included a motorcycle rider losing control while travelling below the speed limit on a wet road surface. This does not suggest an inherent safety concern regarding use of the Balranald-Ivanhoe Road by heavy vehicles, noting that Tronox will make financial contributions to maintenance and to rectify "high risk" road safety deficiencies on the route.

4.1.5 School Buses

It is understood that no commercial school buses currently operate on the road haulage route although there are some informal carpooling arrangements along the road haulage route.

4.2 Proposed Local Roads Route

The proposed local road route for light vehicles travelling to and from the west between the Atlas-Campaspe Mine and Mildura/Buronga consists of (Figure 3.1 and Figure 3.2):

- Arumpo Road between Silver City Highway and Marma Box Creek Road;
- Marma Box Creek Road between Arumpo Road and Link Road; and
- Link Road between Marma Box Creek Road and Atlas-Campaspe Mine Access Road.

The proposed local road route for light vehicles travelling to and from the east and south between the Atlas-Campaspe Mine and Balranald, Sydney and Melbourne consists of (Figure 3.1 and Figure 3.2):

- Link Road between Atlas-Campaspe Mine Access Road and Boree Plains-Gol Gol Road (part of the approved road haulage route);

- Boree Plains-Gol Gol Road between Link Road and Magenta Road (part of the approved road haulage route);
- Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road; and
- Balranald-Ivanhoe Road south of Boree Plains-Gol Gol Road (existing approved route).

4.2.1 Route Description

A description of the relevant local roads sections is provided below.

Arumpo Road (MR431) is a Regional Road which links from the Silver City Highway (HW22) north of Buronga to the western side of Lake Mungo at Mungo National Park. Access to the Mungo National Park is available via Arumpo Road. Its intersection with Marma Box Creek Road is a T-intersection and is aligned such that Arumpo Road has priority. Arumpo Road is a two-lane road, and has a sealed surface between the Silver City Highway and a point approximately 18 km north-east of its intersection with the Silver City Highway. North-east of this point, it has a good quality unsealed road surface. Arumpo Road is an approved route for A-double and modular B-triple road trains and 4.6m high vehicles.

Marma Box Creek Road is an unsealed local road which provides an east-west link between Arumpo Road and Link Road. The intersection of Marma Box Creek Road with Link Road is a T-intersection, with Link Road being the minor road (terminating leg) and Marma Box Creek Road the major road which bends through 90 degrees at the intersection.

Descriptions of **Link Road**, **Boree Plains-Gol Gol Road** and **Balranald-Ivanhoe Road** (MR67) are provided in Section 4.1.1.

4.2.2 Existing Road Conditions

TTPP reviewed the existing conditions along the proposed local roads route, by driving the route during daylight hours on Tuesday 26 March 2019. The weather was fine and sunny, the road surfaces were dry and the vehicle used was a Mitsubishi Outlander LS. Observations made along the route are presented in Appendix B, and key findings are described below.

The condition of the unsealed portions of the route changes along the route, but the road surface is poor in sections, with some loose surfaces, rutting, and corrugations. These irregularities along the road profile require drivers to adjust speed to reflect the local conditions. Loose material on the parts of the route includes fine bulldust, which is raised by vehicles and restricts visibility for other drivers.

Stock grids are typically of sufficient width for one vehicle to pass, and have width marker signage (D4-3) on each side of the road at the grid, however many of the width markers are incorrectly located such that they suggest the road width is greater than the available width at the grid. This may cause drivers to misjudge the available width, especially at night.

Signage and guideposts are used along the unsealed part of the route. Warning signs are provided to alert drivers to local conditions, such as diagrammatic curve warning signs, CAMs, approaching intersection signs and GRID warning signs in advance of stock grids. Road directional signs are provided at main intersections, which typically include a sight board, road names and distance and destination advice. Occasional guideposts were observed, typically in the vicinity of curves, local accesses or to highlight other localised hazards such as culverts. Use of guide posts is somewhat inconsistent, with some curves having no guide posts to provide alignment information to drivers particularly at night.

Overall, the alignment of the roads and the intersections is satisfactory, providing adequate sight distance for drivers to observe an obstruction on the road or a vehicle approaching in the opposite direction and adjust their travel path if needed, to observe an approaching intersection, and to observe potentially conflicting vehicles at intersections. Clear zones are generally maintained along the route, however some embankments on Marma Box Creek Road and Link Road appear somewhat steep, which may cause a vehicle which has left the road to overturn rather than allow the driver to be able to correct and steer back to the travel path.

As the observations were undertaken during fine weather and dry conditions, no wet weather conditions were observed, noting that wet weather closes the route to traffic.

4.2.3 Traffic Volumes

Traffic surveys undertaken on Balranald-Ivanhoe Road in May 2012 (GTA Consultants, 2012) indicate that at that time, Balranald-Ivanhoe Road carried an average of 35 vehicles per day south of the Orange Broken Hill Railway, and an average of 32 vehicles per day north of Hatfield-The Vale Road. Surveys of other local roads were not possible due to road surface conditions, however are expected to be lower than those recorded on Balranald-Ivanhoe Road.

RMS collects and publishes traffic volume data at selected locations on its roads. Available data on the proposed local roads route include Arumpo Road 30 m north of Mourquong Road at Mourquong (Station 98156) which carried 394 vehicles per day in 2006 (including 108 or 27 percent heavy vehicles) and 341 vehicles per day in 2010. Data have not been collected at those stations since 2010, so more recent changes in traffic cannot be identified from RMS data. It is noted that traffic volumes at the north-eastern end of Arumpo Road further away from Buronga are expected to be lower (Appendix A).

EMM (2015) examined the road transport implications of the Balranald Mineral Sands Project. EMM reports an estimated daily traffic volume on Arumpo Road at 20 to 30 vehicles per day on its eastern and western sections respectively, based on hourly counts conducted by EMM in October 2014. It is noted however that EMM refers to Marma Box Creek Road as Arumpo Road, hence this estimate actually applies to Marma Box Creek Road west and south of Link Road. EMM (2015) indicates that sections of Marma Box Creek Road will be used by construction traffic during construction of the Nepean mine, and part will also be used as part of the Nepean access road. These sections all lie to the south of the Nepean mine, and do not overlap with the local roads proposed to be used by the modified Project.

EMM (2015) examined the likely routes used by traffic generated during the construction and operational stages of the Balranald Mineral Sands Project, and found that traffic would approach and depart to and from the south, so would not use any of the local roads proposed to be used by Project traffic.

4.2.4 Road Safety History

Validated crash data was obtained from RMS covering the period from 1 January 2014 to 31 December 2018, noting that data for the latest nine months of that period is preliminary and subject to change. Crash data was reviewed on the following roads relevant to the use of the local road routes:

- Arumpo Road between Silver City Highway and Marma Box Creek Road;
- Marma Box Creek Road between Arumpo Road and Link Road;
- Link Road between Marma Box Creek Road and Boree Plains-Gol Gol Road; and
- Boree Plains-Gol Gol Road between Link Road and Balranald-Ivanhoe Road.

The data indicates that six crashes were reported over that period, all of which occurred on unsealed portions of Arumpo Road in the Wentworth Shire:

- Saturday 4 October 2014 at 3.30 pm in fine weather and dry unsealed road surface. An eastbound car in Arumpo Road travelling at 80 km/h lost control on a right-hand bend and left the carriageway to the right. One person suffered a minor/other injury and speed was nominated as a contributing factor. The crash occurred 260 m west of Petro Mail Road.
- Thursday 6 November 2014 at 4.00 pm in unknown weather conditions and dry road surface. The driver of a westbound light truck travelling at 40 km/h on Arumpo Road was distracted outside of the vehicle and struck a westbound B-double travelling at 30 km/h on a straight section of road. One person suffered minor/other injuries. The crash occurred 600 m east of Wamberra Road.

- Tuesday 9 December 2014 at 6.20 pm in fine weather and dry road unsealed road surface. A southbound car in Arumpo Road travelling at an unknown speed struck a southbound B-double travelling at 30 km/h in Arumpo Road. The crash occurred on a straight section of the road and one person suffered minor/other injuries. The crash occurred approximately 31 km north of Silver City Highway (approximately 12 km north-east of Wamberra Road) and the road was noted to have potholes/corrugations.
- Tuesday 21 June 2016 at 4.00 pm in fine weather and on a wet unsealed road surface. An eastbound light truck travelling at 100 km/h lost control on a straight section of road. Two people suffered minor/other injuries. The crash occurred approximately 60 km east of Silver City Highway (approximately 3 km east of Petro Mail Road).
- Monday 11 July 2016 at 6.00 pm (dusk) in fine weather and on a wet unsealed road surface. An eastbound four-wheel drive with an insecure or projecting load travelling at 70 km/h on Arumpo Road lost control on the carriageway on a bend where the road was flooded/submerged. Three people suffered minor/other injuries and speed was nominated as a contributing factor. The crash occurred 500 m east of Petro Mail Road.
- Monday 4 June 2018 at 1.00 pm in fine weather and on a dry unsealed road surface. An eastbound motorcycle travelling at 40 km/h in Arumpo Road lost control on a bend and left the carriageway. Speed was nominated as a contributing factor and one person suffered minor/other injuries. The crash occurred 50 m east of Wamberra Road.

Two of the six reported crashes occurred on a section of Arumpo Road which has now been sealed, i.e. Arumpo Road is now sealed for approximately 6 km to the north-east of Wamberra Road.

Speed was nominated as a contributing factor to three of the six reported crashes, noting that in all three crashes, the speed of the vehicle was below the 100 km/h speed limit. A vehicle is assessed as having been speeding based on certain criteria, including that the vehicle was performing a manoeuvre characteristic of excessive speed, such as skidding, sliding or losing control on a bend and that the driver was not distracted, drowsy or ill and was not swerving to avoid an animal or other vehicle, or failure of the vehicle occurred. Only one crash involved a vehicle travelling at the 100 km/h speed limit, and it occurred on a wet unsealed road surface.

The crash data for the route does not suggest an inherent safety concern regarding use of Arumpo Road by light vehicles.

5 Approved and Modified Project Traffic

The road transport aspects of the Project were examined by GTA Consultants (2012), which considered the volume and distribution of traffic generated by the Project during its peak construction phase, and in the longer term during its operational phase with the cumulative impacts of background traffic growth and operational activity associated with Iluka Resources Limited's Balranald Mineral Sands Project. This section summarises and updates those forecasts as relevant to the Modification. These forecasts do not consider the number of vehicle trips expected to be generated directly between the township of Ivanhoe and the Ivanhoe Rail Facility, as the number of trips is small and would not be impacted by the Modification.

5.1 Approved Project

5.1.1 Approved Project Trip Generation

Construction Employees

With the exception of up to ten employees working at the Ivanhoe Rail Facility, the construction workforce will be housed in the accommodation camp at the Atlas-Campaspe Mine. The construction employees will travel to and from the accommodation camp at the start and end of their roster periods, being five days on (weekdays) and two days off (weekends). The Modification would not change the number and residential distribution of the peak construction workforce, nor the rosters and shift arrangements that were examined by GTA Consultants (2012). Table 5.1 summarises the vehicle trips generated by the peak construction workforce travelling to and from the Atlas-Campaspe Mine site on Mondays, being the busiest day of the week for the movement of the construction workforce.

Table 5.1: Peak Construction Employee Vehicle Trips to/from Atlas-Campaspe Mine

Residential Location	AM Peak[A]	PM Peak[A]	Daily[B]
Mildura/Buronga	54	54	108
Broken Hill	27	27	54
Balranald	22	22	44
Ivanhoe	6	6	12
Total Trips	**109**	**109**	**218**

Source: GTA Consultants (2012)
[A] Vehicle trips per hour (AM Peak Monday and Saturday, PM Peak Monday and Friday)
[B] Vehicle trips per day (Monday)

Construction Visitors and Deliveries

GTA Consultants (2012) found that on a typical day during peak construction, five visitors would be expected to the Atlas-Campaspe Mine, generating 10 light vehicle trips per day. Visitors will be drawn from:

- Sydney and Melbourne 6 vehicle trips per day;
- Mildura 2 vehicle trips per day; and
- Broken Hill 2 vehicle trips per day.

GTA Consultants (2012) found that on a typical day during peak construction, five deliveries would be expected to the Atlas-Campaspe Mine, generating 10 heavy vehicle trips per day. Deliveries will be drawn from:

- Sydney and Melbourne 6 vehicle trips per day;
- Mildura 2 vehicle trips per day; and
- Broken Hill 2 vehicle trips per day.

Operational Employees

With the exception of up to three employees working at the Ivanhoe Rail Facility, the operational workforce will be housed in the accommodation camp at the Atlas-Campaspe Mine during their roster period. The operational employees would travel to and from the accommodation camp at the start and end of their roster periods, which vary for different types of employees. The GTA Consultants (2012) assessment examined the arrivals and departures of the operational employees based on the roster arrangements and found that a maximum of 83 percent of the operational workforce will start or end a roster on any one day, generating up to 136 vehicle trips per day. These busiest days are expected to occur on 10 to 11 days per year. The busiest peak hour was identified by GTA Consultants (2012) as occurring on half of the busiest days, when a morning peak of 92 vehicle trips and an evening peak of 44 vehicle trips would occur.

As a robust assessment consistent with GTA Consultants (2012), the two peaks are each assumed to occur within one hour. On this basis, Table 5.2 summarises the vehicle trips generated by the operational workforce travelling to and from the Atlas-Campaspe Mine site.

Table 5.2: Operational Employee Vehicle Trips to/from Atlas-Campaspe Mine

Residential Location	Average Day	Busiest Days of the Year		
		AM Peak[A]	PM Peak[A]	Daily[B]
Mildura/Buronga	14	36	18	54
Broken Hill	7	17	9	26
Balranald	11	28	14	42
Ivanhoe	4	9	5	14
Total Trips	**36**	**92**	**44**	**136**

Source: GTA Consultants (2012)
[A] Vehicle trips per hour on the busiest 5 to 6 days per year
[B] Vehicle trips per day on the busiest 10 to 11 days per day

Operational Visitors and Deliveries

GTA Consultants (2012) found that on a typical day, 10 visitors will be expected to the Atlas-Campaspe Mine, generating 20 light vehicle trips per day. Visitors will be drawn from:

- Melbourne 10 vehicle trips per day;
- Sydney 4 vehicle trips per day;
- Mildura 4 vehicle trips per day; and
- Broken Hill 2 vehicle trips per day.

GTA Consultants (2012) found that on a typical day, five deliveries will be expected to the Atlas-Campaspe Mine, generating 10 heavy vehicle trips per day. Deliveries will be drawn from:

- Sydney and Melbourne 6 vehicle trips per day;
- Mildura 2 vehicle trips per day; and
- Broken Hill 2 vehicle trips per day.

Mineral Concentrate Transport

Project-generated mineral concentrate will be hauled via road approximately 175 km from the Atlas-Campaspe Mine to the Ivanhoe Rail Facility, using a fleet of RMS approved vehicles via the road haulage route. Later in the project life, MSP process waste containers will be unloaded from trains at the Ivanhoe Rail Facility and backloaded to the Atlas-Campaspe Mine using the same fleet of vehicles which transport mineral concentrate from the Atlas-Campaspe Mine.

The number of loaded vehicles travelling from the Atlas-Campaspe Mine to the Ivanhoe Rail Facility is approved to a maximum of 24 per day. With the return of empty vehicles or waste containers, the approved Project would therefore generate a maximum of 48 vehicle trips per day on the approved road haulage route.

The haulage vehicles will operate 24 hours per day, so the trips would be spread throughout the day and night, generating an average of two vehicle trips per hour. To take account of hour-to-hour variations in production and transport rates, GTA Consultants (2012) assumed that mineral concentrate transport may generate up to five haulage vehicle trips per hour during peak hours.

The approved Project would generate a maximum of three trains per week travelling from the Ivanhoe Rail Facility to the MSP, generating up to six train movements per week (three arrivals and three departures).

5.1.2 Approved Project Total Traffic on Road Network

Table 5.3 summarises the distribution of the Project-generated traffic on the road network as approved, during the peak construction and operational stages.

Table 5.3: Approved Project Traffic on the Road Network

Road and Location[A]	Construction Stage			Operational Stage		
	AM Peak[B]	PM Peak[B]	Daily[C]	AM Peak[D]	PM Peak[D]	Daily[E]
1. Atlas-Campaspe Mine Access Road	114 (5)	114 (5)	228 (10)	101 (12)	55 (12)	156 (80)
2. Arumpo Road between Marma Box Creek Road and Silver City Highway	0 (0)	0 (0)	0 (0)	38 (0)	20 (0)	58 (0)
3. Balranald-Ivanhoe Road between Ivanhoe Rail Facility and Hatfield-The Vale Road	34 (1)	34 (1)	68 (2)	27 (8)	15 (8)	42 (72)
4. Balranald-Ivanhoe Road between Hatfield-The Vale Road and Boree Plains-Gol Gol Road	80 (4)	80 (4)	160 (8)	0 (4)	0 (4)	0 (8)
5. Balranald-Ivanhoe Road between Boree Plains-Gol Gol Road and Sturt Highway	80 (4)	80 (4)	160 (8)	35 (4)	21 (4)	56 (8)
6. Boree Plains-Gol Gol Road between Link Road and Magenta Road	114 (5)	114 (5)	228 (10)	62 (12)	36 (12)	98 (80)
7. Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road	0 (0)	0 (0)	0 (0)	35 (0)	21 (0)	56 (0)
8. Hatfield-The Vale Road between Magenta Road and Balranald-Ivanhoe Road	114 (5)	114 (5)	228 (10)	27 (12)	15 (12)	42 (80)
9. Link Road between Atlas-Campaspe Mine access and Marma Box Creek Road	0 (0)	0 (0)	0 (0)	38 (0)	20 (0)	58 (0)
10. Link Road between Atlas-Campaspe Mine access and Boree Plains-Gol Gol Road	114 (5)	114 (5)	228 (10)	62 (12)	36 (12)	98 (80)
11. Magenta Road between Boree Plains-Gol Gol Road and Hatfield-The Vale Road	114 (5)	114 (5)	228 (10)	27 (12)	15 (12)	42 (80)
12. Marma Box Creek Road between Link Road and Arumpo Road	0 (0)	0 (0)	0 (0)	38 (0)	20 (0)	58 (0)
13. Sturt Highway between Balranald and Mildura	55 (1)	55 (1)	110 (2)	0 (1)	0 (1)	0 (2)

Note: light vehicles (heavy vehicles)
[A] Refer to Figures 3.1 and 3.2
[B] Vehicle trips per hour (AM Peak Monday and Saturday, PM Peak Monday and Friday)
[C] Vehicle trips per day, Monday only
[D] Vehicle trips per hour, busiest 5 to 6 days of the year
[E] Vehicle trips per day, busiest 10 to 11 days of the year

5.1.3 Approved Project Ivanhoe Rail Facility Intersection

The intersection of the Ivanhoe Rail Facility access road and Balranald-Ivanhoe Road will be construction to the satisfaction of RMS and CDSC (Section 2.2). While a detailed design has not been prepared, the conceptual layout of the intersection includes a large radius left turn slip road for the loaded trucks entering the Ivanhoe Rail Facility from Balranald-Ivanhoe Road. Right turns into and out of the Ivanhoe Rail Facility and left turn out of the Ivanhoe Rail Facility would occur at a standard T-intersection, at which the access road would meet Balranald-Ivanhoe Road at 90 degrees, and standard intersection priority rules would apply.

The operational Project-generated vehicle turning movements at the intersection with the approved Project will include:

- loaded haulage vehicles would turn left from Balranald-Ivanhoe Road via the slip lane into the access road (24 trips per day, up to three trips per hour);
- empty (or backloaded MSP process waste) haulage vehicles will turn right from the access road to Balranald-Ivanhoe Road (24 trips per day, up to three trips per hour);
- employees, visitors and deliveries travelling between the Atlas-Campaspe Mine and Ivanhoe or Broken Hill will travel northbound or southbound along Balranald-Ivanhoe Road past the access road (up to 44 trips per day, up to 28 trips per hour);
- Ivanhoe Rail Facility employees will turn right from Balranald-Ivanhoe Road into the access road at the start of their shift (three trips per day, up to three trips per hour); and
- Ivanhoe Rail Facility employees will turn left from the access road on to Balranald-Ivanhoe Road at the end of their shift (three trips per day, up to three trips per hour).

5.2 Modified Project

5.2.1 Modified Project Trip Generation

Construction Employees

The Modification would not change the number and residential distribution of the peak construction workforce, nor the rosters and shift arrangements that were examined by GTA Consultants (2012). The peak construction workforce for the modified Project would therefore generate the same number of vehicle trips as described in Section 5.1.

Construction Visitors and Deliveries

The Modification would not change the number of vehicle trips made by visitors and deliveries to the Project during peak construction from that described in Section 5.1.

Operational Employees

The Modification would not change the number and residential distribution of the operational workforce, nor the rosters and shift arrangements that were examined by GTA Consultants (2012). The operational workforce for the modified Project would therefore generate the same number of vehicle trips as described in Section 5.1.

It is understood that Tronox is currently reviewing the feasibility of operating shuttle buses between the Atlas-Campaspe Mine and Buronga/Mildura or Balranald for Project workers. If a Project worker shuttle bus was to operate it would reduce the number of vehicle trips described in Section 5.1.

Operational Visitors and Deliveries

The Modification would not change the number and distribution of vehicle trips made by visitors and deliveries to the Project.

Mineral Concentrate Transport

With the proposed increase in production with the Modification, the number of haulage vehicle departures from the Atlas-Campaspe Mine would increase. From approximately Year 12 of the Project, MSP process waste containers would be unloaded from trains at the Ivanhoe Rail Facility and backloaded to the Atlas-Campaspe Mine using the same fleet of vehicles which transport mineral concentrate from the Mine. The Modification would not change this backloading arrangement, which will not impact the number of haulage truck trips on the haulage route.

With the Modification, the number of loaded vehicles travelling from the Atlas-Campaspe Mine to the Ivanhoe Rail Facility would increase from 24 to 35 per day. With the return of empty vehicles or waste containers, the Modification would therefore increase the maximum haulage vehicle trips on the haulage route from 48 vehicle trips per day to 70 vehicle trips per day.

The haulage vehicles will operate 24 hours per day, so the trips would be spread throughout the day and night. The Modification would increase the average number of haulage vehicle trips per hour from two to three trips per hour. It has been assumed for this assessment that to take account of hour-to-hour variations in production and transport rates, mineral concentrate transport may generate up to seven haulage vehicle trips per hour during peak hours.

With the Modification, the number of trains travelling from the Ivanhoe Rail Facility to the MSP would increase, from a maximum of three to four per week, generating up to eight train movements per week (four arrivals and four departures).

5.2.2 Modified Project Total Traffic on Road Network

The Modification would not change the number of vehicle trips generated during the construction phase of the Project, nor would it change the origin/destination of the generated trips. The Modification would however permit the use of alternative local roads by construction employees and visitors in light vehicles, impacting the routes used to and from:

- Mildura/Buronga – employees and visitors may use the proposed route via Link Road, Marma Box Creek Road and Arumpo Road instead of via Link Road, Magenta Road, Hatfield-The Vale Road, Balranald-Ivanhoe Road and Sturt Highway; and
- Balranald, Sydney and Melbourne – employees and visitors may use the route via Boree Plains-Gol Gol Road to Balranald-Ivanhoe Road instead of via Magenta Road, Hatfield-The Vale Road and south along Balranald-Ivanhoe Road.

Similarly, the Modification would not change the number of vehicle trips generated by employees, visitors and deliveries during the operational phase of the Project, nor would it change the origin/destination of those trips. The Modification would however permit the use of alternative local roads by operational employees and visitors in light vehicles, impacting the routes used to and from:

- Mildura/Buronga – employees and visitors may use the proposed route via Link Road, Marma Box Creek Road and Arumpo Road instead of via Link Road, Magenta Road, Hatfield-The Vale Road, Balranald-Ivanhoe Road and Sturt Highway; and
- Balranald, Sydney and Melbourne – employees and visitors may use the route via Boree Plains-Gol Gol Road to Balranald-Ivanhoe Road instead of via Magenta Road, Hatfield-The Vale Road and south along Balranald-Ivanhoe Road.

With the proposed increase in production, an increase in the number of trips generated between the Atlas-Campaspe Mine and the Ivanhoe Rail Facility would occur, which would continue to use the approved road transport route.

Table 5.4 summarises the distribution of the Project-generated traffic on the road network as modified, during the peak construction and operational stages.

If Tronox was to operate a Project worker shuttle bus between the Atlas-Campaspe Mine and Buronga/Mildura or Balranald, the number of light vehicle trips on Link Road, Marma Box Creek Roads, Arumpo Road and Boree Plains-Gol Gol Road shown in Table 5.4 would reduce.

Table 5.4: Modified Project Traffic on the Road Network

Road and Location[A]	Construction Stage			Operational Stage		
	AM Peak[B]	PM Peak[B]	Daily[C]	AM Peak[D]	PM Peak[D]	Daily[E]
1. Atlas-Campaspe Mine Access Road	114 (5)	114 (5)	228 (10)	101 (12)	55 (12)	156 (80)
2. Arumpo Road between Marma Box Creek Road and Silver City Highway	55 (0)	55 (0)	110 (0)	38 (0)	20 (0)	58 (0)
3. Balranald-Ivanhoe Road between Ivanhoe Rail Facility and Hatfield-The Vale Road	34 (1)	34 (1)	68 (2)	27 (8)	15 (8)	42 (72)
4. Balranald-Ivanhoe Road between Hatfield-The Vale Road and Boree Plains-Gol Gol Road	0 (4)	0 (4)	0 (8)	0 (4)	0 (4)	0 (8)
5. Balranald-Ivanhoe Road between Boree Plains-Gol Gol Road and Sturt Highway	25 (4)	25 (4)	50 (8)	35 (4)	21 (4)	56 (8)
6. Boree Plains-Gol Gol Road between Link Road and Magenta Road	59 (5)	59 (5)	118 (10)	62 (12)	36 (12)	98 (80)
7. Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road	25 (0)	25 (0)	50 (0)	35 (0)	21 (0)	56 (0)
8. Hatfield-The Vale Road between Magenta Road and Balranald-Ivanhoe Road	34 (5)	34 (5)	68 (10)	27 (12)	15 (12)	42 (80)
9. Link Road between Atlas-Campaspe Mine access and Marma Box Creek Road	55 (0)	55 (0)	110 (0)	38 (0)	20 (0)	58 (0)
10. Link Road between Atlas-Campaspe Mine access and Boree Plains-Gol Gol Road	59 (5)	59 (5)	118 (10)	62 (12)	36 (12)	98 (80)
11. Magenta Road between Boree Plains-Gol Gol Road and Hatfield-The Vale Road	34 (5)	34 (5)	68 (10)	27 (12)	15 (12)	42 (80)
12. Marma Box Creek Road between Link Road and Arumpo Road	55 (0)	55 (0)	110 (0)	38 (0)	20 (0)	58 (0)
13. Sturt Highway between Balranald and Mildura	0 (1)	0 (1)	0 (2)	0 (1)	0 (1)	0 (2)

Note: light vehicles (heavy vehicles)
[A] Refer to Figures 3.1 and 3.2
[B] Vehicle trips per hour (AM Peak Monday and Saturday, PM Peak Monday and Friday)
[C] Vehicle trips per day, Monday only
[D] Vehicle trips per hour, busiest 5 to 6 days of the year
[E] Vehicle trips per day, busiest 10 to 11 days of the year

5.2.3 Modified Project Ivanhoe Rail Facility Intersection

The Modification includes a revised alignment of the intersection between the Ivanhoe Rail Facility access road and Ivanhoe-Balranald Road (Figure 2.2). A preliminary design for the modified intersection has been prepared, which is presented in Figure 3.3.

The operational Project-generated vehicle turning movements at the intersection with the Modification would include:

- loaded haulage vehicles would turn left from Balranald-Ivanhoe Road into the access road (35 trips per day, up to four trips per hour);
- empty (or backloaded MSP process waste) haulage vehicles would turn right from the access road to Balranald-Ivanhoe Road (35 trips per day, up to four trips per hour);
- employees, visitors and deliveries travelling between the Atlas-Campaspe Mine and Ivanhoe or Broken Hill would travel northbound or southbound along Balranald-Ivanhoe Road past the access road (up to 44 trips per day, up to 28 trips per hour);
- Ivanhoe Rail Facility employees would turn right from Balranald-Ivanhoe Road into the access road at the start of their shift (three trips per day, up to three trips per hour);
- Ivanhoe Rail Facility employees would turn left from the access road on to Balranald-Ivanhoe Road at the end of their shift (three trips per day, up to three trips per hour).

6 Impacts of the Modification

6.1 Project Traffic on the Road Network

Table 6.1 compares the distribution of Project-generated construction traffic on the road network with the approved Project and with the Modification.

Table 6.1: Approved and Modified Project Construction Traffic on the Road Network

Road and Location[A]	Approved Project			Modified Project		
	AM Peak[B]	PM Peak[B]	Daily[C]	AM Peak[B]	PM Peak[B]	Daily[C]
1. Atlas-Campaspe Mine Access Road	114 (5)	114 (5)	228 (10)	114 (5)	114 (5)	228 (10)
2. Arumpo Road between Marma Box Creek Road and Silver City Highway	0 (0)	0 (0)	0 (0)	55 (0)	55 (0)	110 (0)
3. Balranald-Ivanhoe Road between Ivanhoe Rail Facility and Hatfield-The Vale Road	34 (1)	34 (1)	68 (2)	34 (1)	34 (1)	68 (2)
4. Balranald-Ivanhoe Road between Hatfield-The Vale Road and Boree Plains-Gol Gol Road	80 (4)	80 (4)	160 (8)	0 (4)	0 (4)	0 (8)
5. Balranald-Ivanhoe Road between Boree Plains-Gol Gol Road and Sturt Highway	80 (4)	80 (4)	160 (8)	25 (4)	25 (4)	50 (8)
6. Boree Plains-Gol Gol Road between Link Road and Magenta Road	114 (5)	114 (5)	228 (10)	59 (5)	59 (5)	118 (10)
7. Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road	0 (0)	0 (0)	0 (0)	25 (0)	25 (0)	50 (0)
8. Hatfield-The Vale Road between Magenta Road and Balranald-Ivanhoe Road	114 (5)	114 (5)	228 (10)	34 (5)	34 (5)	68 (10)
9. Link Road between Atlas-Campaspe Mine access and Marma Box Creek Road	0 (0)	0 (0)	0 (0)	55 (0)	55 (0)	110 (0)
10. Link Road between Atlas-Campaspe Mine access and Boree Plains-Gol Gol Road	114 (5)	114 (5)	228 (10)	59 (5)	59 (5)	118 (10)
11. Magenta Road between Boree Plains-Gol Gol Road and Hatfield-The Vale Road	114 (5)	114 (5)	228 (10)	34 (5)	34 (5)	68 (10)
12. Marma Box Creek Road between Link Road and Arumpo Road	0 (0)	0 (0)	0 (0)	55 (0)	55 (0)	110 (0)
13. Sturt Highway between Balranald and Mildura	55 (1)	55 (1)	110 (2)	0 (1)	0 (1)	0 (2)

Note: light vehicles (heavy vehicles)
[A] Refer to Figures 3.1 and 3.2
[B] Vehicle trips per hour (AM Peak Monday and Saturday, PM Peak Monday and Friday)
[C] Vehicle trips per day, Monday only

Table 6.2 compares the distribution of Project-generated operational traffic on the road network with the approved Project and with the Modification.

Table 6.2: Approved and Modified Project Operational Traffic on the Road Network

Road and Location[A]	Approved Project			Modified Project		
	AM Peak[B]	PM Peak[B]	Daily[C]	AM Peak[B]	PM Peak[B]	Daily[C]
1. Atlas-Campaspe Mine Access Road	101 (10)	55 (10)	156 (58)	101 (12)	55 (12)	156 (80)
2. Arumpo Road between Marma Box Creek Road and Silver City Highway	0 (0)	0 (0)	0 (0)	38 (0)	20 (0)	58 (0)
3. Balranald-Ivanhoe Road between Ivanhoe Rail Facility and Hatfield-The Vale Road	27 (6)	15 (6)	42 (50)	27 (8)	15 (8)	42 (72)
4. Balranald-Ivanhoe Road between Hatfield-The Vale Road and Boree Plains-Gol Gol Road	73 (4)	41 (4)	114 (8)	0 (4)	0 (4)	0 (8)
5. Balranald-Ivanhoe Road between Boree Plains-Gol Gol Road and Sturt Highway	73 (4)	41 (4)	114 (8)	35 (4)	21 (4)	56 (8)
6. Boree Plains-Gol Gol Road between Link Road and Magenta Road	101 (10)	55 (10)	156 (58)	62 (12)	36 (12)	98 (80)
7. Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road	0 (0)	0 (0)	0 (0)	35 (0)	21 (0)	56 (0)
8. Hatfield-The Vale Road between Magenta Road and Balranald-Ivanhoe Road	101 (10)	55 (10)	156 (58)	27 (12)	15 (12)	42 (80)
9. Link Road between Atlas-Campaspe Mine access and Marma Box Creek Road	0 (0)	0 (0)	0 (0)	38 (0)	20 (0)	58 (0)
10. Link Road between Atlas-Campaspe Mine access and Boree Plains-Gol Gol Road	101 (10)	55 (10)	156 (58)	62 (12)	36 (12)	98 (80)
11. Magenta Road between Boree Plains-Gol Gol Road and Hatfield-The Vale Road	101 (10)	55 (10)	156 (58)	27 (12)	15 (12)	42 (80)
12. Marma Box Creek Road between Link Road and Arumpo Road	0 (0)	0 (0)	0 (0)	38 (0)	20 (0)	58 (0)
13. Sturt Highway between Balranald and Mildura	38 (1)	20 (1)	58 (2)	0 (1)	0 (1)	0 (2)

Note: light vehicles (heavy vehicles)
[A] Refer to Figures 3.1 and 3.2
[B] Vehicle trips per hour (AM Peak Monday and Saturday, PM Peak Monday and Friday)
[C] Vehicle trips per day, Monday only

Table 6.1 and Table 6.2 indicate that the Modification would result in the following changes to daily traffic generated by the Project compared with that of the approved Project:

Busiest Days During Peak Construction Stage

- decrease of 160 light vehicle trips per day on that part of the road haulage route along Magenta Road, Hatfield-The Vale Road and Balranald-Ivanhoe Road between Hatfield-The Vale Road and Boree Plains-Gol Gol Road;
- decrease of 110 light vehicle trips per day on that part of the road haulage route along Link Road and Boree Plains-Gol Gol Road between the Atlas-Campaspe Mine access and the intersection of Boree Plains-Gol Gol Road with Magenta Road;
- decrease of 110 light vehicle trips per day along Balranald-Ivanhoe Road south of Boree Plains-Gol Gol Road and along Sturt Highway between Balranald and Mildura;
- increase of 110 light vehicle trips per day along the proposed local road route to Mildura via Link Road, Marma Box Creek Road and Arumpo Road; and
- increase of 50 light vehicle trips per day along Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road.

Busiest Days During Operational Stage

- decrease of 58 light vehicle trips per day on that part of the road haulage route along Link Road and Boree Plains-Gol Gol Road between the Atlas-Campaspe Mine access and the intersection of Boree Plains-Gol Gol Road with Magenta Road;
- decrease of 114 light vehicle trips per day on that part of the road haulage route along Magenta Road, Hatfield-The Vale Road and Balranald-Ivanhoe Road between Hatfield-The Vale Road and Boree Plains-Gol Gol Road;
- increase of 22 heavy vehicle trips per day on the road haulage route between the Atlas-Campaspe Mine access and the Ivanhoe Rail Facility access (Link Road, Boree Plains-Gol Gol Road, Magenta Road, Hatfield-The Vale Road and Balranald-Ivanhoe Road);
- decrease of 58 light vehicle trips per day along Balranald-Ivanhoe Road south of Boree Plains-Gol Gol Road and along Sturt Highway between Balranald and Mildura;
- increase of 58 light vehicle trips per day along the proposed local road route to Mildura via Link Road, Marma Box Creek Road and Arumpo Road; and
- increase of 56 light vehicle trips per day along Boree Plains-Gol Gol Road between Magenta Road and Balranald-Ivanhoe Road.

6.2 Future Traffic Volumes

6.2.1 Local Roads Routes

Based on the surveyed traffic volumes in 2012 (GTA Consultants, 2012), the local roads along the local roads route to and from the west via Arumpo Road, Marma Creek Box Creek Road and Link Road are expected to carry fewer than 35 vehicles per day. Similarly, Boree Plains-Gol Gol Road to Balranald-Ivanhoe Road is expected to carry fewer than 35 vehicles per day.

During peak construction, the modified Project would generate 110 vehicles per day on Mondays, along the local roads route to and from the west via Arumpo Road, Marma Creek Box Creek Road and Link Road. On Fridays and Saturdays, this would reduce to 56 and 54 vehicle trips per day respectively. On the remaining days, the modified Project would generate negligible traffic on this route.

Once operational, on the busiest 10 to 11 days of the year, the modified Project would generate some 58 vehicles per day on the local roads route to and from the west via Arumpo Road, Marma Creek Box Creek Road and Link Road. On an average day, this would reduce to fewer than 20 vehicles per day.

If Tronox was to operate a Project worker shuttle bus between the Atlas-Campaspe Mine and Buronga/Mildura or Balranald, the number of light vehicle trips on Link Road, Marma Box Creek Roads, Arumpo Road and Boree Plains-Gol Gol Road would reduce.

6.2.2 Road Haulage Route

The Modification would increase mineral concentrate transport from 48 to 70 heavy vehicles per day (two way) on the approved haulage route between the Atlas-Campaspe Mine and the Ivanhoe Rail Facility.

The surveyed traffic volume on Balranald-Ivanhoe Road south of Orange Broken Hill Railway in 2012 was an average of 35 vehicles per day (GTA Consultants, 2012), with background growth assessed at a rate of one percent per annum. EMM (2015) forecasts that the Balranald Mineral Sands Project will not generate any traffic on Balranald-Ivanhoe Road north of its intersection with Marma Box Creek Road.

Allowing for ten years of growth in background traffic, future traffic volumes on Ivanhoe-Balranald Road on the approved road transport route would remain well below 160 vehicles per day and fewer than 50 vehicles per hour in any one hour. The increased maximum haulage proposed with the Modification would have negligible impact on the future traffic volumes on the road transport route, representing an average increase of one vehicle trip per hour compared with the approved Project. This is well within the day-to-day variation in traffic volumes and would not have a perceivable impact on the level of service experienced by drivers along the route.

6.3 Impact on Travel Distances

The proposed alternative local road routes would reduce the travel distance for trips between the Atlas-Campaspe Mine and Mildura/Buronga or Balranald.

The proposed local roads route to the west of the Atlas-Campaspe Mine would reduce the road distance between the Atlas-Campaspe Mine and Mildura/Buronga by approximately 150 km, compared with using with approved route via Magenta Road, Hatfield-The Vale Road and Balranald. Over 12 months of operations of the Project, this represents a saving of over 1.7 million vehicle kilometres travelled (VKT) associated with the movement of employees and visitors between the Atlas-Campaspe Mine and Mildura/Buronga.

The proposed local roads route to the south via Boree Plains-Gol Gol Road would reduce the road distance between the Atlas-Campaspe Mine and Balranald by approximately 32 km, compared with using with approved route via Magenta Road, and Hatfield-The Vale Road. Over 12 months of operations of the Project, this represents a saving of over 400,000 VKT associated with the movement of employees and visitors between the Atlas-Campaspe Mine and Balranald, Sydney and Melbourne.

6.4 Ivanhoe Rail Facility Intersection

A preliminary design for the modified intersection has been prepared (Figure 3.3), the general layout of which has been reviewed by TTPP with regard to intersection operation and Austroads warrants for intersection treatments, discussed in this section.

6.4.1 Intersection Traffic Volumes

The operational Project-generated vehicle turning movements at the intersection with the Modification are described in Section 0 for the approved Project and in Section 5.2.3 for the modified Project. The impact of the Modification on those turning movements is negligible, being:

- an increase of 11 trips per day and one trip per hour by loaded haulage vehicles turning left from Balranald-Ivanhoe Road into the access road; and
- an increase of 11 trips per day and one trip per hour by empty (or backloaded MSP process waste) haulage vehicles turning right from the access road to Balranald-Ivanhoe Road.

The surveyed traffic volume on Balranald-Ivanhoe Road south of Orange Broken Hill Railway in 2012 was an average of 35 vehicles per day (GTA Consultants, 2012), with background growth assessed at a rate of one percent per annum. EMM (2015) forecasts that the Balranald Mineral Sands Project will not generate any traffic on Balranald-Ivanhoe Road past the Ivanhoe Rail Facility access.

6.4.2 Intersection Capacity

At unsignalised intersections with minor roads, where there are relatively low volumes of through and turning vehicles, capacity considerations are usually not significant, and detailed analysis of capacity is not warranted. Austroads (2009) indicates that as a guide, at volumes below the following combinations of maximum design hour volumes at a cross intersection with a two lane two-way road, capacity analysis is not necessary:

- major road 400 vehicles per hour, minor road 250 vehicles per hour;
- major road 500 vehicles per hour, minor road 200 vehicles per hour; and
- major road 650 vehicles per hour, minor road 100 vehicles per hour.

The proposed intersection of the Ivanhoe Rail Facility access road with Balranald-Ivanhoe Road is a T-intersection with fewer potentially conflicting movements than a cross intersection. The forecast peak period vehicle movements at the intersection are well below the threshold volumes, and as such, there is no capacity concerns anticipated at the intersection that would suggest additional capacity would be needed. The average delay to turning vehicles would be low, and the Level of Service experienced by drivers would be good. Formal analysis of the operation of the intersection is not warranted.

6.4.3 Intersection Treatment Warrants

Austroads (2017) sets out warrants for major road turn treatments for basic, auxiliary lane and channelised treatments at rural intersections. The warrants focus on safety performance, while operational performance may require a higher level treatment, although such is not required at the intersection of Balranald-Ivanhoe Road with the Ivanhoe Rail Facility access road (Section 6.4.2).

The peak hour number of vehicles turning from Balranald-Ivanhoe Road into the Ivanhoe Rail Facility with the modified Project would be up to four vehicles turning left in and up to three vehicles turning right in. For these turning volumes, and considering the volumes travelling past on Balranald-Ivanhoe Road, Austroads (2017) indicates that basic left (BAL) and basic right (BAR) turn treatments are warranted in Balranald-Ivanhoe Road at the Ivanhoe Rail Facility access intersection. This is the general minimum preferred treatment at rural road intersections.

The proposed intersection layout includes a rural BAL treatment on Balranald-Ivanhoe Road, with a widened shoulder which assists vehicles turning left to move further off the through carriageway, making it easier for through vehicles to pass a vehicle turning left into the Ivanhoe Rail Facility access road.

The proposed intersection layout includes a rural BAR treatment on Balranald-Ivanhoe Road, with a widened shoulder on Balranald-Ivanhoe Road that allows through vehicles, having slowed, to pass to the left of vehicles which are turning right into the Ivanhoe Rail Facility access road.

Although not addressed by the Austroads (2017) warrants, the BAL treatment on a minor road allows turning movements to occur from a single lane, with a shoulder that is too narrow to be used by left-turning vehicles, so as to prevent vehicles from standing two abreast at the holding line. These design features are preferred to safely manage the movement of vehicles in the high-speed rural environment. The proposed intersection layout includes such a BAL treatment on the Ivanhoe Rail Facility access road.

The proposed design for the intersection is consistent with the treatments warranted by Austroads (2017) and would be constructed with consideration of the swept path of the vehicles to be used for hauling mineral concentrates (Type 1 A-double road trains) and in accordance with Austroads design requirements. The design proposes all linemarking and signage be installed in accordance with AS 1742.2 (2009) and RMS guidelines.

6.5 Recommended Road Improvements

6.5.1 Local Roads Route

Desirable Geometric Road Standards

With the existing traffic volumes and traffic forecast to be generated by the Modification (Section 6.2.1) and its connectivity within the road network, the proposed unsealed roads on the route between Arumpo Road and the Atlas-Campaspe Mine are considered to be Class 4B (minor) roads under ARRB's (2009) classification system for unsealed roads. Class 4B roads are used for connections between local centres of population (in this case, the Atlas-Campaspe Mine) and the primary road network (Arumpo Road). Such roads may or may not be sealed depending on the importance and function of the road, taking into account the economic viability of sealing. They typically carry in the range of 50 to 150 vehicles per day (average daily traffic), and are all-weather two-lane roads formed and gravelled, or single-lane sealed roads with gravel shoulders.

The desirable standard and geometric characteristics for the unsealed local roads along the proposed route based on safety, costs and environmental considerations and in flat terrain (ARRB, 2009) are:

- operating speed 70 kilometres per hour (km/h);
- minimum carriageway width (lanes and shoulders) 7.0 m;
- minimum formation width (carriageway and verges) 9.0 m;
- minimum horizontal radius curve 250 m;
- minimum stopping sight distance 120 m;
- minimum vertical grade 6 per cent;
- minimum crossfall 5 per cent; and
- maximum superelevation 6 per cent.

It is understood that the BSC indicated that it adopts an operating speed of 90 km/h and a minimum horizontal radius curve of 500 m for its local road designs.

Comparing the desirable geometric road standards with the observed conditions (Section 4.2.2), it is evident that much of the route is likely to meet the desirable geometric standard for minimum carriageway width and formation width, and that the generally straight alignment and level terrain provides the required curve geometry and sight distances. Vertical grades, crossfalls and superelevations were not quantified by the observations.

The width of Link Road between Marma Box Creek Road and the Atlas-Campaspe Mine is narrower than the minimum carriageway and formation width requirements for a Class 4B unsealed road.

Road Surface Conditions

The observations of the existing condition of the proposed local roads route (Section 4.2.2) indicate that the condition of the road surface varies along the route, with notable issues being rutting, corrugations, loose material and some steep embankments. It is recommended that the road surface be improved as part of maintenance activities to establish a good riding surface with reduced dust emissions, and monitor and maintain the surface.

At the intersection of Balranald-Ivanhoe Road with Boree Plains-Gol Gol Road, it is recommended that the surface of Boree Plains-Gol Gol Road be sealed on its approach to the intersection, to reduce the likelihood of dust or gravel being transferred onto the high-speed carriageway of Balranald-Ivanhoe Road which can create a hazard for those vehicles.

Recommended Traffic Controls

It is recommended that additional guide posts with reflective markers be provided along the proposed local roads route in accordance with Australian Standard 1742.2 (2009) to enhance delineation of the path to be travelled in both daylight and night-time conditions. At minimum, installation of guide posts should be used in a consistent manner to mark locations where additional instruction about the road alignment is required (typically locations of culverts, tight curves, and across causeways). They should be installed at a uniform distance from the edge of the road formation, with a minimum clearance of 7.0 m between opposite guide posts.

The general alignment of the unsealed component of the local road route is straight, with few curves, noting that Boree Plains-Gol Gol Road has more curves than the other parts of the route. If required, curve warning signs are recommended on all approaches to any high risk sites. Any substandard curves should be delineated with curve alignment markers (CAMs) (D4-6) in accordance with AS1742.2 (2009).

Individual potential hazards may be signposted as appropriate, e.g., curve warning signs, crest warning signs, side road junction signs, and stock grid warning signs, noting that advisory speed signs should not be used along the unsealed roads.

At all stock grids, width marker signs (W4-3) should be located in accordance with AS1742.2, with the inner edges on the line of the vertical obstruction, indicating the width of the travel lane. GRID signs (W5-16) should also be used to warn of each stock grid on the road, and additional signage used in accordance with AS1742.2 if the grid is less than 5.0 m wide.

Give way control signage may not be required at the intersections between unsealed roads in remote areas, and it is generally considered that the priority at intersections along the route is clear from the road layouts. Sight boards should be installed to face the stem of a T-intersection where standard intersection signage would not provide adequate warning of the intersection. If the approach speed on the terminating leg is low, a bidirectional hazard marker (D4-2-3) may be used, otherwise two unidirectional hazard markers (D4-1-1) placed end to end should be used. Sight boards are provided at most intersections along the route, although not all are compliant with the requirements of AS1742.2.

6.5.2 Road Haulage Route

It is recommended that the road upgrade works required by Development Consent SSD_5012 (Section 2.2) be conducted along the road haulage route for the modified Project. These road upgrade works would be suitable for the modified Project traffic generation.

6.6 Road Haulage Road Maintenance

It is recommended that the existing contributions to the maintenance of the road haulage route required by Development Consent SSD_5012 (Section 2.2) be adopted for the modified Project. These road maintenance contributions will increase with the proposed increase in movement of mineral concentrate proposed as part of the Modification.

6.7 Road Safety Implications

With the implementation of the improvements along the local road routes described in Section 6.5, the Modification can be expected to have positive impacts on the safety of the road network and road users (including Project workers) compared with the approved Project, due to:

- reduced VKT by Project-generated light vehicles, reducing exposure to crash risks;
- reduced travel times for the Atlas-Campaspe Mine workforce residing in Mildura/Buronga and Balranald, reducing the risk of drivers either driving or working while fatigued; and
- improved road condition along local road routes for all road users with the recommended surface upgrades, maintenance and traffic controls.

Access to the Mungo National Park is available via Arumpo Road. As described above, the Modification is expected to have positive impacts on the safety of all road users on the road network (including Arumpo Road users) as it would include proposed road improvements (e.g. road surface improvements).

6.8 School Buses

It is anticipated that the TMP would address haulage management measures in the event that the road haulage route is used by school buses during the life of the Project. Such management measures may include some of the following:

- restricting haulage activity to outside the times and/or locations that school buses use the route;
- reducing haulage truck speeds during the hours and locations that the school buses use the route; and
- reducing haulage truck speeds while near to or passing a school bus.

The specific management measures would be most appropriately developed in consultation with school bus operators.

6.9 Railway Level Crossing

GTA (2012) considered the risk of the road and rail traffic interaction associated with the Project at the railway level crossing south of Ivanhoe and concluded:

> *As the total volume of road traffic through the road level crossing south of Ivanhoe would be relatively low and the Project would not generate additional rail traffic movements at this road level crossing, it is considered that the incremental risk of road and rail traffic interaction associated with the Project at this road level crossing would be low. No upgrades to the road level crossing are therefore required.*

As the Modification would not change Project-generated road or rail movements at the road level crossing south of Ivanhoe, it is considered that there would be no change to the risk of road and rail traffic interaction associated with the Project at this road level crossing and no upgrades to the road level crossing are therefore required.

6.10 Transport Management Plan

Tronox has prepared a TMP for the construction phase of the Project in accordance with Condition 9, Schedule 3 of Development Consent SSD_5012 (Section 0). It is recommended that the TMP be updated to incorporate the modified Project.

7 Conclusions

This study has examined the road transport implications of the proposed Modification. The study concludes that:

- subject to the implementation of the recommended road improvements, the proposed local roads routes would satisfactorily accommodate the Project-generated traffic;
- the Modification would reduce VKT associated with Project traffic, and have safety benefits for Project and other road users;
- the existing road haulage route road upgrades required by Development Consent SSD_5012 should be implemented for the modified Project;
- contributions to the road haulage route maintenance required by Development Consent SSD_5012 should be adopted for the modified Project;
- the following improvements to the local road routes should be implemented as part of ongoing road maintenance activities:
  - Link Road between Marma Box Creek Road and the Atlas-Campaspe Mine should be upgraded to meet the minimum carriageway and formation width requirements for a Class 4B unsealed road;
  - the road surface of relevant sections of the local road routes should be improved to establish a good riding surface with reduced dust emissions;
  - the surface of Boree Plains-Gol Gol Road should be sealed on its approach to its intersection with Balranald-Ivanhoe Road;
  - appropriate traffic control signs should be installed along the local road routes;
- the modified intersection of Balranald-Ivanhoe Road with the Ivanhoe Rail Facility access road is consistent with Austroads requirements for the expected traffic demands, and all linemarking and signage be installed in accordance with AS 1742.2 (2009) and RMS guidelines.
- the Project Transport Management Plan (CMA, 2018) should be updated to incorporate the modified Project.

Appendix A

Road Crash Data

Detailed Crash Report

Transport for NSW — Centre for Road Safety

Crash No.	Data Source	Date	Day of Week	Time	Distance		ID Feature	Loc Type	Alignment	Weather	Surface Condition	Speed Limit	No. of Tus	Tu Type/Obj	Age/Sex	Street Travelling	Speed Travelling	Manoeuvre	Degree of Crash-Detailed	Killed	Seriously Inj.	Moderately Inj.	Minor/Other Inj.	Uncateg'd Inj.	Factors S F
South West Region																									
Balranald LGA																									
Mungo																									
Turlee Leaghur Rd																									
1067212	P	14/04/2015	Tue	14:00	1.6 km	N	MARMA BOX CREEK RD	2WY	CRV	Fine	Dry	100	1	VAN	F54	N in TURLEE LEAGHUR RD	60	Proceeding in lane	SC	0	1	0	0	0	S
E57194937								RUM	86	Off left/left bend															
Wentworth LGA																									
Arumpo																									
Arumpo Rd																									
1108332	P	11/07/2016	Mon	18:00	500 m	E	PETRO MAIL RD	2WY	CRV	Fine	Wet	100	1	4WD	M43	E in ARUMPO RD	70	Proceeding in lane	OC	0	0	0	3	0	S
E61571004								RUM	88	Out of cont on bend															
1045763	P	04/10/2014	Sat	15:30	260 m	W	PETRO MAIL RD	2WY	CRV	Fine	Dry	100	1	CAR	M29	E in ARUMPO RD	80	Proceeding in lane	OC	0	0	0	1	0	S
E55898072								RUM	82	Off right/right bend															
1106536	P	21/06/2016	Tue	16:00	60 km	E	SILVER CITY HWY	2WY	STR	Fine	Wet	100	1	TRK	M63	E in ARUMPO RD	100	Proceeding in lane	OC	0	0	0	2	0	
E61706638								RUM	74	On road-out of cont.															
1071320	P	09/12/2014	Tue	18:20	31 km	N	SILVER CITY HWY	2WY	STR	Fine	Dry	100	2	CAR	M22	S in ARUMPO RD	Unk	Proceeding in lane	OC	0	0	0	1	0	
E57138267								RUM	30	Rear end				BDBL	M U	S in ARUMPO RD	30	Proceeding in lane							
Wentworth																									
Arumpo Rd																									
1185986	P	04/06/2018	Mon	13:00	50 m	E	WAMBERRA RD	2WY	CRV	Fine	Dry	100	1	M/C	M33	E in ARUMPO RD	40	Proceeding in lane	OC	0	0	0	1	0	S
E68781070								RUM	88	Out of cont on bend															
1047980	P	06/11/2014	Thu	16:00	600 m	E	WAMBERRA RD	2WY	STR	Unk	Dry	100	2	TRK	M50	W in ARUMPO RD	40	Proceeding in lane	OC	0	0	0	1	0	
E55686415								RUM	30	Rear end				BDBL	M64	W in ARUMPO RD	30	Proceeding in lane							

Report Totals: Crashes: 7 Fatal Crashes(FC): 0 Serious Injury Crashes(SC): 1 Moderate Injury Crashes(MC): 0 Minor/Other Injury Crashes(OC): 6 Uncategorised Injury Crashes(UC): 0 Non-Casualty Crashes(NC): 0

Killed(K): 0 Seriously Injured(S): 1 Moderately Injured(M): 0 Minor/Other Injured(O): 9 Uncategorised Injured(U): 0

Session dataset Balranald, Wentworth LGAs; all crashes for 2014, 2015, 2016, 2017, 2018 reporting years. Blue route

Note: *Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.*

Crash self reporting, including self reported injuries began Oct 2014. Trends from 2014 are expected to vary from previous yrs. More unknowns are expected in self reported data. Reporting yrs 1996-2004 & 2018 Q4 onwards contain uncategorised inj crashes.

Detailed Crash Report

Crash No.	Data Source	Date	Day of Week	Time	Distance	ID Feature	Loc Type	Alignment	Weather	Surface Condition	Speed Limit	No. of Tus	Tu Type/Obj	Age/Sex	Street Travelling	Speed Travelling	Manoeuvre	Degree of Crash-Detailed	Killed	Seriously Inj.	Moderately Inj.	Minor/Other Inj.	Uncateg'd Inj.	Factors	S	F
South West Region																										
Balranald LGA																										
Ivanhoe																										
Balranald Rd																										
1142710	P	25/05/2017	Thu	10:00		Unk Unk UNKNOWN UK	2WY	STR	Fine	Wet	100	1	M/C	M68	E in BALRANALD RD	80	Proceeding in lane	MC	0	0	1	0	0		
E64650657							RUM:	74	On road-out of cont.																	
Western Region																										
Unincorporated LGA																										
Broken Hill																										
Menindee Rd																										
1134648	P	16/04/2017	Sun	21:00	30 km E	BROKEN HILL TN	2WY	STR	Fine	Dry	100	1	4WD	M36	W in MENINDEE RD	100	Proceeding in lane	NC	0	0	0	0	0	S	F
E387969192							RUM:	74	On road-out of cont.																	
1069067	P	08/05/2015	Fri	18:00	65 km E	BROKEN HILL TN	2WY	STR	Fine	Dry	110	1	TRK	M22	W in MENINDEE RD	110	Proceeding in lane	MC	0	0	2	0	0		
E57575744							RUM:	74	On road-out of cont.																	
1174567	P	06/07/2018	Fri	17:00	18.5 km S	HOLTON DR	2WY	STR	Fine	Dry	110	1	4WD	M57	N in MENINDEE RD	110	Proceeding in lane	FC	1	0	1	0	0		F
E68689743							RUM:	70	Off road to left																	

Report Totals: Crashes: 4 Fatal Crashes(FC): 1 Serious Injury Crashes(SC): 0 Moderate Injury Crashes(MC): 2 Minor/Other Injury Crashes(OC): 0 Uncategorised Injury Crashes(UC): 0 Non-Casualty Crashes(NC): 1

Killed(K): 1 Seriously Injured(S): 0 Moderately Injured(M): 4 Minor/Other Injured(O): 0 Uncategorised Injured(U): 0

Session dataset Balranald, Unincorporated, Wentworth LGAs; all crashes for 2014, 2015, 2016, 2017, 2018 reporting years. orange route

Note: *Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.*

Crash self reporting, including self reported injuries began Oct 2014. Trends from 2014 are expected to vary from previous yrs. More unknowns are expected in self reported data. Reporting yrs 1996-2004 & 2018 Q4 onwards contain uncategorised inj crashes.

Appendix B

Existing Road Conditions

Arumpo Road – from Silver City Highway to Marma Box Creek Road

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
0	11.7	11.7	Asphalt	Sealed, good condition, well maintained, centre line marking and guide posts used.	80	6.6	10-13	A sign-posted speed limit is provided once along Arumpo Road proximal to the intersection with Silver City Highway. The speed along the road is restricted to 80km/hr. Below is an image of the general road conditions for this section of Arumpo Road. 
11.7	16.9	5.2	Asphalt	Surface becomes rougher		6.6	10	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
16.9	19	2.1	Asphalt	Continues as above.		6.6	8-10	Stock grid 6.6 m wide 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
19	24.5	5.5	Asphalt	No line-marking Signposted prior to end of seal "CAUTION ROAD SURFACE CONDITIONS VARY"		6.6	8-10	 End of sealed road 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
24.5	25.9	1.4	Gravel for initial 50 m, then transitions to primarily dirt	Poor, rough, unsealed road cambers to the centre, with rutting and corrugations along vehicle paths. The rutting can influence vehicle direction and veer vehicles off a straight path if close attention is not made to the shape of the road. Smaller vehicles may be subject to scraping as the ruts can lower the vehicle to the ground. Some dust raised by passing vehicles, but visibility maintained.	No sign-posted speed limit	-	12-15	  Sign posted warning: roads cannot be used when wet, fines apply. TTPP intentionally drove along the positive mounds (crests created by the ruts/troughs) along this section to prevent scraping the underside of the car, or avoided the visible tyre paths altogether and drove closer to the centre of the road

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
25.9	27.1	1.2	Gravel and dirt	Road flattens out, harder surface, finer gravel with some dirt sections showing truck tyre paths	N/A	-	12	
27.1	28.3	1.2	Gravel, dirt, hard clay	Continues as above	N/A	-	12	
28.3	28.8	0.5		Continues as above	N/A	-	15	Stock grid ~7m wide
28.8	29.3	0.5		Road becomes lumpy and dusty, truck tyre paths with ruts can be seen in the road	N/A	-	15	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
29.3	33.9	4.6		Centre of road flattens out, with lumpy sections along the shoulders. Truck tyre paths are visible.	N/A	-	15 with some sections narrowing to 12	
33.9	42.1	8.2		Road becomes harder with intermittent loose gravel/dirt sections and harder clay, gravel sections, with a particularly rough section.	N/A	-	12	Dust raised by a passing B99 and a passing truck and dog while driving along this section restricted visibility, TTPP had to slow and wait for the dust to clear before proceeding.  

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
42.1	45.8	3.7	Primarily dirt with some loose gravel	Visible rutting and corrugations	N/A	-	12	
45.8	46.5	0.7	Sand/dirt	Road becomes quite sandy and lumpy with visible rutting	N/A	-	15-20	
46.5	47.6	1.1	Sand/ hard clay, dirt	Road flattens out temporarily with dirt/sand sections on the shoulders.	N/A	-	-	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
47.6	54	6.4	Hard clay, gravel	Road becomes harder and flatter	N/A	-	-	
54	61.5	7.5		Continues as above	N/A	-	-	Stock grid @ 54 km, on short length of seal, width does not allow for two vehicles to pass 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
61.5	73	11.5	Hard clay, sand and gravel	Some rocky sections, primarily flat with sections showing visible rutting. There is a some particularly rough sections along this part of the route	N/A	-	-	Stock grid @ 61.5km, width does not allow for two vehicles to pass  Wider stock grid with a wet weather warning sign provided along the section:  Road signs are given close to the intersection of Arumpo and Marma Box Creek Road

Marma Box Creek Road – from Arumpo Road to Link Road

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
0	0.3	0.3	Dirt road with gravel	Road is lumpy and rocky on approach to the stock grid	N/A	N/A	7	Some road signs have poor visibility and are not standing upright  Stock grid @ 0.3 km
0.3	3.1	2.8	Hard clay	Road flattens out	N/A	N/A	7	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
3.1	5.1	2	Hard clay, gravel and sand	Road becomes gravellier with some sandy sections				
5.1	6.1	1	Primarily sand with hard clay	Road becomes smoother (less gravel)			7-10	Road detour past single-lane stock grid 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
6.1	7.6	1.5	Gravel and sand	Road becomes very gravelly with some sand			7-10	Some rocks were observed, which could puncture the tyres 
7.6	14.8	7.2	Hard clay and gravel	Road is primarily hard clay with loose gravel with some notably rough sections immediately before and after stock grids.			10	Stock grid @ 7.6km 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
14.8	15.7	0.9	Hard clay and gravel	Road becomes very gravelly			10	Stock grid @ 15.7km 
15.7	18.7	3	Hard clay and gravel	Continues as above			10	
18.7	20.1	1.4	Hard clay and gravel	Mix of very gravelly sections and smoother sections			10	Stock grid @ 20.1 km
20.1	29.4	9.3	Hard clay and gravel	Continues as above			10	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
29.4	33.8	4.4	Hard clay, gravel and sand	Road becomes sandier and there is corrugations and visible rutting along wheel paths. There are intermittent sections of hard clay with occasional gravel sections.			7-15	
33.8	36.4	2.6	Hard clay and sand	Road becomes sandier but primarily hard clay			10	Stock grid @ 36.4km
36.4	37	0.6	Hard clay and gravel	Road becomes gravellier			10	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes and Photos
37	39	2	Hard clay, gravel and sand	Road is very sandy initially then transitions to gravelly clay			7-11	 

Link Road – from Marma Box Creek Road to Boree Plains Road

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
0	1.3	1.3	Hard clay and gravel and dirt	Road is significantly narrower than both Arumpo and Marma Box Creek Roads. Initial 50 m is some 10 m wide, narrowing to 5-6 m thereafter, with visible rutting.			5-10	 
1.3	1.7	0.4	Hard clay, gravel and dirt	Road widens out, lumpy with gravel			8	

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
1.7	8.9	7.2	Hard clay and gravel	Coarser gravel with some sandy sections.			10	
8.9	10	1.1		Road becomes more gravelly and rougher/bumpier			10	Stock grid @ 8.9 km 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
10	13.4	3.4		Some lumpy rough sections created by the rutting and due to rocks on the road			10	Stock grid @ 13.4 km 
13.4	15.9	2.5		Continues as above			10	Mine entrance on left in this section
15.9	16.5	0.6	Hard clay, gravel and dirt	Road is gravelly and hard with lots of broken rock. Road condition is very poor around the mine access			10-12	
16.5	20.7	4.2	Hard clay, gravel and dirt	Lumpy, gravelly road, flatter than previous section. Some sections have very poor conditions similar to the mine access.			7-10	TTPP drove on the right hand side of the road along some sections to avoid the ruts

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
20.7	21	0.3		Road is very gravelly and bumpy on approach and exit of stock grid.				

Boree Plains Road – Link Road to Boree Plains Road

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
0	0.1	0.1	Hard clay and gravel	Hard clay, gravelly flat road			10	
0.1	2	1.9	Hard clay, gravel and dirt	Continues as above			12	Stock grid @ 0.1km 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
2	5	3	Hard clay, gravel and dirt	Road becomes harder and flatter, with minimal gravel for some sections			7-10	 
5	6	1		Continues as above			7-10	Stock grid @ 5km

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
6	8.3	2.3		Road becomes very gravelly with rocks				
8.3	10.1	1.8		Continues as above			10	Stock grid @ 8.3km 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
10.1	10.5	0.4		Continues as above			10	Stock grid @ 10.1 km 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
10.5	13.2	2.7		Road is flatter in some sections and has visible rutting			10	 Stock grid @ 12.1km 

Section Start (km)	Section End (km)	Section Length (km)	Road Type	Road Condition	Posted Speed Limit (km/h)	Road Width (m)	Unsealed Road Width (m)	Notes
13.2	18	4.8		Road narrows at curves in the road. Some sections of road have visible wheel paths which have created ruts			10-15	Stock grid @ 17.9km 

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APPENDIX B

AIR QUALITY REVIEW

ATLAS-CAMPASPE MINERAL SANDS PROJECT

OPTIMISATION MODIFICATION

APPENDIX B

AIR QUALITY REVIEW

TRONOX

katestone
www.katestone.com.au

16 July 2019

Attn: Haakon Nielssen

Tronox Mining Australia Limited
PO Box 4032
MILDURA VIC 3502

Re: Air Quality Review for the Atlas-Campaspe Mineral Sands Project Optimisation Modification

Dear Haakon,

Katestone has prepared an Air Quality Review for the proposed Atlas-Campaspe Mineral Sands Project Optimisation Modification. The Air Quality Review of the potential air quality impacts associated with the Modification is based on:

- A review of the existing air quality monitoring in the vicinity of the Atlas-Campaspe Mine
- A comparison of dust emissions for the modified Project with the information presented in the existing Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013) for the approved Project.

The Air Quality Review found that the Modification is unlikely to alter the outcomes of the Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013) for the approved Project and the modified Project would not contribute to any additional exceedances of the relevant air quality criteria at any sensitive receptors in the vicinity of the Project.

Please contact the undersigned on (07) 3369 3699 if you would like to discuss the review.

Yours sincerely,

Tania Haigh – Senior Air Quality Consultant

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1. INTRODUCTION

The Atlas-Campaspe Mineral Sands Project (the Project) is being developed by Cristal Mining Australia Limited, which will be renamed Tronox Mining Australia Limited (Tronox) on 25 July 2019. Development Consent (SSD_5012) for the Project was issued under the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* in 2014.

The Project includes the development of a mineral sands mining operation (herein referred to as the Atlas-Campaspe Mine), together with the construction and operation of a rail loadout facility located near the township of Ivanhoe (herein referred to as the Ivanhoe Rail Facility).

The Atlas-Campaspe Mine is located approximately 80 kilometres (km) north of Balranald, NSW and 270 km south-east of Broken Hill, NSW (Figure 1). The Ivanhoe Rail Facility is located approximately 135 km north-east of the Atlas-Campaspe Mine, and is approximately 4.5 km to the south-west of the township of Ivanhoe (Figure 1).

Product (mineral concentrates) generated as a result of operations at the Atlas-Campaspe Mine will be trucked to the Ivanhoe Rail Facility for transfer to train wagons, which will then be railed to the existing Broken Hill Mineral Separation Plant (the MSP) (Figure 1).

The Project will integrate with currently existing/approved Tronox operations in western NSW, including (Figure 1):

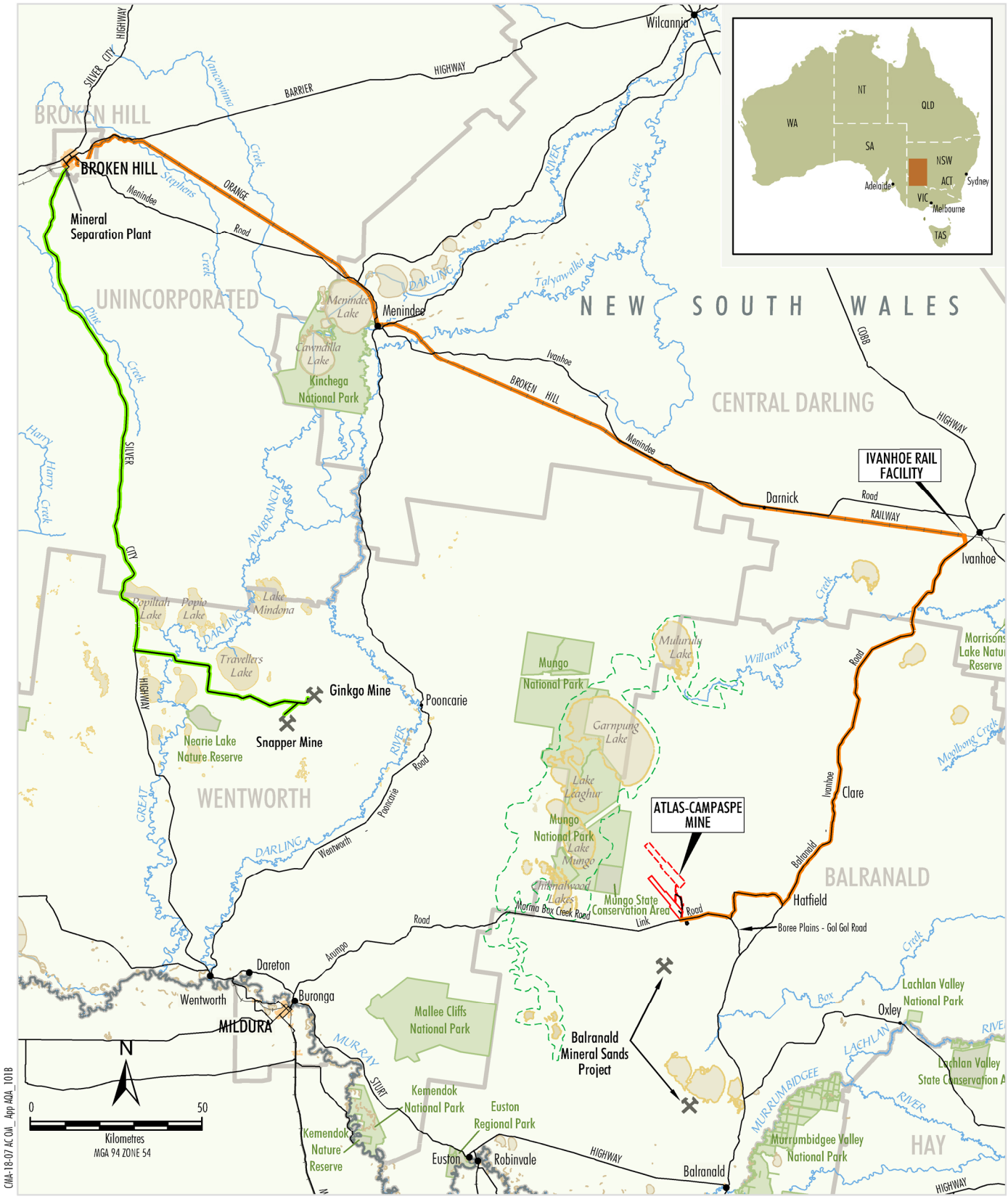
- the MSP – located in Broken Hill approximately 270 km north-west of the Atlas-Campaspe Mine
- Snapper Mine – located approximately 105 km to the west of the Atlas-Campaspe Mine
- Ginkgo Mine – located approximately 100 km to the west of the Atlas-Campaspe Mine.

This Air Quality Review has been prepared to support the application to modify Development Consent (SSD 5012) for the Project.

2. OVERVIEW OF THE MODIFICATION

Tronox proposes to modify Development Consent (SSD 5012) for the Project to allow for changes to optimise the Project (herein referred to the Optimisation Modification or Modification). The Modification would include:

- The option to use an overland conveyor to transfer overburden in addition to haul trucks;
- Increased mineral concentrate production from 546,000 tonnes per annum (tpa) to 665,000 tpa;
- Increased mineral concentrate transport from 450,000 tpa to 665,000 tpa;
- Increased mineral concentrate transport truck trips from 24 per day to 35 per day;
- Increased MSP process waste disposal from 50,000 tpa to 65,000 tpa;
- Use of local roads other than the road haulage route by Project-related light vehicles to access site (Figure 1);
- The option to develop on-site solar power generation infrastructure at the Atlas-Campaspe Mine to supplement diesel generator sets (Figure 2);
- Development of an emergency airstrip at the Atlas-Campaspe Mine (Figure 2);
- Relocation of the accommodation camp (inside the approved surface development area) (Figure 2);
- Construction and operation of a telecommunications tower at the Atlas-Campaspe Mine;
- Increased mineral concentrate transport train length (from 600 metres [m] to 920 m) and frequency (from six to eight train movements per week [i.e. four arrivals, four departures]);
- Extension to the Ivanhoe Rail Facility hardstand area (Figure 3);
- Extension of the Ivanhoe Rail Facility rail siding and addition of a passing siding;
- Revised alignment of the Ivanhoe Rail Facility access road and access road intersection (Figure 3); and
- A groundwater supply for the Ivanhoe Rail Facility (Figure 3).



LEGEND

- National Park, Regional Park or State Conservation Area
- Willandra Lakes Region World Heritage Area
- Local Government Area Boundary
- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Existing Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Approved Mineral Concentrate Transport Route*

Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012)

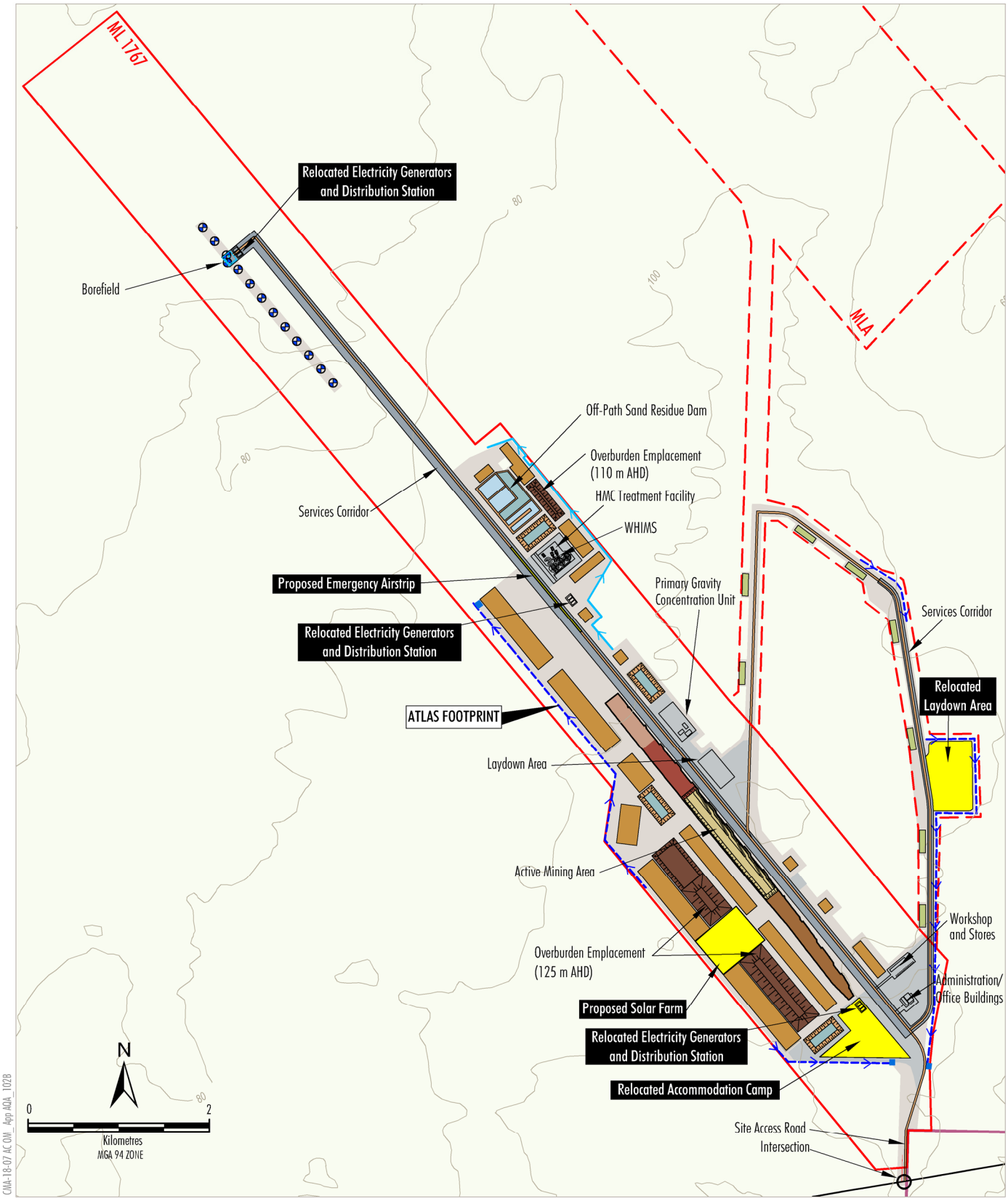
TRONOX

OPTIMISATION MODIFICATION

Regional Location

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines.

Figure 1



Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012) and Tronox (2019)

LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Exploration Licence Boundary (EL)
- Up-catchment Diversions
- Collection Drains
- Bore
- Approximate Extent of Surface Development - Year 2
- Fixed Infrastructure Areas
- Soil Stockpile
- Process Water Storage
- Overburden Emplacement
- Stage 1 Rehabilitation - Stabilised Landform with Seed/Cover Crop Application

Active Mining Area

- Vegetation Clearance/Soil Stripping
- Overburden Removal
- Ore Zone/Extraction Area
- Overburden Replacement/Process Waste Emplacement/Soil Replacement
- Sediment Basin

ACMSP Modification

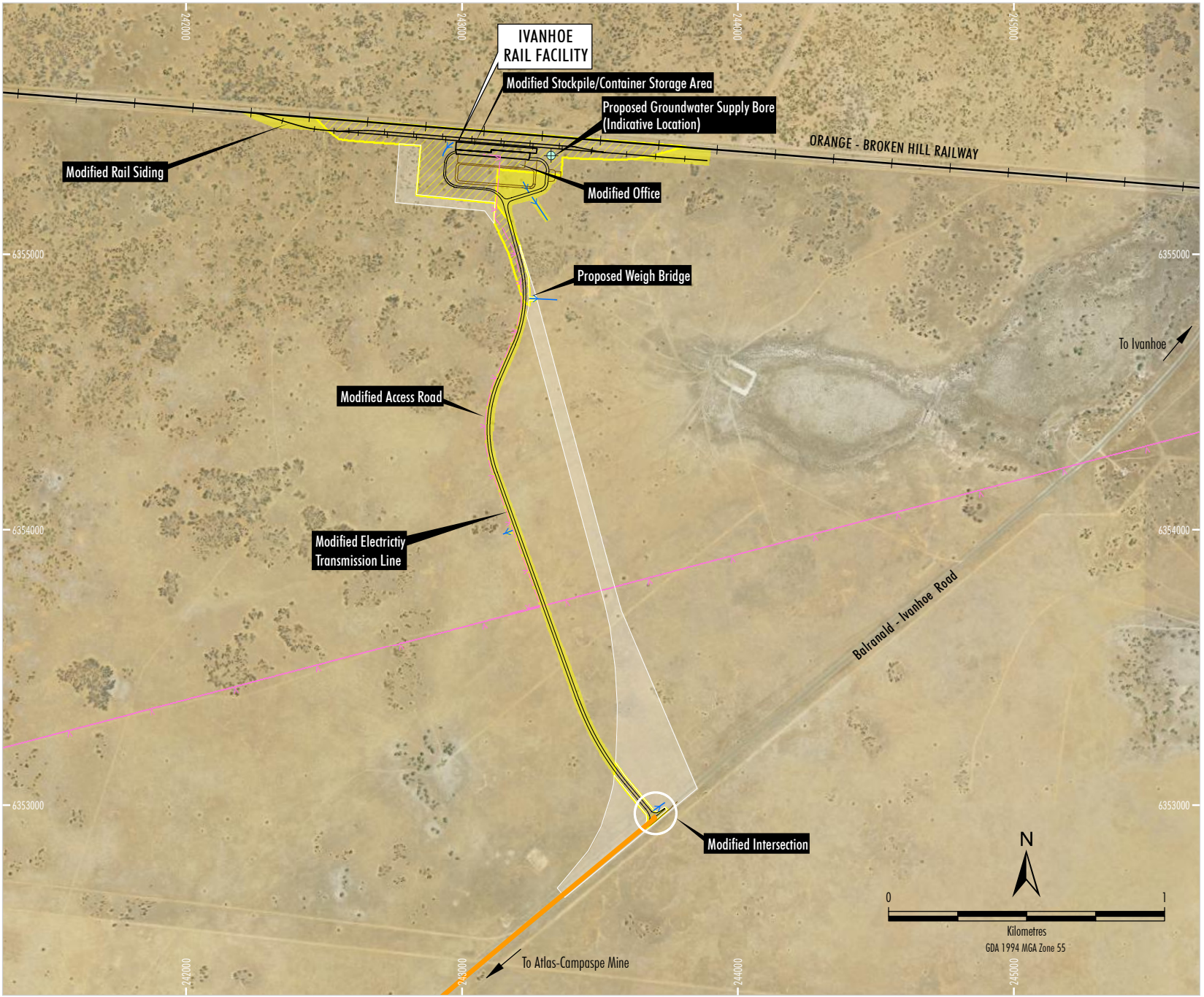
- Modification Surface Development Area

TRONOX

OPTIMISATION MODIFICATION

Modified Atlas-Campaspe Mine
General Arrangement - Year 2

Figure 2



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*
- Existing Electricity Transmission Line

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012); Tronox (2019)
Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

TRONOX

OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility
General Arrangement

Figure 3

CMA-18-07 AC OM_ App AQA_201C

The Modification would not change the following components of the Project:

- Mine path or mine life;
- Mining method;
- Mineral concentration methods;
- Overburden and ore extraction rate;
- Sand residue, coarse reject and process waste placement management;
- Annual maximum water supply/demand;
- Rehabilitation works;
- Biodiversity offset area; or
- Workforce.

3. RELEVANT AIR QUALITY CRITERIA AND PERFORMANCE MEASURES

3.1 RELEVANT AIR QUALITY GUIDELINES

The Air Quality and Greenhouse Gas Assessment for the approved Project (Katestone Environmental, 2013) was prepared in accordance with the (now) superseded *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW Department of Environment and Conservation [DEC], 2005) (Section 6).

Subsequent to the grant of Development Consent (SSD_5012), the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Environment Protection Authority [EPA], 2017) (Approved Methods) were introduced, which lists the statutory methods and air quality criteria that are to be used to model and assess emissions and impacts of air pollutants from stationary sources in NSW. The Approved Methods (EPA, 2017) introduced criteria for $PM_{2.5}$, and a reduced annual average PM_{10} criterion of 25 µg/m^3.

Ambient air quality in each state in Australia must be monitored and reported against the standards and goals defined in the *National Environment Protection (Ambient Air Quality) Measure 1998* (Air NEPM) (National Environment Protection Council [NEPC], 2016). Whilst these standards exist to evaluate ambient air quality, rather than the potential impact of an individual Project, they have been considered here for completeness.

3.2 DEVELOPMENT CONSENT (SSD 5012)

Air quality criteria are provided in Condition 19, Schedule 3 of Development Consent (SSD_5012). These conditions are reproduced below.

Air Quality Criteria

The Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed to ensure particulate matter emissions generated by the development do not exceed the criteria in Table 5, 6 and 7 at any residence on privately-owned land.

Table 5: Long term impact assessment criteria for particulate matter

Pollutant	***Averaging Period***	***[d]Criterion***
Total suspended particulate (TSP) matter	*Annual*	*[a] 90 µg/m^3*
Particulate matter < 10 µm (PM_{10})	*Annual*	*[a] 30 µg/m^3*

Table 6: Short term impact assessment criterion for particulate matter

Pollutant	***Averaging Period***	***[d]Criterion***
Particulate matter < 10 µm (PM_{10})	*24 hour*	*[a] 50 µg/m^3*

Table 7: Long term impact assessment criteria for deposited dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	[d]Criterion
[c]Deposited Dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 5-7:

a Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources);

b Incremental impact (i.e. incremental increase in concentrations due to the development on its own);

c. Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and

d. Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.

The air quality related operating conditions are detailed in Condition 20, Schedule 3 of Development Consent (SSD_5012) and reproduced below.

Operating Conditions

The Applicant shall:

a) implement all reasonable and feasible measures to minimise off-site odour, fume, dust and greenhouse gas emissions of the development;
b) minimise any visible off-site air pollution generated by the development;
c) minimise the surface disturbance of the site;
d) operate an air quality management system that uses dust deposition gauges to monitor the performance of the development and implement air quality mitigation measures to ensure compliance with the relevant condition of this consent; and
e) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note d under Table 7),

to the satisfaction of the Secretary.

3.3 ENVIRONMENT PROTECTION LICENCE 21007

Tronox holds Environment Protection Licence (EPL) 21007 issued under the NSW *Protection of the Environment (Operations) Act 1997* (POEO Act) for the Project. Although EPL 21007 does not include air quality criteria, Condition M2.2 of EPL 21007 does identify six locations in the vicinity of the Atlas-Campaspe Mine site where dust deposition monitoring must be conducted on a monthly basis, and one location in the vicinity of the Atlas-Campaspe Mine site where a high-volume air sampler is to be operated to monitor PM_{10} and TSP every six days.

Operating conditions relevant to air quality are provided in Conditions O3 and O4 of EPL 21007:

O3 Dust

O3.1 All operations and activities occurring at the premises must be carried out in a manner that will minimise the emission of dust from the premises.

O3.2 Trucks entering and leaving the premises that are carrying loads must be covered at all times, except during loading and unloading.

O3.3 The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises.

3.4 SUMMARY OF AIR QUALITY CRITERIA

Air quality criteria relevant to the Project are reproduced in Table 1.

Table 1 Particulate and dust deposition monitoring criteria for the Project

Pollutant	Averaging Period	Criterion	Source
TSP	Annual	90 µg/m^3	Development Consent, Approved Methods
PM_{10}	24-hour	50 µg/m^3	Development Consent, Approved Methods, Air NEPM
	Annual	30 µg/m^3	Development Consent
	Annual	25 µg/m^3	Approved Methods, Air NEPM
$PM_{2.5}$	24-hour	25 µg/m^3	Approved Methods, Air NEPM
	Annual	8 µg/m^3	Approved Methods, Air NEPM
Deposited dust	Annual	2 g/m^2/month (incremental)	Development Consent, Approved Methods
	Annual	4 g/m^2/month (total)	Development Consent, Approved Methods

4. EXISTING AIR QUALITY MANAGEMENT

Air quality management at the Project is undertaken in accordance with the Air Quality Management Plan (AQMP) (Cristal Mining Australia [CMA], 2018). The AQMP was prepared in accordance with Condition 21, Schedule 3 of Development Consent (SSD 5012) and includes:

- A description of the key sources of emissions
- Relevant air quality criteria applicable to the Project
- Air quality management measures for the Project
- Air quality monitoring program components
- A contingency plan to manage any unpredicted impacts and their consequences.

Table 2 provides a summary of the air quality management measures and controls included in the AQMP.

Tronox have advised that no air quality-related complaints have been received to date.

Table 2 Air Quality Management Measures and Controls

Project Phase	Management Measure
Construction	• Regular watering of roads and exposed areas to reduce wheel-generated dust and restricting vehicle speeds. • Dust-generating activities such as earthworks will not be carried out during high wind conditions (greater than 10 m/s). • Establishment of vegetation on stockpiled materiel material to prevent wind erosion. • Minimisation of haul trips and trip distances, where practicable. • Erecting physical barriers such as bunds and/or wind breaks around stockpiles or areas where earth moving is required, where practicable. • Earth moving activities will be avoided during unfavourable meteorological conditions, where practicable. • Minimising speed (speed limit of 40 kilometres per hour) of on-site traffic, where applicable, to minimise wheel generated dust.
Operational (Atlas-Campaspe Mine site)	• Watering of exposed haul roads within the active mining area. • Watering during topsoil removal. • Progressive rehabilitation of exposed areas. • Control of truck speeds. • Minimisation of travel speed and distance travelled for bulldozing.
Operational (mineral concentrate transport route)	• All vehicles transporting mineral concentrate from the Atlas-Campaspe Mine site will be covered to minimise potential losses. • All rail wagons transporting mineral concentrate along the Orange-Broken Hill Railway will be covered to minimise potential losses. • All MSP process waste transport will be undertaken in sealed containers.

Source: CMA (2018).

5. EXISTING AIR QUALITY ENVIRONMENT

5.1 SENSITIVE RECEIVERS

The Boree Plains residence (Tronox owned) is the closest residence to the Atlas-Campaspe Mine footprint and is located approximately 7 km away from the Campaspe deposit and approximately 18 km away from the Atlas deposit (where Project activities are occurring) (Figure 4). Other rural residences (e.g. Marona, Glen Tilt, Magenta and Langleydale) are located at least 14 km away from the Atlas-Campaspe Mine footprint (Figure 4).

The nearest receptors to the mineral concentrate transport route are located approximately 800 m (Magenta) and 1,300 m (Langleydale) from the unsealed sections of the haul road (Figure 4).

The township of Ivanhoe is representative of the closest residential area to the Ivanhoe Rail Facility. The Ivanhoe Rail Facility is located approximately 4.5 km from Ivanhoe (Figure 3).

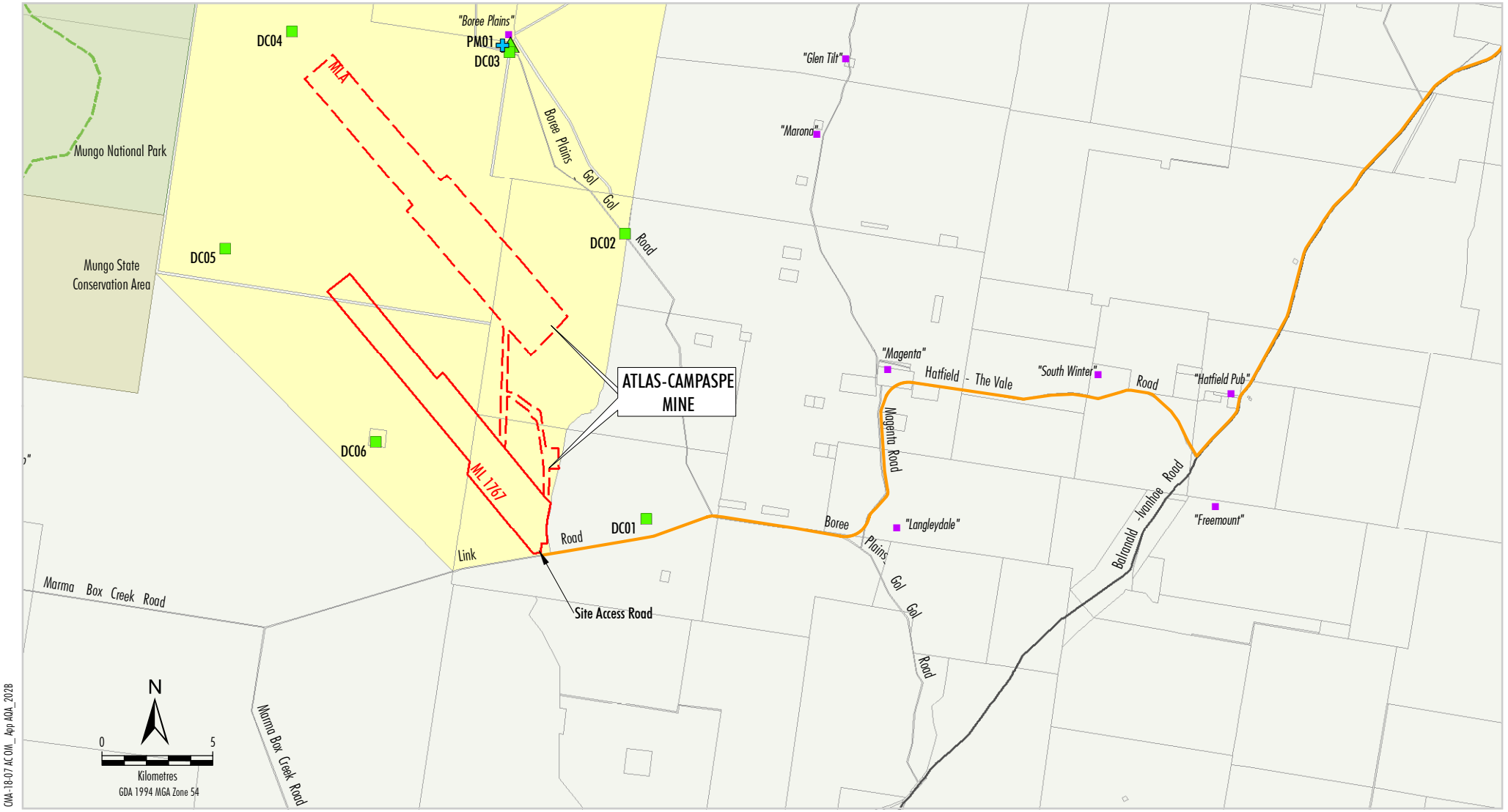
5.2 AIR QUALITY MONITORING

Tronox operates a network of dust deposition gauges (DC01 to DC06), as well as a high volume air sampler (HVAS) (PM01) (Figure 4) in accordance with the AQMP.

A summary of the air quality monitoring results is provided below.

Particulate Monitoring

PM_{10} and TSP are monitored using a high-volume sampler on a 1-in-6 day schedule. The high-volume sampler is located near the sensitive receptor (i.e. Boree Plains – Figure 4) with the highest predicted ground-level concentrations due to the Atlas-Campaspe Mine site operations in the Air Quality Assessment (Katestone Environmental, 2013). The TSP concentration is calculated based on the PM_{10} measurement applying a PM_{10}/TSP ratio of 0.67.



LEGEND

- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Willandra Lakes Region World Heritage Area
- National Park
- State Conservation Area
- Tronox Owned Land
- Private Landholder
- Dwelling
- Approved Mineral Concentrate Transport Route
- Automatic Weather Station
- Dust Gauge Location
- PM_{10} /TSP Monitoring Site

Source: © NSW Department of Finance, Services & Innovation (2018)
Cristal Mining Australia (2012)

TRONOX

OPTIMISATION MODIFICATION

Atlas-Campaspe Mine
- Air Quality Monitoring Sites

Figure 4

Table 3 summarises the PM_{10} monitoring data collected between 4 September 2018 and 8 February 2019. Figure 5 shows PM_{10} monitoring data over the same period. Measurements reported on 22 and 28 December 2018 and 3 January 2019 were identical, as were the two measurements reported on 15 and 25 January 2019. Tronox advised this was due to the filter paper not being changed during these periods and the single sample result has been reported for each sampling period.

Table 3 Summary of PM_{10} monitoring data from the Project site collected to date

Parameter	Number of samples*	Maximum 24-hour average (µg/m³)	Number of measurements > 50 µg/m³	Average (µg/m³)
PM_{10}	27	242.0	9	45.8
PM_{10} – excluding measurements known to have been recorded during periods with dust storms	25	89.3	7	33.8
Criterion	**-**	**50.0**	**-**	**25/30**

Table note:

* Measurements reported on 22 and 28 December 2018 and 3 January 2019 were identical, as were the two measurements reported on 15 and 25 January 2019. Tronox advised that this was due to the filter paper not being changed during these periods and a single sample result reported for each sampling period.

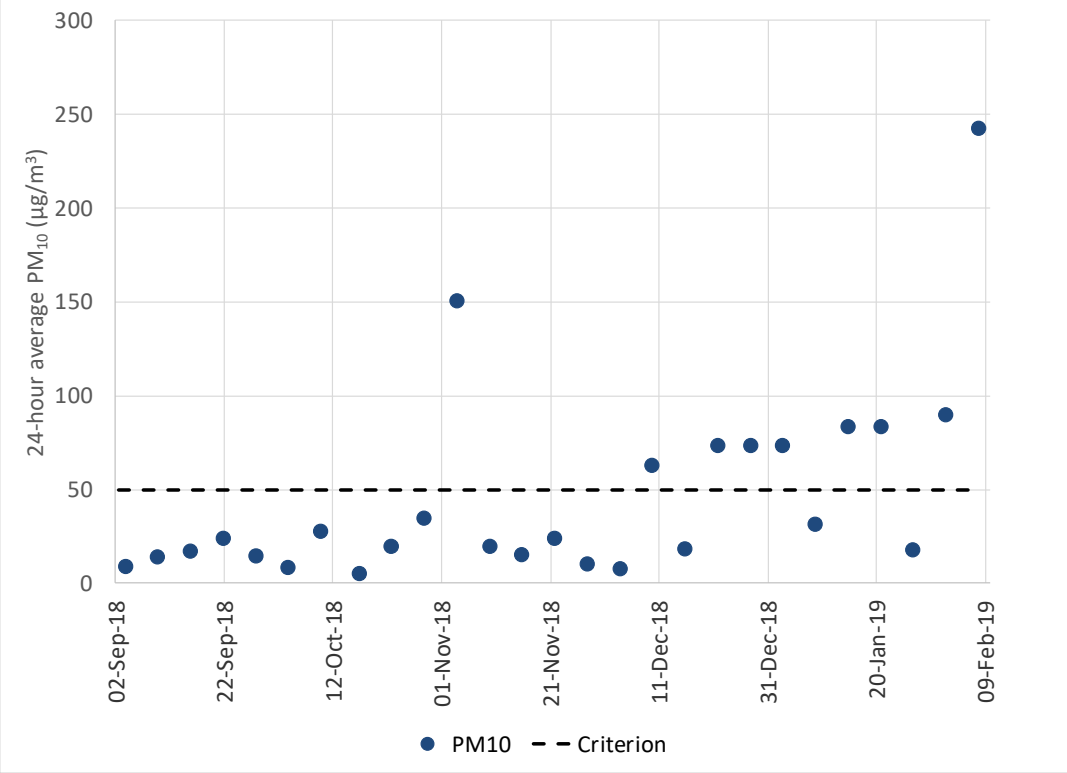


Figure 5 24-hour average PM_{10} concentrations measured at PM01

Twenty-four hour average PM_{10} measurements recorded at PM01 exceeded the Development Consent (SSD 5012) 24-hour PM_{10} criterion of 50 µg/m^3 on a total of nine days during this period (Table 3 and Figure 5).

It is expected that natural sources of wind-blown dust are likely to contribute to ambient concentrations in the region. This is particularly due to the location and proximity of the Project to nearby ephemeral lakes, which can be a considerable source of dust in dry periods. Significant amounts of silt can be deposited into these lakes as rain water drains into them, and after the surface dries this material becomes available to be swept up by the wind (Katestone Environmental, 2013). These conditions are expected to be currently present as 2018 was the sixth-driest year on record in New South Wales since 2002 (BoM, 2019a) and the warmest year on record. Whilst above average monthly rainfall was recorded for the state during October and November, overall rainfall measured in western New South Wales was below average for the year. Summer 2018-2019 was also a record warm summer with very dry conditions across the state, and a number of dust storms occurred during the period (BoM, 2019b). Meteorological monitoring stations in western New South Wales, including at Broken Hill Airport, measured higher than average maximum and minimum temperatures and low to average rainfall during summer. Dust storms were noted by Tronox at the site on 4 November 2018 and 8 February 2019.

In addition, as PM01 is located approximately 18 km north of current Project activities, it is expected that other closer sources in the region such as wind-blown dust are contributing to particulate matter levels at PM01.

Daily average meteorological data recorded at the on-site monitoring station indicates that the winds on most exceedance days were from southerly directions, which is the predominant wind direction at the Project site, particularly during summer. During southerly winds, the monitoring station would be downwind of the Atlas-Campaspe Mine site.

Whilst there is not a full year of data available to calculate an annual average, the average of the data collected to date shows that the average PM_{10} concentration recorded to date is 45.8 µg/m^3 based on all data (and 33.8 µg/m^3 excluding dates on which dust storms occurred). This is above the Development Consent (SSD 5012) annual average PM_{10} criterion of 30 µg/m^3 and the Approved Methods criterion of 25 µg/m^3 (Table 1).

The average TSP concentration calculated to date is 68.7 µg/m^3, which complies with the air quality criteria of 90 µg/m^3.

Given the elevated PM_{10} measurements recorded during the construction period, consideration could be given to additional PM_{10} monitoring to determine the contribution of activities at the Atlas-Campaspe Mine site to measured concentrations. For example, one additional PM_{10} monitoring station on the southwestern side of the Atlas-Campaspe Mine may assist in distinguishing the likely contribution of elevated ambient background concentrations and on-site activities to elevated PM_{10} measurements.

Dust Deposition Monitoring

Figure 6 presents the monthly dust deposition measurements from the six monitoring sites collected between January 2018 to February 2019. Also shown for comparison on Figure 6 is the guideline of 4 grams per square meter per month (g/m^2/month); however, it should be noted this applies to the annual average, not monthly dust deposition rates. Rolling annual averages for the available period are presented in Table 4, and these are well below the guideline of 4 g/m^2/month.

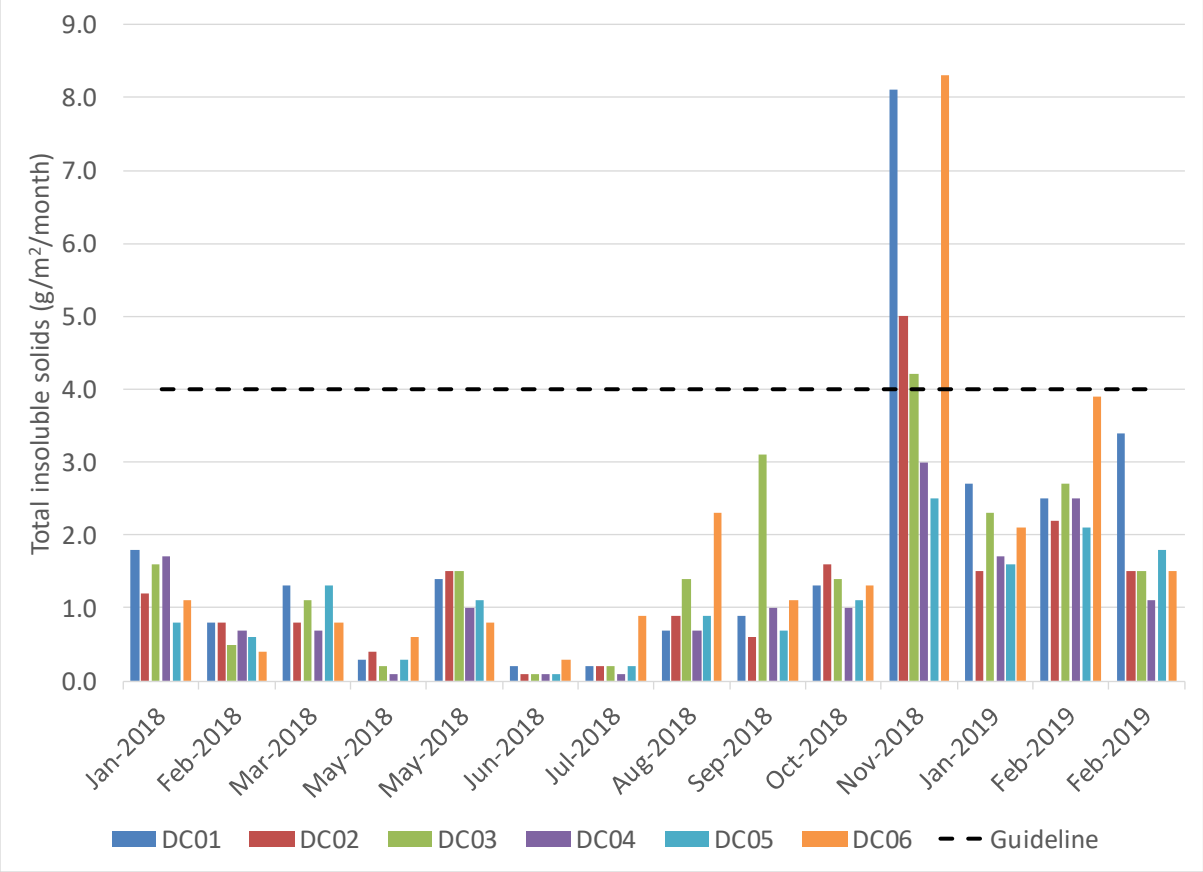


Figure 6 **Monthly dust deposition measurements**

Table 4 **Annual average dust deposition measurements**

Date	12-month average dust deposition (g/m²/month)					
	DC01	DC02	DC03	DC04	DC05	DC06
24-Jan-2018 – 9-Jan-2019	1.6	1.2	1.5	1.0	0.9	1.7
16-Feb-2018 – 5-Feb-2019	1.7	1.3	1.6	1.1	1.0	1.9
27-Mar-2018 – 26-Feb-2019	1.9	1.4	1.6	1.1	1.1	2.0
Objective	**4.0**					

6. OVERVIEW OF EXISTING AIR QUALITY ASSESSMENT

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken for the Project by Katestone Environmental (2013). As described in Section 3.1, the assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) and included an assessment of the potential air quality impacts associated with the Atlas-Campaspe Mine, Ivanhoe Rail Facility and mineral concentrate transport between the Atlas-Campaspe Mine and Ivanhoe Rail Facility.

6.1 ATLAS-CAMPASPE MINE SITE

Potential air quality impacts at the Atlas-Campaspe Mine were modelled for Year 16 of the Project to assess the potential impact at sensitive receptors, including the nearest residence (Boree Plains – which is now Tronox owned) (Figure 4). The next nearest residence is approximately 14 km away from the Atlas-Campaspe Mine.

An emission inventory was prepared for Year 16 of the Atlas-Campaspe Mine operations in consideration of the anticipated mining activities for that year, including topsoil and overburden removal rates, haul road distances and routes, stockpile and pit areas and equipment operating hours. The major emission sources were associated with overburden removal; on-site haulage; and wind erosion from exposed areas (Katestone Environmental, 2013). The assessment of Year 16 operations accounted for the maximum overburden extraction rate from the Project life (notwithstanding that those maximum rates were scheduled to occur in Year 5) thereby providing a conservative estimate of potential air quality impacts (Katestone Environmental, 2013).

Consideration of the potential cumulative impacts associated with the construction and operation of the Balranald Mineral Sands Project were conservatively incorporated in the Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013).

The Air Quality and Greenhouse Gas Assessment concluded (Katestone Environmental, 2013):

- The operation of the Atlas-Campaspe Mine plus contemporaneous background concentrations is not predicted to result in any additional exceedances of the impact assessment criterion for 24-hour average PM_{10} of 50 µg/m^3 at any sensitive receptors.
- Annual average PM_{10} and TSP, $PM_{2.5}$ and dust deposition rates at the nearest sensitive receptors due to the Project and ambient background concentrations were not predicted to result in any additional exceedances compared to background concentrations.
- No cumulative air quality impacts are expected from the coincident construction and operation of the Project and the Balranald Mineral Sands Project.

6.2 IVANHOE RAIL FACILITY

Potential air quality impacts at the Ivanhoe Rail Facility were also assessed in the Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013). As operations at the Ivanhoe Rail Facility would generally remain unchanged throughout the Project life, one scenario that would represent all years of operation was assessed. An emissions inventory was prepared for the Ivanhoe Rail Facility and the major emission source was determined to be wheel generated dust from unpaved haul road (Katestone Environmental, 2013).

The Air Quality and Greenhouse Gas Assessment concluded (Katestone Environmental, 2013):

- The operation of the Ivanhoe Rail Facility plus contemporaneous background concentrations is not predicted to result in any additional exceedances of the impact assessment criterion for 24-hour average PM_{10} of 50 µg/m^3 at any sensitive receptors.
- Annual average PM_{10} and TSP, $PM_{2.5}$ and dust deposition rates at the nearest sensitive receptors due to the Project and ambient background concentrations were not predicted to result in any additional exceedances compared to background concentrations.

6.3 MINERAL CONCENTRATE TRANSPORT

The Air Quality and Greenhouse Gas Assessment also addressed the potential air quality impacts associated with mineral concentrate transport on unsealed sections of the mineral concentrate transport route and concluded (Katestone Environmental, 2013):

- The maximum 1-hr average PM_{10} concentration at a distance of 25 m from the unsealed sections of the mineral concentrate transport route were predicted to range from 40.4 µg/m^3 to 25.6 µg/m^3 for vehicles travelling at 100 km/hr and 40 km/hr, respectively, which is below the 24-hour average air quality objective of 50 µg/m^3.

- At a distance of 500m from the road, the maximum 1-hour average PM_{10} concentration from the unsealed sections of the mineral concentrate transport route were predicted to range from 2.3 µg/m^3 to 1.5 µg/m^3 to for vehicles travelling at 100km/hr and 40 km/hr, respectively, which is well below the 24-hour average air quality objective of 50 µg/m^3.

7. POTENTIAL AIR QUALITY IMPACTS DUE TO THE MODIFICATION

7.1 ATLAS-CAMPASPE MINE SITE

The following components of the Modification have the potential to change the TSP, PM_{10} and $PM_{2.5}$ emissions at the Atlas-Campaspe Mine:

- Increased mineral concentrate production from 546,000 tpa to 665,000 tpa;Addition of conveyors to transfer overburden (haul trucks are currently approved).

Emission rates of TSP, PM_{10} and $PM_{2.5}$ due to Year 16 of operations for the approved Atlas-Campaspe Mine and modified Atlas-Campaspe Mine are presented in Table 5.

Table 5 Summary of emission rates due to Year 16 of the Approved and Modified Atlas-Campaspe Mine operations

Activity	Emission rate (g/s) due to the Approved Atlas-Campaspe Mine*			Emission rate (g/s) due to the Modified Atlas-Campaspe Mine			% increase
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	
Topsoil removal	1.8	0.4	0.2	1.8	0.4	0.2	0%
Overburden removal	18.6	7.4	1.6	18.6	7.4	1.6	0%
Ore removal	0.7	0.3	0.1	0.7	0.3	0.1	0%
Ore processing – screening	2.9	1.0	0.1	2.9	1.0	0.1	0%
Product stacking	0.0018	0.0008	0.0001	0.0022	0.0010	0.0002	22%
Road train loading	0.004	0.002	0.0003	0.004	0.002	0.0003	22%
Overburden haulage	20.3	6.5	0.7	20.3	6.5	0.7	0%^
HMC/MSP on-site haulage	5.2	1.3	0.1	7.6	1.9	0.2	46%
Grading	0.9	0.3	0.03	0.9	0.3	0.03	0%
Wind erosion	7.7	4.3	0.7	7.7	4.3	0.7	0%
TOTAL	**58.0**	**21.5**	**3.4**	**60.4**	**22.1**	**3.4**	**4%**

Table notes:

* Katestone Environmental (2013)

^ Note that emissions would reduce if conveyors are adopted.

Emissions due to product stacking and road train loading are expected to increase by 22% and on-site haulage of mineral concentrate is also expected to increase by 46% due to increased production. Overall, emissions from the modified Atlas-Campaspe Mine site are expected to increase by 4% compared to emissions from the approved Atlas-Campaspe Mine.

The use of conveyors to transport some or all of the overburden rather than haul trucks would reduce emissions from the Atlas-Campaspe Mine. Overburden haulage accounts for 6.5 grams per second (g/s), or 30%, of the estimated Atlas-Campaspe Mine emissions of PM_{10}. Based on an estimated 95% reduction in dust emissions, the use of conveyors instead of haul trucks would reduce emissions from overburden transport from 6.5 g/s to 0.3 g/s. Given that PM_{10} emissions from the modified Atlas-Campaspe Mine are expected to increase by 0.6 g/s due to the higher mineral concentrate production rate, the transport of even a portion of overburden via conveyor instead of haul truck would result in overall PM_{10} emissions rates that are lower than those assessed for the approved Atlas-Campaspe Mine.

Given that the Modification would result in either a decrease or a relatively small increase in emissions (depending if the conveyor is adopted) (Table 5) and the significant distances to the nearest sensitive receptors (Figure 4), it is likely that the conclusions of the Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013) for the approved Project (Section 6.1) would remain valid, and the modified Project would not contribute to any additional exceedances of the relevant air quality criteria at any sensitive receptors in the vicinity of the Atlas-Campaspe Mine site.

7.2 IVANHOE RAIL FACILITY

The following components of the Modification have the potential to change the TSP, PM_{10} and $PM_{2.5}$ emissions at the Ivanhoe Rail Facility:

- Increased mineral concentrate transport/handling from 450,000 tpa to 665,000 tpa
- Increased mineral concentrate transport truck trips from 24 per day to 35 per day
- Extension to the Ivanhoe Rail Facility hardstand area and rail siding to accommodate the longer trains
- Revised alignment of the Ivanhoe Rail Facility access road and access road intersection (i.e. increased distance from the nearest privately-owned receptors)
- Addition of a groundwater supply (i.e. water would be available for dust suppression resulting in less wheel-generated dust).

Table 6 presents the emission rates for the approved Ivanhoe Rail Facility and the modified Ivanhoe Rail Facility.

Table 6 Summary of emission rates due to the Ivanhoe Rail Facility – as per the Air Quality Report, and due to the proposed amended Project

Activity	Emission rate (g/s) at the Approved Ivanhoe Rail Facility*			Emission rate (g/s) at the Modified Ivanhoe Rail Facility			% increase
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	
Wheel generated dust from unpaved access road	4.17	1.04	0.11	3.39	0.84	0.1	-16%
Dumping of mineral concentrates onto stockpiles	0.0056	0.0026	0.0004	0.0083	0.0039	0.0006	48%
FEL transfer of mineral concentrates from stockpile to rail wagon	0.017	0.008	0.001	0.025	0.012	0.002	48%
Wind erosion of mineral concentrate stockpiles	0.007	0.004	0.001	0.011	0.006	0.001	50%
TOTAL	**4.20**	**1.06**	**0.12**	**3.44**	**0.86**	**0.10**	**-15%**

* Katestone Environmental (2013)

Overall the Modification would result in a 15% reduction in emissions from the Ivanhoe Rail Facility.

Whilst the proposed increase in mineral concentrate handling and associated increase in mineral concentrate transport truck trips would increase emissions at the Ivanhoe Rail Facility, the addition of a bore at the Ivanhoe Rail Facility will provide water for dust suppression on the access road that would reduce emissions associated with wheel generated dust from mineral concentrate transport trucks. The addition of dust suppression on the haul road results in a 16% decrease in emissions in from wheel generated dust from access road despite the increase in mineral concentrate truck numbers compared to the Air Quality and Greenhouse Gas Assessment, which did not account for dust suppression on the haul road.

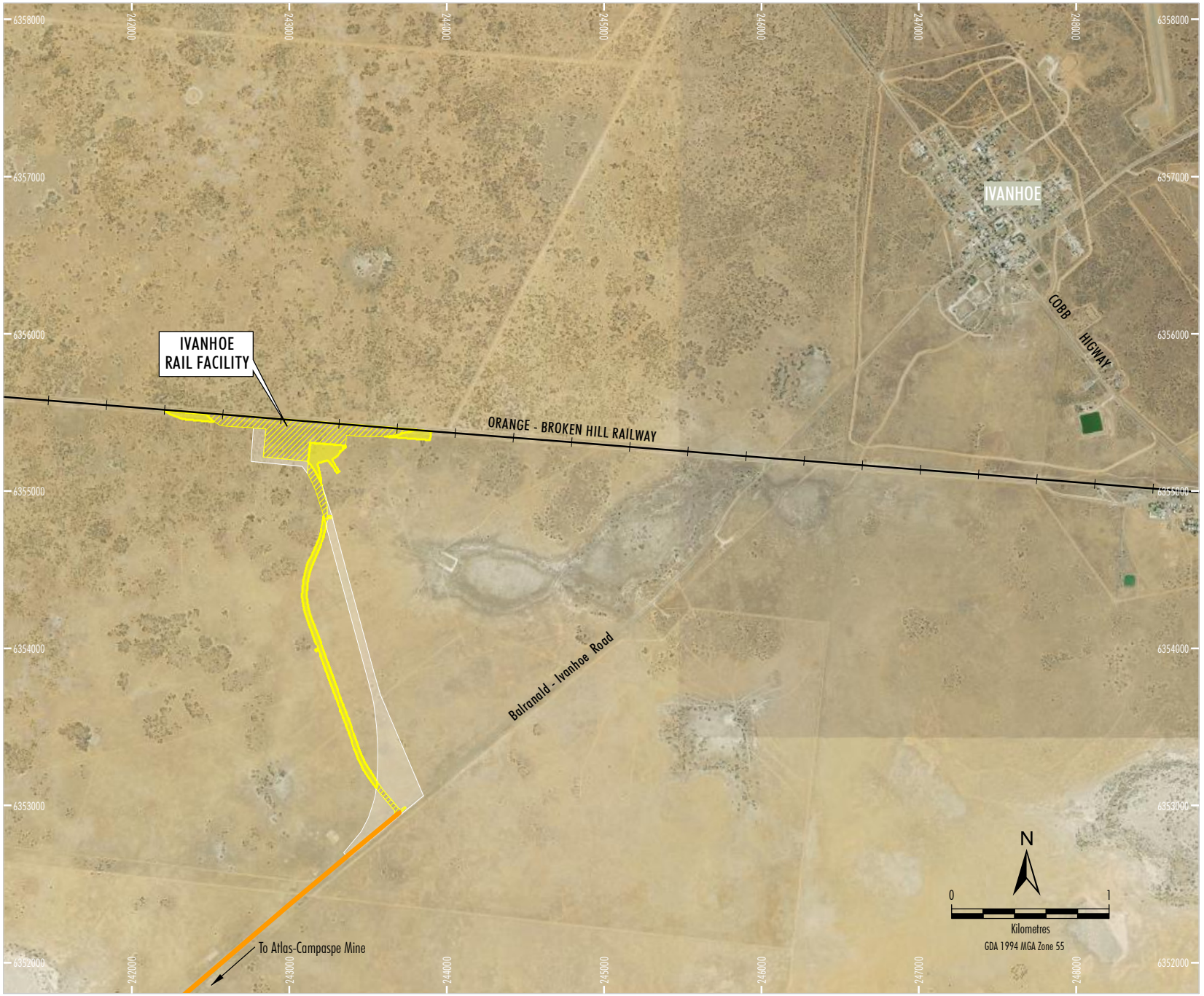
The modified Ivanhoe Rail Facility layout (e.g. minor changes to the site access road alignment and stockpile areas) also results in changes to emissions from wind erosion and wheel generated dust from the haul road.

Given that the Modification would result in reduction in emissions from the Ivanhoe Rail Facility (Table 6) and the distances to the nearest sensitive receptors (Figure 7), it is likely that the conclusions of the Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013) for the approved Project (Section 6.1) would remain valid, and the modified Project would not contribute to any additional exceedances of the relevant air quality criteria at any sensitive receptors in the vicinity of the Ivanhoe Rail Facility.

7.3 MINERAL CONCENTRATE TRANSPORT

Emissions of dust due to product transport along unsealed sections of the mineral concentrate transport route are expected to increase by approximately 46% due to the increase in trips per day from 24 to 35.

An increase in trips per day from 24 to 35 along the mineral concentrate transport route is however unlikely to result in additional exceedances of the relevant air quality criteria given the relatively small contribution of the mineral concentrate transport route emissions to ground-level concentrations, the reduction in this contribution with increasing distance from the mineral concentrate transport route and the distance between the mineral concentrate transport route and sensitive receptors.



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012); Tronox (2019)
Orthophoto: © NSW Department of Finance, Services & Innovation (2018)

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OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility and Surrounds

Figure 7

CMA-18-07 AC OM_ App AQA_203A

8. CONCLUSIONS

This Air Quality Review of the potential air quality impacts associated with the Modification is based on:

- A review of the existing air quality monitoring in the vicinity of the Atlas-Campaspe Mine
- A comparison of dust emissions for the modified Project with the information presented in the existing Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013) for the approved Project.

The Air Quality Review found that the Modification is unlikely to alter the outcomes of the Air Quality and Greenhouse Gas Assessment (Katestone Environmental, 2013) for the approved Project and the modified Project would not contribute to any additional exceedances of the relevant air quality criteria at any sensitive receptors in the vicinity of the Project.

9. REFERENCES

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APPENDIX C

NOISE REVIEW

ATLAS-CAMPASPE MINERAL SANDS PROJECT

OPTIMISATION MODIFICATION

APPENDIX C

NOISE REVIEW

TRONOX

ACOUSTICS AND AIR

ATLAS-CAMPASPE MINERAL SANDS PROJECT OPTIMISATION MODIFICATION

NOISE REVIEW

REPORT NO. 11241-A
VERSION A

JULY 2019

PREPARED FOR

TRONOX MINING AUSTRALIA LIMITED

WILKINSON MURRAY

DOCUMENT CONTROL

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A	Draft	12 April 2019	Lee Hudson	John Wassermann

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TABLE OF CONTENTS

GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

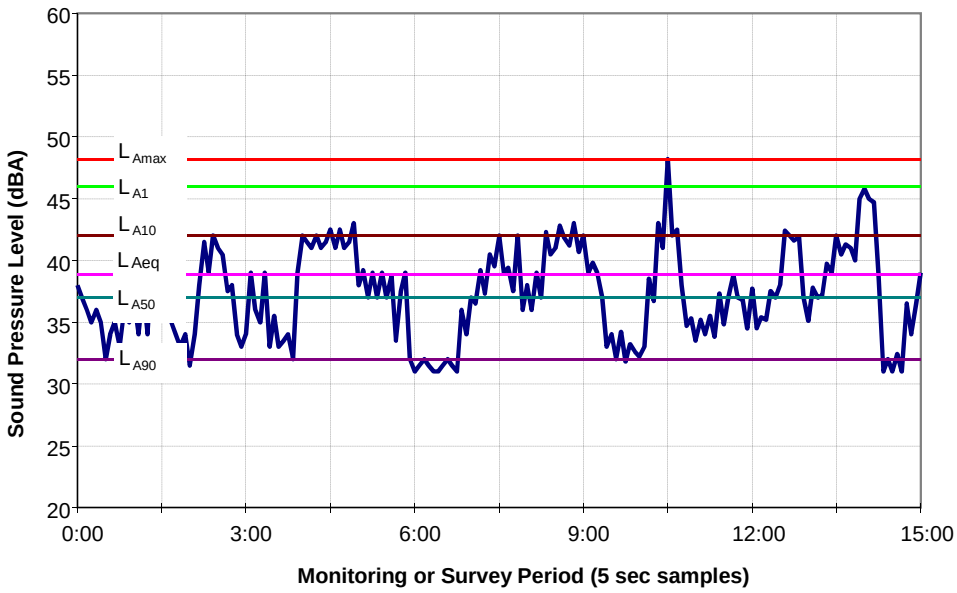
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

The Atlas-Campaspe Mineral Sands Project (the Project) is being developed by Cristal Mining Australia Limited, which will be renamed Tronox Mining Australia Limited (Tronox) on 25 July 2019. Development Consent (SSD_5012) for the Project was issued under the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* in 2014.

The Project includes the development of a mineral sands mining operation (herein referred to as the Atlas-Campaspe Mine), together with the construction and operation of a rail loadout facility located near the township of Ivanhoe (herein referred to as the Ivanhoe Rail Facility).

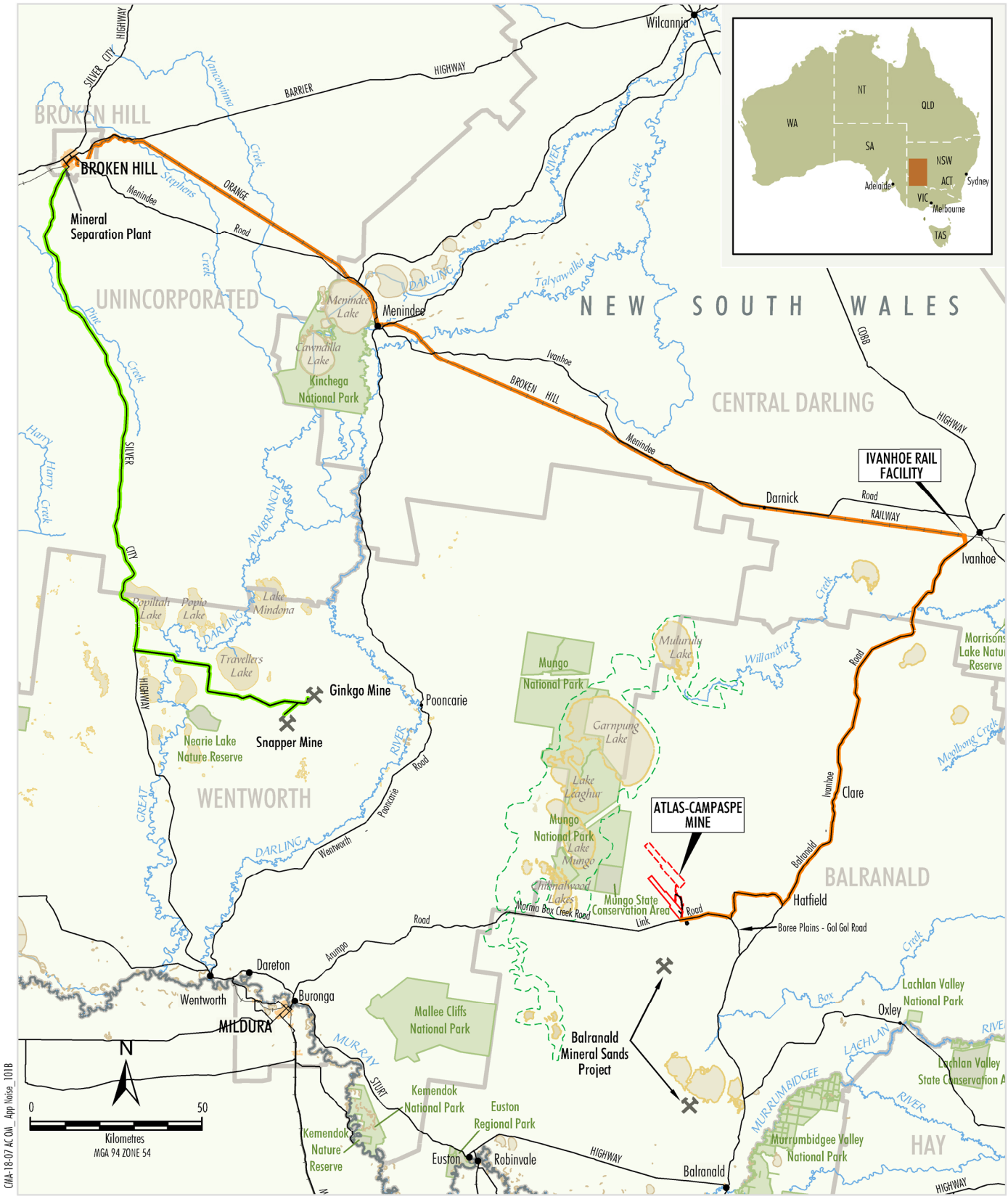
The Atlas-Campaspe Mine is located approximately 80 kilometres (km) north of Balranald, NSW and 270 km south-east of Broken Hill, NSW (Figure 1-1). The Ivanhoe Rail Facility is located approximately 135 km north-east of the Atlas-Campaspe Mine, and is approximately 4.5 km to the south-west of the township of Ivanhoe (Figure 1-1).

Product (mineral concentrates) generated as a result of operations at the Atlas-Campaspe Mine will be trucked to the Ivanhoe Rail Facility for transfer to train wagons, which will then be railed to the existing Broken Hill Mineral Separation Plant (the MSP) (Figure 1-1).

The Project will integrate with currently existing / approved Tronox operations in western NSW, including (Figure 1-1):

- the MSP – located in Broken Hill approximately 270 km north-west of the Atlas-Campaspe Mine;
- Snapper Mine – located approximately 105 km to the west of the Atlas-Campaspe Mine; and
- Ginkgo Mine – located approximately 100 km to the west of the Atlas-Campaspe Mine.

This Noise Review has been prepared to support the application to modify Development Consent (SSD_5012) for the Project.



LEGEND

- National Park, Regional Park or State Conservation Area
- Willandra Lakes Region World Heritage Area
- Local Government Area Boundary
- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Existing Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Approved Mineral Concentrate Transport Route*

Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012)

TRONOX

OPTIMISATION MODIFICATION

Regional Location

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines.

Figure 1-1

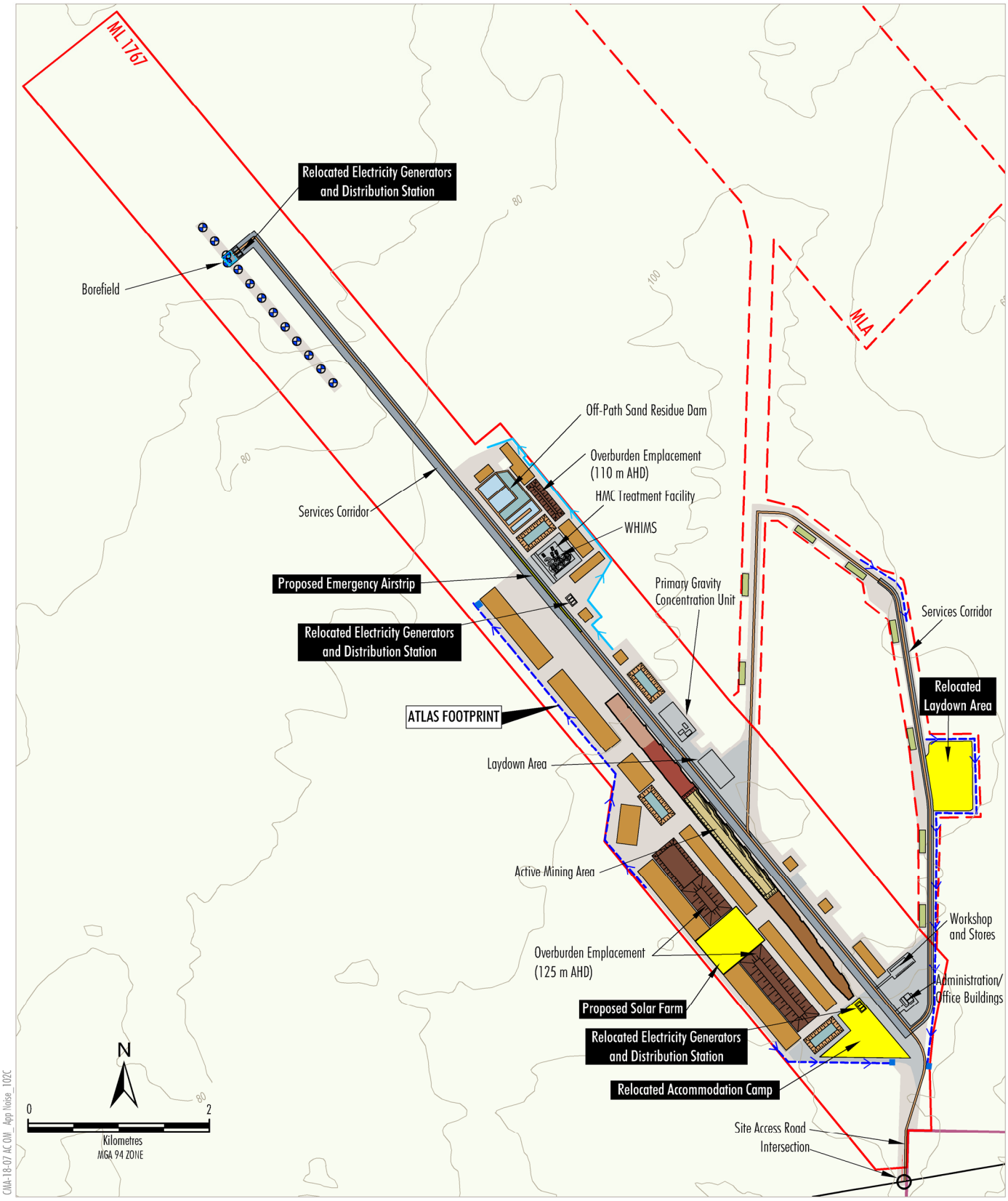
2 OVERVIEW OF THE MODIFICATION

Tronox proposes to modify Development Consent (SSD_5012) for the Project to allow for changes to optimise the Project (herein referred to the Optimisation Modification or Modification). The Modification would include:

- Increased mineral concentrate production from 546,000 tonnes per annum (tpa) to 665,000 tpa;
- Increased mineral concentrate transport from 450,000 tpa to 665,000 tpa;
- Increased mineral concentrate transport truck trips from 24 per day to 35 per day;
- Increased mineral concentrate transport train length (from 600 metres [m] to 920 m) and frequency (from six to eight train movements per week [i.e. four arrivals, four departures]);
- Increased MSP process waste disposal from 50,000 tpa to 65,000 tpa;
- The option to use an overland conveyor to transfer overburden in addition to haul trucks;
- The relocation of the Atlas-Campaspe Mine accommodation camp;
- The option to develop on-site solar power generation infrastructure at the Atlas-Campaspe Mine to supplement diesel generator sets (Figure 2-1);
- Development of an emergency airstrip at the Atlas-Campaspe Mine (Figure 2-1);
- Construction and operation of a telecommunications tower at the Atlas-Campaspe Mine;
- An extension to the Ivanhoe Rail Facility hardstand area (Figure 2-2);
- An extension of the Ivanhoe Rail Facility rail siding and addition of a passing siding (Figure 2-2);
- A revised alignment of the Ivanhoe Rail Facility access road and access road intersection (Figure 2-2);
- A groundwater supply bore for the Ivanhoe Rail Facility (Figure 2-2); and
- The use of local roads other than the road haulage route by Project-related light vehicles to access site (Figure 1-1).

The Modification would not change the following components of the Project:

- Mine path or mine life;
- Mining method;
- Mineral concentration methods;
- Overburden and ore extraction rate;
- Sand residue, coarse reject and process waste placement management;
- Annual maximum water supply/demand;
- Rehabilitation works;
- Biodiversity offset area; or
- Workforce.



Source: © NSW Department of Finance, Services & Innovation (2018); Cristal Mining Australia (2012) and Tronox (2019)

LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Exploration Licence Boundary (EL)
- Up-catchment Diversions
- Collection Drains
- Bore
- Approximate Extent of Surface Development - Year 2
- Fixed Infrastructure Areas
- Soil Stockpile
- Process Water Storage
- Overburden Emplacement
- Stage 1 Rehabilitation - Stabilised Landform with Seed/Cover Crop Application

Active Mining Area

- Vegetation Clearance/Soil Stripping
- Overburden Removal
- Ore Zone/Extraction Area
- Overburden Replacement/Process Waste Emplacement/Soil Replacement
- Sediment Basin

ACMSP Modification

- Modification Surface Development Area

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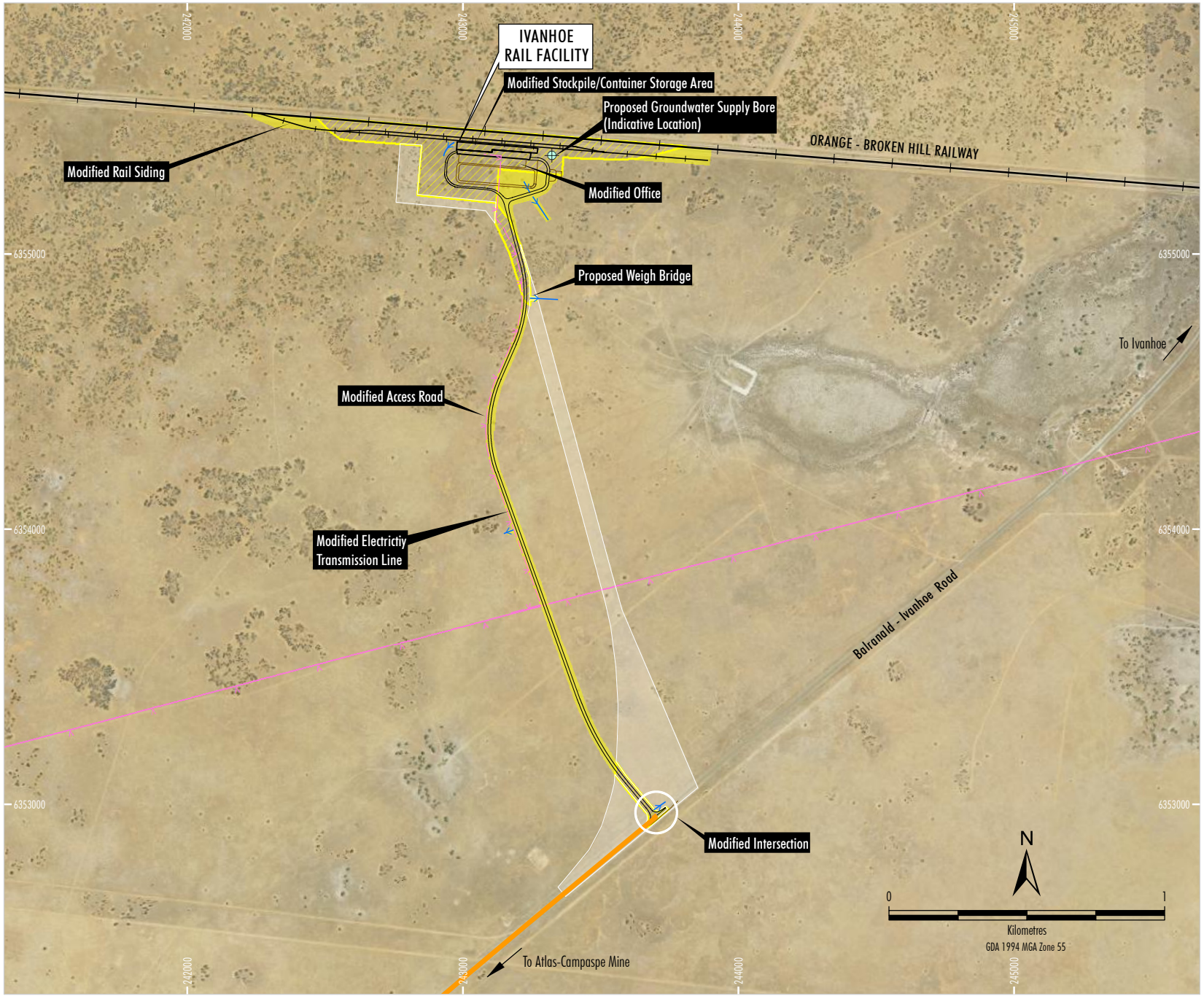
OPTIMISATION MODIFICATION

Modified Atlas-Campaspe Mine
General Arrangement - Year 2

Figure 2-1



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*
- Existing Electricity Transmission Line

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012); Tronox (2019)
Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

TRONOX

OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility
General Arrangement

Figure 2-2

3 NOISE CRITERIA

3.1 Operational Noise

The applicable operational noise criteria for the Project is stipulated in Condition 16, Schedule 3 of Development Consent (SSD_5012) and are reproduced in Table 3-1.

Table 3-1 Development Consent (SSD_5012) Operational Noise Criteria

Location	Day	Evening	Night	
	$L_{Aeq,15min}$	$L_{Aeq,15min}$	$L_{Aeq,15min}$	$L_{Aeq,1min}$
All privately-owned land	35	35	35	45
Mungo National Park & Mungo State Conservation Area	50	50	50	-

The applicable operational noise criteria for the Project (Table 3-1) were based on rating background levels (RBL) of 30 dBA for the day, evening and night periods (i.e. the minimum RBLs assumed for assessment purposes in accordance with the procedures documented in the Industrial Noise Policy [INP] [Environmental Protection Authority, 2000]), based on the background noise survey conducted by Wilkinson Murray (2012) for the approved Project (Section 4.2).

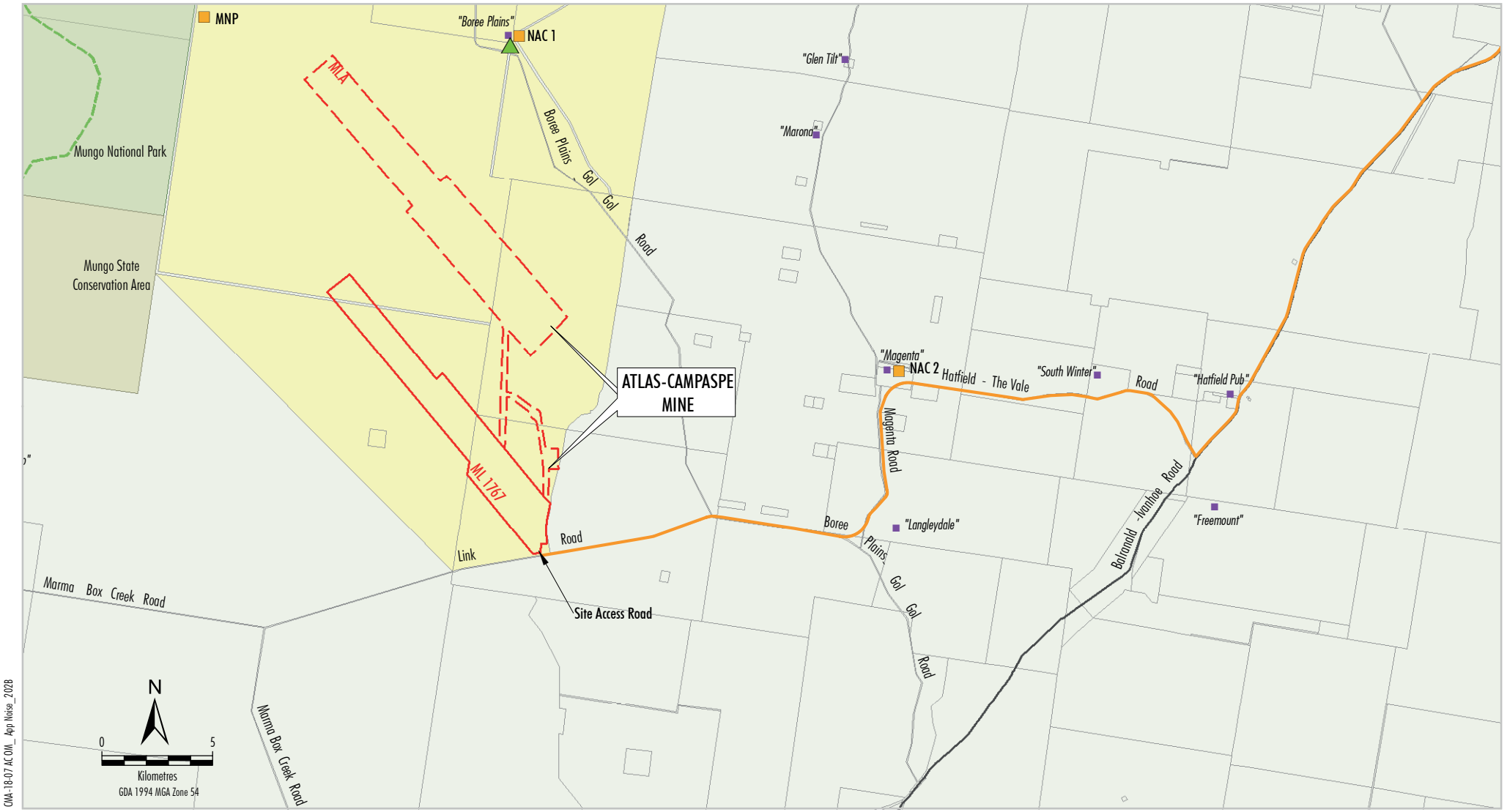
In accordance with Condition 16, Schedule 3 of Development Consent (SSD_5012), the criteria in Table 3-1 do not apply under the following meteorological conditions:

- Periods of rain or hail;
- Average wind speed exceeding 5 metres per second (m/s);
- Wind speeds greater than 3 m/s at 10 m above ground level; or
- Temperature inversions greater the 3 degrees Celsius (°C) / 100 m.

Also in accordance with Condition 16, Schedule 3 of Development Consent (SSD_5012), these criteria do not apply where Tronox has an agreement with the owner/s or leaseholders of the residence to generate higher noise levels, and Tronox has advised the Department of Planning and Environment in writing of the terms of this agreement.

Tronox holds Environment Protection Licence (EPL) 21007 issued under the NSW *Protection of the Environment Operations Act 1997* for the Project. Condition L3.1 details the criteria applicable to noise generated by the operations measured at each monitoring point established under EPL 21007. The EPL 21007 operational noise criteria are shown in Table 3-2.

The monitoring locations are as identified in the Noise Management Plan (Cristal Mining Australia [CMA], 2018) prepared in accordance with Condition 18, Schedule 3 of Development Consent (SSD_5012) and are shown on Figure 3-1.



OMA-18-07 AC OM_ App Noise_202B

LEGEND

- Mining Lease Boundary (ML 1767)
- Mining Lease Application Boundary (MLA)
- Willandra Lakes Region World Heritage Area
- National Park
- State Conservation Area
- Tronox Owned Land
- Private Landholder
- Dwelling
- Approved Mineral Concentrate Transport Route
- Automatic Weather Station
- Noise Monitoring Location

Source:© NSW Department of Finance, Services & Innovation (2017); Cristal Mining Australia (2012)

TRONOX

OPTIMISATION MODIFICATION

Atlas-Campaspe Mine - Noise Monitoring Sites

Figure 3-1

Table 3-2 EPL 21007 Operational Noise Criteria

Location	Noise Level (Day, Evening and Night) $L_{Aeq,15min}$ dBA
Mungo National Park (MNP)	50
NAC1 "Boree Plains"	35
NAC2 "Magenta"	35

dBA = A-weighted decibel

The Noise Management Plan (CMA, 2018) also includes monitoring locations representative of privately-owned receivers most likely to be affected by noise generated by the Ivanhoe Rail Facility (NI1, NI2 and NI3). NI1, NI2 and NI3 and are shown in Figure 3-2. NI1 is representative of Ivanhoe Township, NI2 represents residences on the Cobb Highway and NI3 represents the Warakirri Correctional Centre.

The EPL 21007 operational noise criteria are consistent with Development Consent (SSD_5012).

Noise Policy for Industry Project Trigger Levels

The *Noise Policy for Industry* (NPfI) (Environment Protection Authority [EPA], 2017) outlines a process for determining Project Noise Trigger Levels for assessing potential operational noise impacts, and supersedes the INP (EPA, 2000).

The Project Noise Trigger Levels for the Project determined in accordance with the NPfI are outlined in Table 3-3.

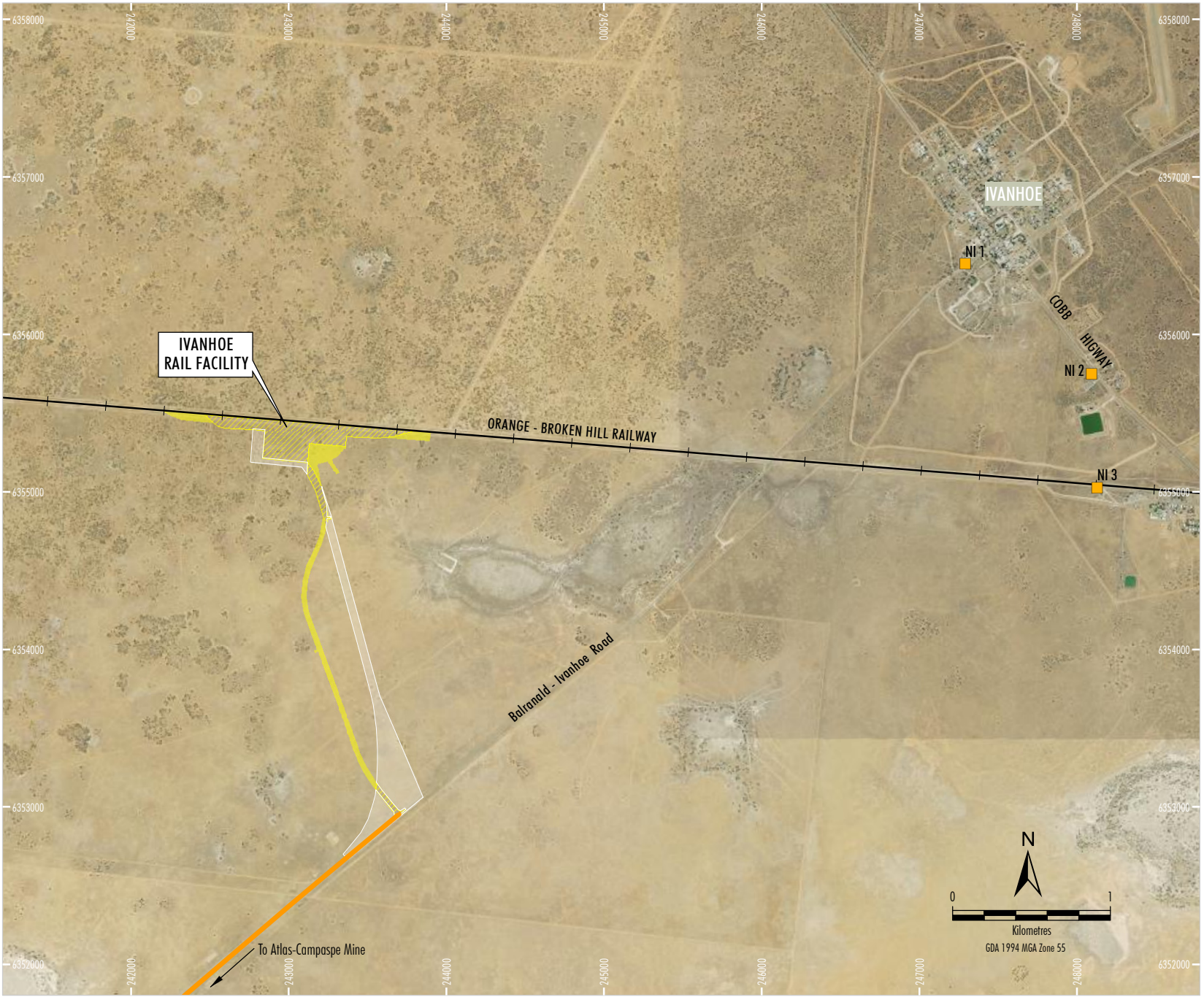
Table 3-3 NPfI Project Noise Trigger Levels

Location	Day	Evening	Night	
	$L_{Aeq,15min}$	$L_{Aeq,15min}$	$L_{Aeq,15min}$	L_{AFmax}
All privately-owned land	40	35	35	52

The Project Noise Trigger Levels outlined in Table 3-3 are based on the following:

- RBLs of 35 dBA, 30 dBA, and 30 dBA (i.e. the minimum assumed RBLs in accordance with the NPfI) for the day, evening and night periods respectively, based on the background noise survey conducted by Wilkinson Murray (2012) for the approved Project (Section 4.2).
- The surrounding receivers are situated in an area which would be classified as "Rural" under the NPfI, and the relevant recommended $L_{Aeq,Period}$ amenity noise levels are 50 dBA, 45 dBA and 40 dBA for daytime, evening and night time periods, respectively.

The existing Development Consent and EPL 21007 noise criteria (Tables 3-1 and 3-2) are more stringent than the NPfI Project Noise Trigger Levels outlined in Table 3-3. The potential noise impacts of the Modification have been assessed against the NPfI criteria in Section 7.



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*
- Noise Monitoring Location

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012); Tronox (2019)
Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

TRONOX

OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility - Noise Monitoring Sites

Figure 3-2

CMA-18-07 AC OM_ App Noise_203B

3.2 Road Traffic Noise

Development Consent (SSD_5012) does not stipulate any quantitative criteria in regard to noise from road or rail traffic. Condition 17, Schedule 3 of Development Consent (SSD_5012) does however include operating conditions to manage and minimise road or rail traffic emissions as follows:

The Applicant shall:

(a) implement all reasonable and feasible measures to minimise the construction, operational, road and rail noise of the development;

…

(d) only use locomotives and rolling stock that are approved to operate on the NSW rail network in accordance with the noise limits in the ARTC's EPL.

Criteria for assessment of noise from traffic on public roads are set out in the NSW *Road Noise Policy* (RNP) (Department of Environment, Climate Change and Water, 2011). These criteria are shown in Table 3-4.

Table 3-4 Criteria for Traffic Noise – Residences

Type of Development	Noise Level Criterion	
	Day (7am-10pm)	**Night (10pm-7am)**
Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15hour}$ 60 dBA	$L_{Aeq,9hour}$ 55 dBA
Existing residences affected by **additional traffic** on existing local roads generated by land use developments.	$L_{Aeq,1hour}$ 55 dBA	$L_{Aeq,1hour}$ 50 dBA

The RNP states:

> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

The RNP defines daytime as 7.00am to 10.00pm and night time as 10.00pm to 7.00am.

Noise monitoring location NAC2 ("Magenta"), as shown on Figure 3-1, is representative of the privately-owned receiver most likely to be affected by noise generated by Project road traffic on the road haulage route.

3.3 Rail Traffic Noise

Criteria for assessment of noise from rail traffic operating on the Orange-Broken Hill Railway are documented in the Australian Rail Track Corporation's (ARTC) (operator of the Orange-Broken Hill Railway) EPL 3142. Condition L6 of EPL 3142 does not nominate specific environmental noise limits but notes that:

> *It is an objective of this Licence to progressively reduce noise levels to the goals of 65 dB(A)Leq, (day time from 7am – 10pm), 60 dB(A)Leq, (night time from 10pm – 7am) and 85dB(A) (24 hr) max pass-by noise, at one metre from the façade of affected residential properties through the implementation of the Pollution Reduction Programs.*

In addition, the EPA's *Environmental Assessment Requirements for Rail Traffic – Generating Developments* (Office of Environment and Heritage, 2012) provides rail noise assessment criteria which are presented in Table 3-5.

Table 3-5 EPA Rail Noise Assessment Criteria

Descriptor	Rail Traffic Noise Goal
$L_{Aeq,24hour}$	60 dBA
Maximum Pass-by L_{Amax} (95th percentile)	85 dBA

Note: 95th percentile equates to the 5% exceedance value.

The EPA's rail noise assessment criteria are similar to the ARTC's EPL 3142 noise goals, however, the EPA assessment criteria have an averaging period of 24 hours, rather than daytime (15 hours) and night time (9 hours) as for the ARTC's EPL 3142 noise goals. The EPA rail noise assessment requirements also provide:

> *Where the cumulative noise level exceeds the noise assessment trigger levels, and project-related noise increases are predicted, all feasible and reasonable noise mitigation measures should be implemented. As a general principle, where the reduction of existing noise levels can be achieved through feasible and reasonable measures, a reduction in noise levels to meet the noise assessment trigger levels is the primary objective. In all cases where the LAeq noise level increases are more than 2dB(A), strong justification should be provided as to why it is not feasible or reasonable to reduce the increase.*

In addition, the EPA's *Environmental Assessment Requirements for Rail Traffic – Generating Developments* also provide guidance in relation to the geographical extent of rail noise assessment which should be undertaken for a rail traffic generating development (such as the Project):

> *Ideally, the geographical extent of the rail noise assessment should be to where project/related rail noise increases are less than 0.5dB. This roughly equates to where project/related rail traffic represents less than 10% of total line/corridor rail traffic.*

The EPA's *Rail Infrastructure Noise Guideline* (EPA, 2013) provides the following criteria for rail traffic generating developments:

Rail traffic generating developments

- $L_{Aeq,9hour}$ = 55 dBA;
- $L_{Aeq,15hour}$ = 60 dBA; and
- L_{Amax} (95th percentile) = 80 dBA.

4 EXISTING NOISE ENVIRONMENT

4.1 Receiver Locations

The potentially sensitive receiver locations in vicinity of the Project areas are shown on Figure 3-1 and Figure 3-2.

The Boree Plains residence (Tronox owned) is the closest residence to the Atlas-Campaspe Mine footprint and is located approximately 7 km away from the Campaspe deposit and approximately 18 km away from the Atlas deposit (where Project activities are occurring) (Figure 3-1). Other rural residences (e.g. Marona, Glen Tilt, Magenta and Langleydale) are located at least 14 km away from the Atlas-Campaspe Mine footprint (Figure 3-1).

The closest residential receivers to the mineral concentrate transport route in the Project area were identified as follows (and are shown on Figure 3-1):

- South Winter – approximately 1 km from Hatfield-The Vale Road;
- Magenta – approximately 0.8 km from Magenta Road;
- Langleydale – approximately 1.3 km from Magenta Road;
- Kilfera – approximately 1.5 km from Balranald-Ivanhoe Road; and
- Hatfield Pub – approximately 49 m from Balranald-Ivanhoe Road.

The township of Ivanhoe is representative of the closest residential area to the Ivanhoe Rail Facility. The Ivanhoe Rail Facility is located approximately 4.5 km from Ivanhoe (Figure 3-2).

4.2 Ambient Noise Monitoring

Monitoring to characterise the noise environment of the area surrounding the Project was carried out by Wilkinson Murray (2012) for the Project. The survey results are shown in Table 4-1.

Table 4-1 Background Noise Survey Results

Location	Site	Monitoring Period	RBL (dBA)		
			Day	Evening	Night
Boree Plains (NAC1)	Atlas-Campaspe Mine	15/11/2011 to 30/11/2011	28	27	24
Min Min		15/11/2011 to 26/11/2011	25	25	25
32 Mitchell Street, Ivanhoe (NI1)	Ivanhoe	12/04/2012 to 19/04/2012	28	29	25

dBA = A-weighted decibel

4.3 Compliance Noise Monitoring

Compliance noise monitoring in accordance with the Noise Management Plan (CMA, 2018) was carried out by GHD on behalf of Tronox on 14 May 2018. The results are shown in Table 4-2. No mechanically-generated noise was audible from the Atlas-Campaspe Mine throughout the measurement period and the measured levels are well below the Project-specific noise limits as required under Development Consent (SSD_5012) and EPL 21007 conditions.

Table 4-2 Compliance Survey Ambient Noise Monitoring Results

Location	Time	Measured Noise Levels dBA		Estimated Project Contribution dBA
		$L_{Aeq,15min}$	$L_{A90,15min}$	$L_{Aeq,15min}$
NAC2	1022-1037	24	18	Inaudible
NAC2	1040-1055	24	18	Inaudible
NAC1	1146-1200	28	19	Inaudible
NAC1	1207-1222	27	19	Inaudible
MNP	1326-1340	23	19	Inaudible
MNP	1345-1359	24	18	Inaudible

4.4 Meteorology

4.4.1 General

At relatively large distances from a source the resultant noise levels from a noise source will be influenced by meteorological conditions, specifically:

- wind; and
- temperature gradients.

Wind can increase noise at a receiver when it blows from the direction of the noise source at relatively low wind speeds (below 3 m/s). An increase in wind strength greater than 3 m/s generally results in a corresponding increase in wind noise at the receiver which masks noise from the source under investigation.

Temperature inversions (positive temperature gradients) can increase noise levels at surrounding receivers by the reflection of sound waves from warmer upper layers of air. Temperature inversions occur predominantly at night.

In assessing noise impacts, the criteria are expected to apply under weather conditions that are likely to occur at a particular site for a significant period of time.

The NPfI describes two approaches for assessing these effects; the simple and the more detailed approach.

The simple approach forgoes a detailed analysis of meteorological data and simply applies given default meteorological parameters to predict noise levels. This approach assumes that meteorological effects are present for a significant amount of time, avoiding the need to quantify these effects in detail. It is conservative, in that it is likely to predict the upper range of increases in noise levels due to meteorological conditions.

The more detailed approach involves an analysis of meteorological data to determine whether inversions and/or wind effects are significant features warranting assessment. Where assessment is warranted, default parameters are available for use in predicting noise or where preferred, measured values maybe used instead.

Tronox has installed an automatic weather station (AWS) at the Atlas-Campaspe Mine (Figure 3-1). In the absence of data from the AWS, the following summary of the synthetic site-specific meteorological data for both the Atlas-Campaspe Mine and the Ivanhoe Rail Facility are as presented in the Katestone Environmental Pty Ltd (2012) *Air Quality and Greenhouse Gas Assessment* prepared for the Project.

4.4.2 Wind

Figure 4-1 and Figure 4-2 show seasonal wind roses for the Atlas-Campaspe Mine and the Ivanhoe Rail Facility, respectively. For both sites the highest frequencies of winds generally occur from the south and southwest.

Figure 4-1 Seasonal Wind Roses for the Atlas-Campaspe Mine (Katestone, 2012)

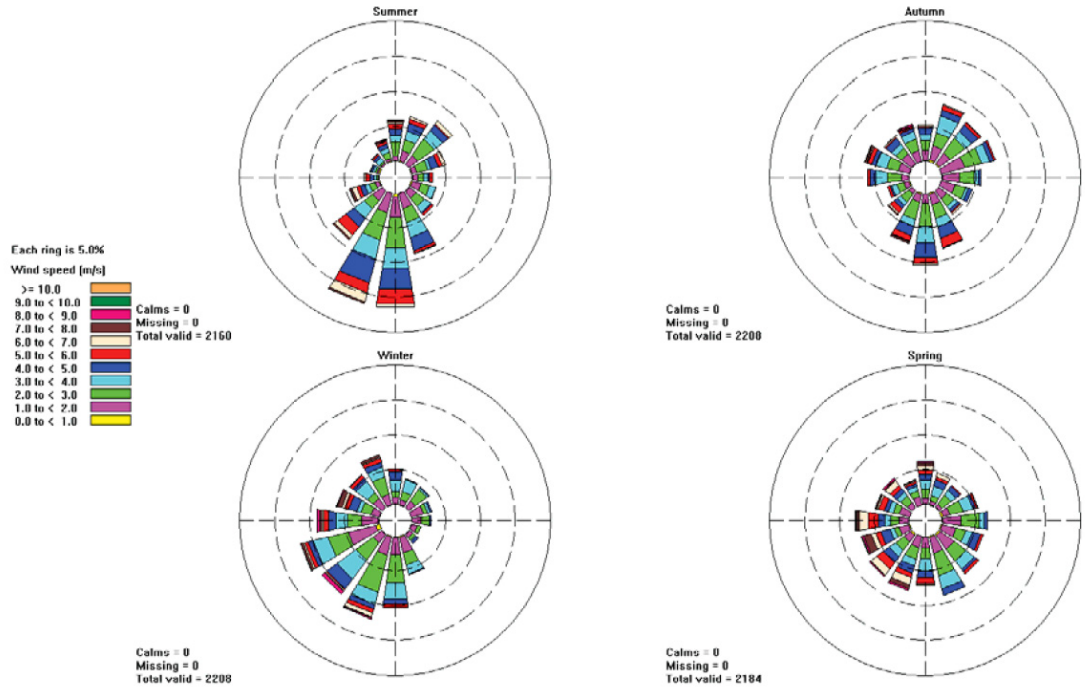


Figure 4-2 Seasonal Wind Roses for the Ivanhoe Rail Facility (Katestone, 2012)

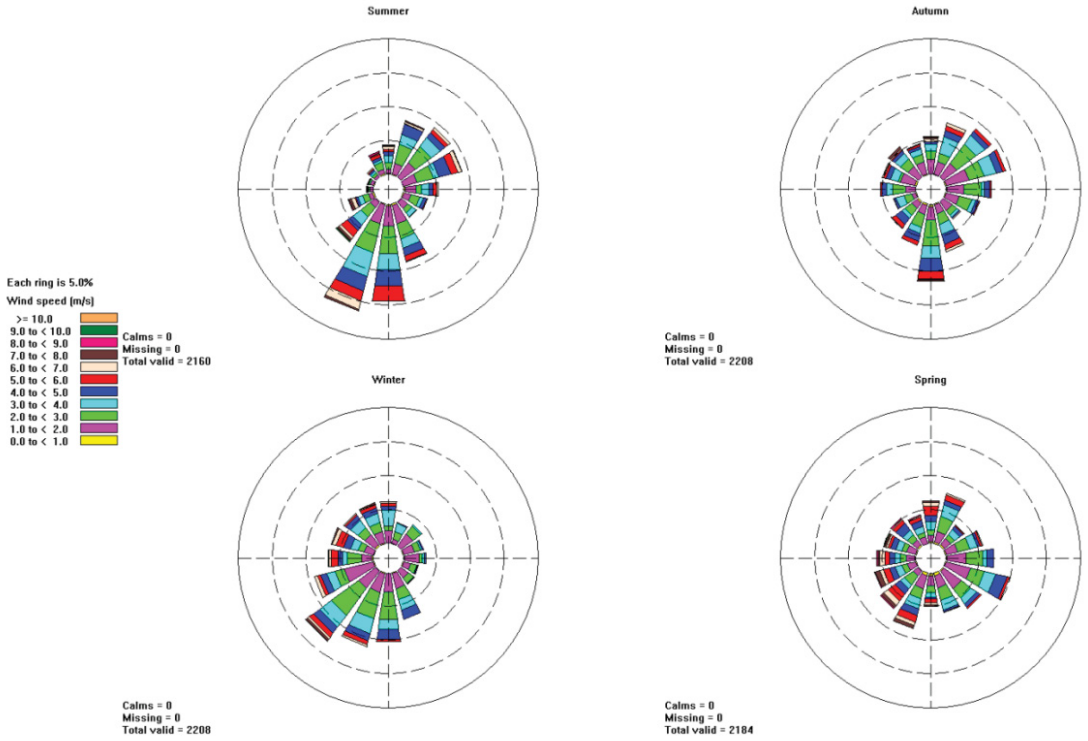


Figure 4-1 and Figure 4-2 indicate that the winds at the Atlas-Campaspe Mine and Ivanhoe Rail Facility are similar and can be considered predominantly moderate. These figures also show that approximately 50 percent (%) of winds are between 2 and 4 m/s, with little seasonal variation.

4.4.3 Temperature Inversion

Pasquill-Gifford stability conditions indicate the potential for temperature inversions. There are seven stability classes referred to as A to G. The predicted frequencies of occurrence of stability class are shown in Table 4-3 and Table 4-4 for the Atlas-Campaspe Mine and for the Ivanhoe Rail Facility, respectively.

Pasquill-Gifford stability conditions A to D indicate lapse conditions (negative temperature gradient). Pasquill-Gifford stability conditions E to G indicate temperature inversion conditions, E indicating a temperature gradient of between -0.5 and 1.5 ^{o}C / 100 m, F indicating a temperature gradient of between 1.5 and 4^{o}C / 100 m and G indicating a temperature gradient greater than 4^{o}C / 100 m.

Table 4-3 Distribution of Atmospheric Stability Categories for the Atlas-Campaspe Mine

Stability	Percentage Occurrence
A	1.3
B	7.9
C	18.2
D	28.9
E	11.3
F/G	32.4

Table 4-4 Distribution of Atmospheric Stability Categories for the Ivanhoe Rail Facility

Stability	Percentage Occurrence
A	1.5
B	8.6
C	19.1
D	26.8
E	9.4
F/G	34.6

Stability Classes F and G apply normally at night when winds are light, and the sky is clear. Class E describe intermediate conditions between those described above.

There is a high percentage of D, E, F and G class conditions for both areas (Table 4-3 and Table 4-4), reflecting a prevalence of stable meteorological conditions.

4.5 Meteorological Conditions Used for Noise Assessment Purposes

For the detailed noise assessment carried out for the Project, Wilkinson Murray (2012) used the following INP (EPA, 2000) default meteorological parameters to predict noise levels at each receiver. The Project area is located in an arid/semi-arid area that has annual average rainfall of less than 500 millimetres. For such conditions, the INP recommends the following default meteorological conditions that enhance noise levels:

- Strong (G-class stability category) inversions:

  8^{o}C / 100 m inversion strength and source-to-receiver drainage flow wind of 1 m/s.

- Gradient wind:

  Source-to-receiver gradient wind of 3 m/s.

Comparison of the synthesised wind and temperature inversion conditions with the INP default conditions indicates that the INP default meteorological conditions provide a maximum-case scenario in terms of enhancement of operational noise due to meteorological factors.

The NPfI recommends different default meteorological conditions that enhance noise levels under the conditions experienced at the Project:

- 4^{o}C / 100 m inversion strength and source-to-receiver drainage flow wind of 2 m/s.

The default meteorological parameters adopted by Wilkinson Murray (2012) in accordance with the INP are considered to be conservative in the context of the NPfI default meteorological conditions.

5 EXISTING NOISE MANAGEMENT

Noise management at the Project is undertaken in accordance with the Noise Management Plan (CMA, 2018). The Noise Management Plan (CMA, 2018) was prepared in accordance with Condition 18, Schedule 3 of Development Consent (SSD_5012) and includes the following noise management measures for the Project:

- Development and implementation of an equipment maintenance schedule to maintain equipment noise emission levels and reduce the likelihood of tonal noise impacts;
- Development and implementation of a noise awareness program to educate employees on the effects of noise and quiet work practices;
- Drivers will be made aware of the potential for noise impact through site-specific inductions and staff education programs to reinforce quiet driving styles/attitudes;
- An awareness of industry developments will be maintained in relation to noise mitigation engineering for individual plant items in order to assess inherent cost and practicability;
- The number of vehicle trips to and from the Atlas-Campaspe Mine will be optimised by ensuring that transport trucks are loaded to their operating capacity;
- All loose and rattling truck body parts will be fixed or tightened to minimise noise emissions from 'body rumble' (i.e. when loose panels vibrate when a truck hits a bump, causing noise to emanate from the panel);
- The use of locomotives and rolling stock that are approved to operate on the NSW rail network in accordance with ARTC's EPL 3142; and
- Implementation of operational changes to minimise noise impacts during periods of adverse meteorological conditions in accordance with Condition 17(c), Schedule 3 of Development Consent (SSD_5012).

Tronox has advised that no noise-related complaints have been received to date.

6 OVERVIEW OF PREVIOUS ASSESSMENT

Wilkinson Murray (2012) prepared a Noise Assessment for Project in accordance with the *Industrial Noise Policy* (EPA 2000) and considered the noise impacts associated with the Atlas-Campaspe Mine, Ivanhoe Rail Facility and mineral concentrate transport between the Atlas-Campaspe Mine and the MSP.

6.1 Atlas-Campaspe Mine Site

Operational noise emissions at the Atlas-Campaspe Mine were modelled for two scenarios, namely (Wilkinson Murray, 2012):

- An initial construction scenario (Year 1) where infrastructure will be built, dry mining unit (DMU) assembled, etc. The construction activities will be largely concentrated at the south-eastern end of the Atlas footprint. The mobile fleet will include construction specific items.
- A typical maximum-case operational scenario when all plant is working concurrently during Year 16 with operations 24 hours a day. The major items of mobile fleet will be consistent throughout the life of the Project. As such, Year 16 of operations was chosen for modelling due to its proximity to the nearest residential receiver (Boree Plains).

A schedule of major operational and construction mobile and fixed equipment for the Atlas-Campaspe Mine relevant to Year 1 (i.e. the plant with potential to contribute to noise levels at the receiver locations) and the modelled sound power level (SWL) associated with each item was prepared and is reproduced in Table 6-1.

The predicted Year 1 noise levels for the Atlas-Campaspe Mine (including maximum case Year 1 under meteorological gradient wind of 3 m/s and night time noise contours for 8°C / 100 m inversion strength and 1 m/s wind) complied with Project-specific noise criteria of 35 dBA for all modelled receivers.

Table 6-1 Approved Equipment and Sound Power Levels– Year 1

Equipment	Construction No. of Units	L_{Aeq} SWL (dBA)	Source
Backhoe (CAT 330B)	1	102	WM Measurements
Bobcat	1	97	WM Measurements
Bus (Toyota Coaster)	2	109	WM Measurements
Road Roller/Compactor (CAT 825G)	2	109	WM Measurements
Scraper (Water Cart) (CAT 740)	1	115	WM Measurements
Grader (CAT 16G)	2	108	WM Measurements
Front End Loader (IT62G)	1	113	WM Measurements
Crane (GROVE RT650E/ LIEBHERR LTM 1100)	4	105	WM Measurements
Mobile Fuel Tank (MACK)	1	109	WM Measurements

Equipment	Construction No. of Units	L_{Aeq} SWL (dBA)	Source
1,000 kVA Generators	4	98	WM Measurements
Scraper / Laser Bucket (Case STX 535/ New Holland t9060)	9	115	WM Measurements
Dozer (CAT D11)	3	116	WM Measurements
Excavator (EX 1900/PC1800)	3	114	WM Measurements
Haul Truck (CAT 777D)	12	115	WM Measurements
Water Truck (CAT 773)	2	115	WM Measurements
Service Truck (MACK)	1	109	WM Measurements
Maintenance Truck (Isuzu)	1	109	WM Measurements
Lighting Tower (ALL Light)	8	103	WM Measurements
Garbage Truck	1	109	WM Measurements
Electric Pump	4	103	WM Measurements
Sewage Treatment Plant	1	97	WM Measurements
Accommodation Block	1	102	WM Measurements
Total		130	

Source: Wilkinson Murray (2012)
WM Measurements = Wilkinson Murray Measurements
kVA = kilovolt-ampere

For the Year 16 operational noise scenario, a schedule was prepared of the indicative major operational mobile and fixed equipment for the Atlas-Campaspe Mine relevant to mining operations (i.e. the plant with potential to contribute to noise levels at the receiver locations) and the modelled SWL associated with each item. The plant and equipment schedule is reproduced in Table 6-2.

Based on the Year 16 modelling, noise levels associated with the Atlas-Campaspe Mine (including those under maximum-case meteorological gradient wind of 3 m/s and also night time 8°C / 100m inversion strength and 1 m/s wind) were predicted to readily comply with Project-specific noise criteria of 35 dBA for all modelled receivers for the life of the Atlas-Campaspe Mine.

Table 6-2 Approved Equipment and Sound Power Levels – Years 2-20

Equipment	No. of Units	L_{Aeq} SWL (dBA)	Source
Dozer (CAT D11)	4	116	WM Measurements
Excavator (EX1900/PC1700)	4	114	WM Measurements
Scraper (Water Cart) (CAT740)	1	115	WM Measurements
Front End Loader (CAT990)	3	113	WM Measurements
Front End Loader (CAT IT62G)	1	113	WM Measurements
Grader (CAT 16G)	2	108	WM Measurements
Road Roller/Compactor (CAT 825G)	1	109	WM Measurements
Front End Loader (CAT980H)	2	111	WM Measurements
Water Truck (CAT 773)	2	115	WM Measurements

Equipment	No. of Units	L_{Aeq} SWL (dBA)	Source
1,000 kVA generators	4	98	WM Measurements
Haul Truck (CAT 777D)	12	115	WM Measurements
Scraper (Laser Bucket) (Case STX535/New Holland t9060)	9	115	WM Measurements
DMUs	2	112	Holmes Air Sciences (2007)
Primary Gravity Concentration Unit	1	103	Holmes Air Sciences (2007)
Electric Pumps	16	103	Holmes Air Sciences (2007)
Truck (Kenworth T650)	2	109	WM Measurements
Bobcat	1	97	WM Measurements
Bus (Toyota Coaster)	2	109	WM Measurements
Crane (GROVE RT650E/ LIEBHERR LTM 1100)	1	105	WM Measurements
Mobile Fuel Tank (MACK)	1	109	WM Measurements
Service Truck (MACK)	1	109	WM Measurements
Maintenance Truck (Isuzu)	1	109	WM Measurements
Lighting Tower (ALL Light)	8	103	WM Measurements
Garbage Truck (International 8 m^3)	1	109	WM Measurements
Sewerage Treatment plant	1	97	WM Measurements
Accommodation Block	1	102	WM Measurements
Total		131	

Source: Wilkinson Murray (2012)
WM Measurements = Wilkinson Murray Measurements
kVA = kilovolt-ampere

Noise levels at the boundary of the Mungo National Park, the Mungo State Conservation Area and the Willandra Lakes Region World Heritage Area were also predicted to readily comply with the relevant amenity criteria of 50 dBA for an "area specifically reserved for passive recreation" during maximum case operations. Noise levels would be less than 20 dBA and would likely be inaudible in most instances (Wilkinson Murray, 2012).

Modelling of L_{Amax} noise levels at nearby receivers was undertaken for typical instantaneous noise sources, such as reversing alarms. This analysis concluded that predicted noise levels would comply comfortably with the 45 dBA $L_{A1,1\ min}$ criterion applicable to assessment of potential sleep disturbance at all privately-owned receivers.

Consideration was given to the potential cumulative impacts associated with the construction and operation of the Iluka Resources Limited Balranald Mineral Sands Project (SSD-5285). Based upon the Project Scoping Report for the Balranald Mineral Sands Project (Iluka Resources Limited, 2012), mining of the West Balranald and Nepean deposits would be undertaken in series. Whilst mining is being undertaken at the Atlas deposit, operations at the Balranald Mineral Sands Project would be focussed on the West Balranald deposit (approximately 45 km south of the Atlas deposit). By the time operations at the Balranald Mineral Sands Project progress to the Nepean deposit (northern-most deposit) Project mining operations would be focussed at the Campaspe deposit.

The Balranald Mineral Sands Project would be operating at its northern-most extent during Year 11 of operations at the Atlas-Campaspe Mine. This would result in a distance between the operational ore extraction areas of the Atlas-Campaspe Mine and the Balranald Mineral Sands Project (Nepean deposit) of approximately 21 km.

Modelling demonstrated that the maximum-case operational noise contour of 35 dBA resulting from the Atlas-Campaspe Mine would extend no further than approximately 4.5 km south from the Atlas-Campaspe Mine active mining area.

Accordingly, it was concluded that no cumulative noise impact would occur from the coincident construction or operation of the Project and the Balranald Mineral Sands Project (Wilkinson Murray, 2012).

6.2 Ivanhoe Rail Facility

Table 6-3 outlines the indicative equipment schedule and associated SWLs adopted for modelling and assessment of Ivanhoe Rail Facility.

Table 6-3 Sound Power Levels and Proposed Equipment – Ivanhoe Rail Facility

Equipment	No. of Units	L_{Aeq} SWL (dBA)	Source
Front End Loader (Cat 988)	1	114	WM Measurements
Truck (Kenworth T650)	1	109	WM Measurements
Forklift (Hyster 12 to 16 tonne)	1	106	WM Measurements
Locomotive (81 class Locomotive)	2	109	WM Measurements
Total		117	

Under the maximum-case meteorological gradient wind of 3 m/s scenario and night time 8°C / 100 m inversion strength and 1 m/s wind assessment scenario, the predicted 35 dBA operational noise contour was established not to extend as far as the Ivanhoe township. As such, it was concluded that operational noise would achieve Project-specific noise limits at all modelled receivers.

Modelling of L_{Amax} noise levels at nearby receivers was undertaken for typical instantaneous noise sources, such as reversing alarms. This analysis concluded that predicted noise levels would comply comfortably with the 45 dBA $L_{A1,1\ min}$ criterion applicable to assessment of potential sleep disturbance at all privately-owned receivers.

6.3 Road Traffic

The Road Transport Assessment (GTA, 2012) projected the future traffic volumes on roads in the Project region for Year 1 and Year 20[1] of operations. Traffic noise levels at the closest residential receiver (Magenta residence which is approximately 0.8 km from Magenta Road [Figure 3-1]) were predicted by Wilkinson Murray (2012) based on the estimated traffic scenarios presented in the Road Transport Assessment (GTA, 2012). The predicted traffic noise levels at the Magenta residence were found to be well within both day and night time road traffic noise criteria. Accordingly, the criteria would be met at all other receivers along the road.

[1] Year 20 projections include a conservative estimate of traffic generated by the Balranald Mineral Sands Project.

Balranald-Ivanhoe Road represents the greatest potential cumulative impact of light vehicle traffic from the Project and the Balranald Mineral Sands Project. An assessment of road traffic-related noise was undertaken to determine the anticipated noise levels as a result of potential cumulative increased traffic volumes (particularly light vehicle movements) as presented in the Road Transport Assessment (GTA, 2012). The noise levels were evaluated for compliance with the relevant road noise criteria by Wilkinson Murray (2012) and it was concluded that the relative increase in traffic noise level resulting from the Project-related traffic movements on the Balranald-Ivanhoe Road is likely to be less than 2dB. The RNP states that *an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

6.4 Rail Traffic

Mineral concentrates and MSP process waste will be railed between the Ivanhoe Rail Facility and the MSP via the Orange-Broken Hill Railway. The Project will result in a maximum of two train passbys in any one 24-hour period and the following scenarios could occur:

- Scenario 1 – two train passbys occurring during the daytime (between 7.00am and 10.00pm); or
- Scenario 2 – one passby occurring during the day (between 7.00am and 10.00 pm) and one at night (between 10.00pm and 7.00am); or
- Scenario 3 – two passbys occurring at night (between 10.00pm and 7.00am).

The existing and proposed noise levels at different setback distances from the Orange-Broken Hill Railway were calculated. Prediction of the existing and future proposed offset distances from the Orange-Broken Hill Railway in order to meet the relevant criteria concluded:

- The maximum increase in distance from the railway line at which the ARTC EPL criteria are met including the Project rail movements, compared with the existing/approved rail movements, would be 3 m for daytime operations and 5 m for night time operations. It is anticipated that this increase in distance would not result in any additional exceedances of the daytime criterion, however, would result in an additional exceedance of night time criterion at two additional residential receivers along the Orange-Broken Hill Railway.
- The maximum increase in distance from the railway line at which the EPA criteria are met including the Project rail movements, compared with the existing/approved rail movements, would be 2 m for 24-hour operations. This increase in distance would not result in any additional exceedances of criterion at residential receivers along the Orange-Broken Hill Railway.
- There would be no change to the maximum passby noise as a result of the Project rail movements.

The predicted noise levels indicated that for the Orange-Broken Hill Railway west of the Ivanhoe Rail Facility the peak noise increase associated with the Project was predicted to be approximately 0.7 dBA. Given that the peak Project related noise increase is anticipated to be less than 2 dBA, an assessment of 'reasonable and feasible' noise mitigation measures was not considered necessary.

7 ASSESSMENT OF MODIFIED POTENTIAL NOISE IMPACTS

7.1 Operational Noise Atlas-Campaspe Mine Site

7.1.1 Methodology

Prediction of operational noise levels at the identified receiver locations for the detailed noise assessment was carried out using the Environmental Noise Model (ENM). Factors that are addressed in the modeling are:

- equipment sound level emissions and location;
- screening effects from buildings (if relevant);
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

The Wilkinson Murray (2012) modelling assumed all plant and equipment to be operating concurrently and as such, the predicted results are considered to be conservative.

To assess any potential changes in the previously predicted noise levels (and associated potential noise impact) (Section 6.1), a screening assessment has been conducted based upon changes to the plant and equipment schedules for Year 1 (construction) and Year 2 onwards. The total SWLs of the overall approved mining fleets for each previously assessed stage have been compared with the total SWLs of the modified mining fleets. Where no change in the overall SWLs would occur as a result of the Modification, further modelling of noise emissions is not required.

7.1.2 Operational Noise – Year 1

Table 7-1 shows the indicative modified major operational and construction mobile and fixed equipment for the Atlas-Campaspe Mine in Year 1 (i.e. the plant with potential to contribute to noise levels at the receiver locations) and the modelled SWL associated with each item.

No changes are proposed to either the approved major operational and construction mobile and fixed equipment during the Year 1 stage as a result of the Modification. Given the above, the modified Project operational noise levels during Year 1 would be unchanged from the predicted noise levels in Wilkinson Murray (2012) for the approved Project.

The modified Year 1 noise levels from the Atlas-Campaspe Mine would therefore comply with Project-specific noise criteria of 35 dBA for all modelled receivers under neutral and adverse meteorological conditions.

As described in Section 3.1, the existing Development Consent and EPL 21007 noise criteria (Tables 3-1 and 3-2) are more stringent than the NPfI Project Noise Trigger Levels outlined in Table 3-3. Given the above, the modified Year 1 noise levels from the Atlas-Campaspe Mine are therefore expected to comply with relevant NPfI Project Noise Trigger Levels.

Table 7-1 Modified Equipment and Sound Power Levels – Year 1

Equipment	Construction No. of Units	L_{Aeq} SWL (dBA)	Source
Backhoe (CAT 330B)	1	102	WM Measurements
Bobcat	1	97	WM Measurements
Bus (Toyota Coaster)	2	109	WM Measurements
Road Roller/Compactor (CAT 825G)	2	109	WM Measurements
Scraper (Water Cart) (CAT 740)	1	115	WM Measurements
Grader (CAT 16G)	2	108	WM Measurements
Front End Loader (IT62G)	1	113	WM Measurements
Crane (GROVE RT650E/ LIEBHERR LTM 1100)	4	105	WM Measurements
Mobile Fuel Tank (MACK)	1	109	WM Measurements
1,000 kVA Generators	4	98	WM Measurements
Scraper / Laser Bucket (Case STX 535/New Holland t9060)	9	115	WM Measurements
Dozer (CAT D11)	3	116	WM Measurements
Excavator (EX 1900/PC1800)	3	114	WM Measurements
Haul Truck (CAT 777D)	12	115	WM Measurements
Water Truck (CAT 773)	2	115	WM Measurements
Service Truck (MACK)	1	109	WM Measurements
Maintenance Truck (Isuzu)	1	109	WM Measurements
Lighting Tower (ALL Light)	8	103	WM Measurements
Garbage Truck	1	109	WM Measurements
Electric Pump	4	103	WM Measurements
Sewage Treatment Plant	1	97	WM Measurements
Accommodation Block	1	102	WM Measurements
Total		130	

WM Measurements = Wilkinson Murray Measurements
kVA = kilovolt-ampere

7.1.3 Operational Noise – Year 2 Onwards

Table 7-2 shows the indicative modified major operational mobile and fixed equipment for the Atlas-Campaspe Mine for Year 2 onwards (i.e. the plant with potential to contribute to noise levels at the receiver locations) and the modelled SWL associated with each item.

The changes to the mining equipment fleet proposed as a result of the Modification would involve inclusion of alternative models of excavator, front end loader, grader and haul trucks. The SWLs of these alternative models would not be higher than the levels previously nominated by Wilkinson Murray (2012) for the approved Project, nor would there be any resulting change in the overall SWL of the total fleet.

Table 7-2 Optimisation Modification Sound Power Levels and Proposed Equipment – Year 2 Onwards

Equipment	No. of Units	L_{Aeq} SWL (dBA)	Source
Dozer (CAT D11)	4	116	WM Measurements
Excavator (EX1900/PC1700/**Cat6040**)	4	114	WM Measurements
Scraper (Water Cart) (CAT740)	1	115	WM Measurements
Front End Loader (CAT990/**980**)	3	113	WM Measurements
Front End Loader (CAT IT62G)	1	113	WM Measurements
Grader (CAT 16G, **24H**)	2	108	WM Measurements
Road Roller/Compactor (CAT 825G)	1	109	WM Measurements
Front End Loader (CAT980H)	2	111	WM Measurements
Water Truck (CAT 773)	2	115	WM Measurements
1,000 kVA generators	4	98	WM Measurements
Haul Truck (CAT 777D/**785/793**)	12	115	WM Measurements
Scraper (Laser Bucket) (Case STX535/New Holland t9060)	9	115	WM Measurements
DMUs	2	112	Holmes Air Sciences (2007)
Primary Gravity Concentration Unit	1	103	Holmes Air Sciences (2007)
Electric Pumps	16	103	Holmes Air Sciences (2007)
Truck (Kenworth T650)	2	109	WM Measurements
Bobcat	1	97	WM Measurements
Bus (Toyota Coaster)	2	109	WM Measurements
Crane (GROVE RT650E/ LIEBHERR LTM 1100)	1	105	WM Measurements
Mobile Fuel Tank (MACK)	1	109	WM Measurements
Service Truck (MACK)	1	109	WM Measurements
Maintenance Truck (Isuzu)	1	109	WM Measurements
Lighting Tower (ALL Light)	8	103	WM Measurements
Garbage Truck (International 8 m^3)	1	109	WM Measurements
Sewerage Treatment plant	1	97	WM Measurements
Accommodation Block	1	102	WM Measurements
Total		131	

The Modification includes the possible addition of conveyors to transfer some or all of the overburden rather than the currently approved haul trucks. The SWL of a typical conveyor system has previously been measured at 100 dBA/100 m, which is significantly lower than that generated by haul or product trucks. This introduction of conveyors would reduce noise emissions generated by Atlas-Campaspe Mine operations.

With no change expected in the overall SWL associated with mining operations from Year 2 onwards, there would be no change in operational noise predicted noise levels in Wilkinson Murray (2012) for the approved Project.

The Modification would therefore not change the operational noise propagated to the surrounding environment from Year 2 onwards and noise levels at the surrounding receiver locations considered would be below 35 dBA under neutral and adverse meteorological conditions.

As described in Section 3.1, the existing Development Consent and EPL 21007 noise criteria (Tables 3-1 and 3-2) are more stringent than the NPfI Project Noise Trigger Levels outlined in Table 3-3. Given the above, the modified noise levels from the Atlas-Campaspe Mine for Year 2 onwards are therefore expected to comply with relevant NPfI Project Noise Trigger Levels.

7.2 Ivanhoe Rail Facility

Table 7-3 outlines the modified Ivanhoe Rail Facility equipment (i.e. the plant with potential to contribute to noise levels at the receiver locations) and the SWL.

Table 7-3 Optimisation Modification Sound Power Levels & Proposed Equipment – Ivanhoe Rail Facility

Equipment	No. of Units	L_{Aeq} SWL (dBA)	Source
Front End Loader (Cat 988)	1	114	WM Measurements
Truck (Kenworth T650)	1	109	WM Measurements
Forklift (Hyster 12 to 16 tonne)	1	106	WM Measurements
Reach Stacker Kalmar DRT450 2014 MODEL	1	110	Kalmar measured data
Water cart 16,000L	1	115	WM Measurements
Locomotive (81 class Locomotive)	2	109	WM Measurements
Total		120	

With the addition of a Reach Stacker and water cart, the overall SWL associated with the Ivanhoe Rail Facility operations would increase by a maximum 3 dBA, assuming concurrent operation of all sources.

The Modification would therefore not significantly change the operational noise propagated to the surrounding environment and noise levels at the surrounding receiver locations considered would be below 35 dBA under neutral and adverse meteorological conditions.

Computer modelling of the modified Ivanhoe Rail Facility, based on the model developed by Wilkinson Murray (2012), confirmed that noise levels at the surrounding receiver locations considered would be below 35 dBA (generally below 30 dBA) under neutral and adverse meteorology.

7.3 Road Traffic Noise

The Modification includes an increase in the mineral concentrate transport truck trips from 24 per day to 35 per day. This proposed increase represents a potential 1.6 dBA increase in noise level over the daytime and night time periods (assuming equivalent distribution of vehicles over daytime and night time periods).

On this basis the predicted noise levels at the residential receivers previously assessed by Wilkinson Murray (2012) are presented in Table 7-4.

Table 7-4 Calculated Traffic Noise Levels – Optimised Modification

Location	Predicted Noise Level dBA	Criterion Day / Night dBA	Complies
Magenta	Peak 1 hour $L_{Aeq,1hour}$ 38	55 / 50	Yes
Hatfield – The Vale Road	Peak 1 hour $L_{Aeq,1hour}$ 38	55 / 50	Yes
Balranald / Ivanhoe Road (Kilfera)	$L_{Aeq,15hour}$ / $L_{Aeq,9hour}$ (Day / Night) <25 / <25	60 / 55	Yes
Hatfield Pub	$L_{Aeq,15hour}$ / $L_{Aeq,9hour}$ (Day / Night) 45 / 46	60 / 55	Yes
Balranald-Ivanhoe Road – South of the proposed Balranald Mineral Sands Project Location J	$L_{Aeq,15hour}$ / $L_{Aeq,9hour}$ (Day / Night) 57 / 53	60 / 55	Yes

Noise generated by increased traffic associated with the modified Project complies with the relevant assessment criteria at all receiver locations.

7.4 Rail Traffic Noise

Under the Modification, mineral concentrate transport train length would increase from 600 m to 920 m and train frequency would increase from six to eight train movements per week (i.e. four arrivals, four departures). The hardstand area and rail siding would be extended to accommodate the increase train length. There is also a revised alignment of the Ivanhoe Rail Facility access road and access road intersection (Figure 3-2).

The proposed increase in train frequency is not expected to result in any change to the number of train movements per day. Train movements would occur over additional days per week. Accordingly, the approved rail noise impacts as previously assessed in Wilkinson Murray (2012) would remain unchanged as follows:

- No additional exceedance of the ARTC EPL daytime criterion, however an additional exceedance of night time criterion at two additional residential receivers along the Orange-Broken Hill Railway locations within 5 m of the railway line.
- The EPA criteria would be met with no additional exceedances of the criterion at residential receivers along the Orange-Broken Hill Railway.
- There would be no change to the maximum passby noise as a result of the optimised Project rail movements.

8 CONCLUSION

This Noise Review has reviewed the aspects of the Modification that have the potential to generate noise to the surrounding environment. These operations have been reviewed in relation to the Noise Assessment (Wilkinson Murray, 2012) previously prepared for the Project.

This review concludes that the proposed modifications at the Atlas-Campaspe Mine are not expected to cause any significant increase in operational noise levels at the nearest surrounding receivers. All operational noise criteria (including NPfI Project Noise Trigger Levels) are predicted to be achieved.

Noise emissions due to proposed modifications at the Ivanhoe Rail Facility would not result in any significant increase in noise levels at surrounding receivers. All operational noise criteria (including NPfI Project Noise Trigger Levels) are predicted to be achieved.

Road traffic noise resulting from the modified Project would meet the relevant regulatory limits at receivers located in proximity to the transport routes.

Noise generated as a result of Project rail movements would not increase as a result of the proposed modifications to Project rail operations. In summary, the Noise Review found that the Modification is unlikely to significantly alter the outcomes of the Noise Assessment (Wilkinson Murray, 2012) for the approved Project.

9 REFERENCES

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APPENDIX D

VEGETATION CONDITION ASSESSMENT

ATLAS-CAMPASPE MINERAL SANDS PROJECT

OPTIMISATION MODIFICATION

APPENDIX D

VEGETATION CONDITION ASSESSMENT

TRONOX

ATLAS-CAMPASPE MINERAL SANDS PROJECT
OPTIMISATION MODIFICATION

VEGETATION CONDITION ASSESSMENT

Project No. CMA-18-07
Document No. 00987790

1 INTRODUCTION

The Atlas-Campaspe Mineral Sands Project (the Project) is being developed by Cristal Mining Australia Limited, which will be renamed Tronox Mining Australia Limited (Tronox) on 25 July 2019. Development Consent (SSD_5012) for the Project was issued under the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* in 2014.

The Project includes the development of a mineral sands mining operation (herein referred to as the Atlas-Campaspe Mine), together with the construction and operation of a rail loadout facility located near the township of Ivanhoe (herein referred to as the Ivanhoe Rail Facility).

Tronox is seeking to modify the Project under section 4.55(2) of the EP&A Act. The Project Optimisation Modification (the Modification) would include changes to the approved Ivanhoe Rail Facility, resulting in a modified surface development footprint (Figure 1). There would be a net reduction (approximately 12 hectares [ha]) in the amount of native vegetation clearance associated with the modified Ivanhoe Rail Facility (Figure 1).

1.1 PURPOSE

This report has been prepared to document the condition of the vegetation in the additional surface development area associated with the modified Ivanhoe Rail Facility (approximately 10.2 ha), compared to the condition of the vegetation in the surface development area associated with the approved Ivanhoe Rail Facility that would no longer be required to be cleared (approximately 22.1 ha).

2 METHODS

2.1 VEGETATION MAPPING

Flora surveys of the approved Ivanhoe Rail Facility surface development area were conducted by Australian Museum Business Services (AMBS) in October 2012 (AMBS, 2013). The surveys were undertaken using standard techniques (quadrats, rapid data points, vegetation mapping, condition assessment and threatened species searches) in accordance with the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation, 2004).

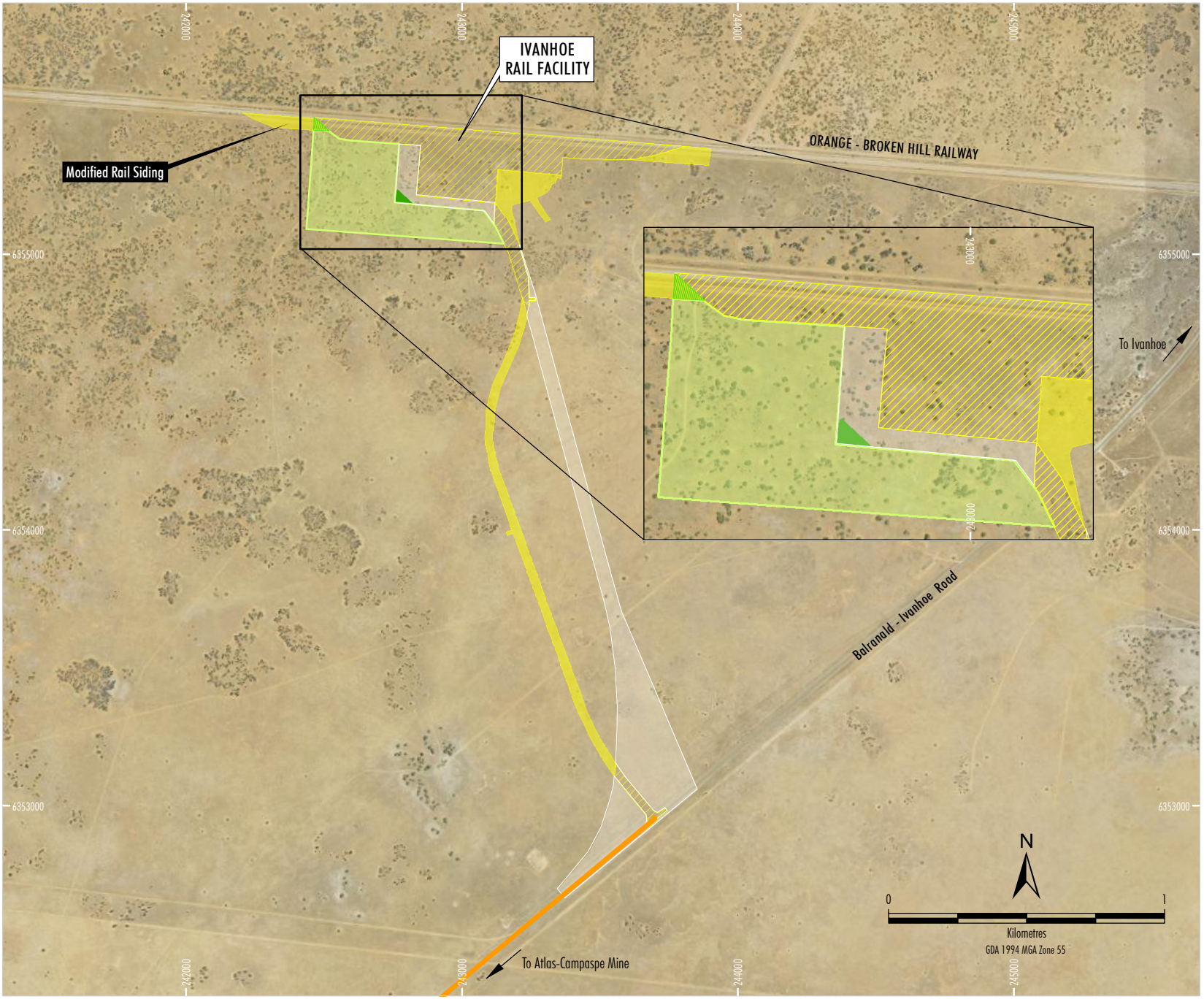
Regional mapping of Plant Community Types (PCTs) (Office of Environment and Heritage [OEH], 2019a) was considered in the assignment of vegetation communities mapped by AMBS (2013) to PCTs as per the BioNET Vegetation Classification (OEH, 2019b).

The Ivanhoe Rail Facility is located in the Darling Depression IBRA Subregion of the Murray Darling Depression IBRA Region (Commonwealth Department of Environment and Energy, 2012). It is also located in the Ivanhoe – Nangara Sandplains Mitchell Landscape (OEH, 2018).

2.2 VEGETATION CONDITION

A vegetation condition assessment of the modified Ivanhoe Rail Facility surface development area was carried out by Botanist Greg Cranston (GHD) on 19 and 20 June 2019. The assessment consisted of nine vegetation plots; five located in the approved Ivanhoe Rail Facility surface development area no longer required, and four located in the modified Ivanhoe Rail Facility surface development area (Figure 2). The number of vegetation plots and data collected at each plot was in accordance with the Biodiversity Assessment Method (BAM) (OEH, 2017).

A vegetation integrity score (VIS) was then calculated using the data obtained by GHD for each of the plots using the BAM Calculator. The calculations were carried out by Jamie Gleeson (Resource Strategies) (assessor accreditation number 0056).



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*
- Approved Vegetation Management Area
- Approved Vegetation Managment Area to be Replaced
- Replacement Vegetation Management Area

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2015); Tronox (2019) Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

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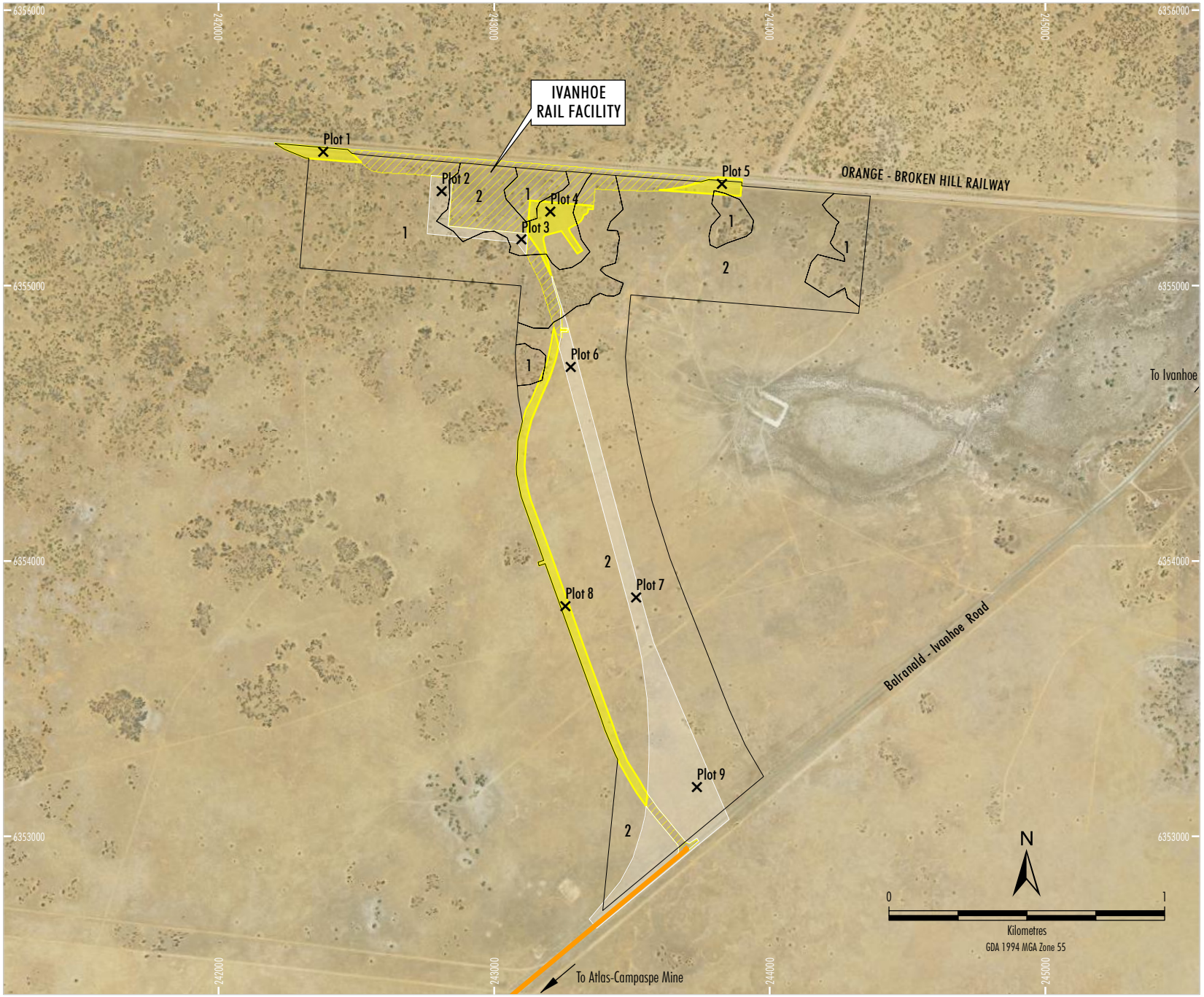
OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility - Surface Development Area

Figure 1

CMA-18-07 AC OM App VC_201B



LEGEND

- Approved Surface Development Area Required
- Additional Surface Development Area
- Approved Surface Development Area not Required
- Approved Mineral Concentrate Transport Route*

Vegetation Communities

- 1 Belah-Rosewood/Acacia Woodland
- 2 Native Grassland/Sparse Acacia/ Chenopod Shrubs
- × Survey Location

* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines

Source: Cristal Mining Australia (2012); AMBS (2012); Tronox (2019) and GHD (2019)
Orthophoto: © NSW Department of Finance, Services & Innovation (2017)

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OPTIMISATION MODIFICATION

Modified Ivanhoe Rail Facility - Vegetation Communities

Figure 2

CMA-18-07 AC OM App VC_202B

3 RESULTS

The same vegetation communities/PCTs recorded in the approved Ivanhoe Rail Facility surface development area (i.e. Native Grassland/Sparse Acacia/Chenopod Shrubs (PCT 166) and Belah-Rosewood/Acacia (PCT 57) are present in the modified Ivanhoe Rail Facility surface development area (Figure 2). No threatened ecological communities under the *Biodiversity Conservation Act, 2016* Act or *Environment Protection and Biodiversity Conservation Act, 1999* occur in either the approved or modified surface development areas. It is unlikely that rare or threatened flora species would occur in the paddock due to the high level of disturbance from agricultural practises.

The vegetation condition plot data for the modified Ivanhoe Rail Facility surface development area is provided in Appendix A and for the approved Ivanhoe Rail Facility surface development area no longer required is provided in Appendix B.

Outputs from the BAM Calculator included scores for composition, structure and function attributes (Table 1). The modified Ivanhoe Rail Facility surface development area has a VIS of 31.3 for PCT 57 and 31 for PCT 166, while the approved Ivanhoe Rail Facility surface development area no longer required has a VIS of 21.3 for PCT 57 and 21 for PCT 166 (Table 1).

Table 1
Ivanhoe Rail Facility Vegetation Integrity Scores

PCT	Area (ha)	BAM Calculator Output			
		Composition Condition Score	Structure Condition Score	Function Condition Score	VIS[1]
Modified Surface Development Area (Plots 1, 4, 5 and 8)					
57[2]	1.7	66.6	16.6	27.7	31.3
166[3]	8.5	71.3	13.5	-	31.0
Approved Surface Development Area (No Longer Required) (Plots 2, 3, 6, 7 and 9)					
57[2]	1.8	62.9	14.5	10.6	21.3
166[3]	20.4	75.6	5.8	-	21.0

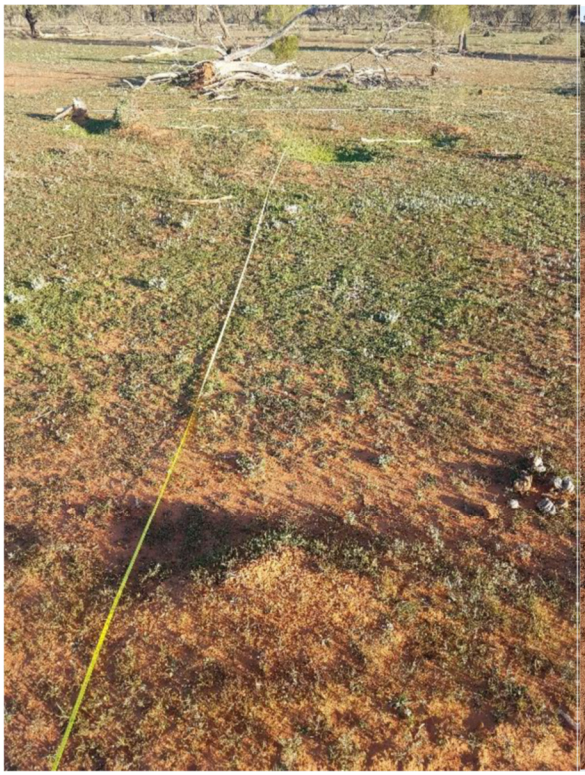
[1] The vegetation integrity score is the measure of vegetation integrity as calculated in the BAM Calculator using input from plot data. Vegetation integrity is the condition of native vegetation assessed for each vegetation zone against the benchmark for the PCT.

[2] PCT 57 – Belah/Black Oak – Western Rosewood – Wilga woodland of central NSW including the Cobar Peneplain Bioregion.

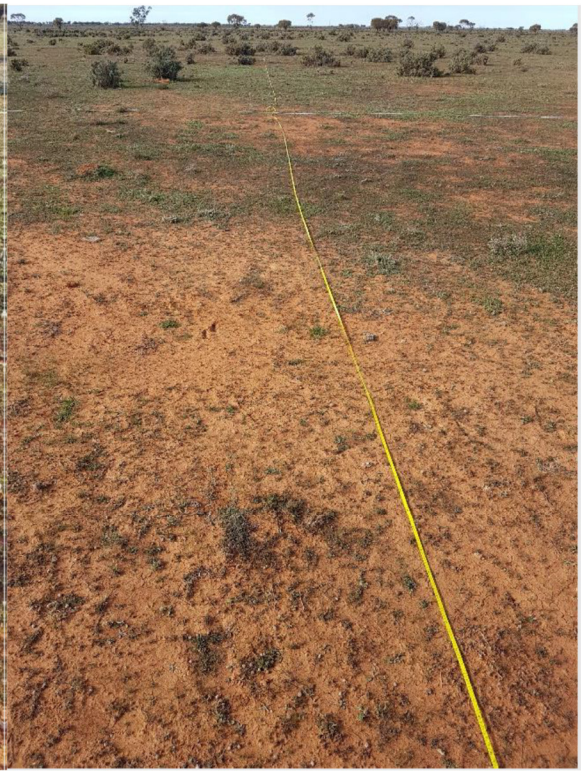
[3] PCT 166 – Disturbed annual saltbush forbland on clay plains and inundation zones mainly of south-western NSW.

The apparent differences in the calculated VIS between the modified Ivanhoe Rail Facility surface development area and approved Ivanhoe Rail Facility surface development area no longer required is likely natural variation and not an actual measure that the vegetation is in better condition in the modified Ivanhoe Rail Facility surface development area. The reasons for this are:

- the quantities of vegetation clearance are so small such that the BAM (OEH, 2017) only requires minimal plots to be sampled (e.g. <2 ha clearance of PCT 57 is sampled by a single BAM plot in accordance with the BAM [OEH, 2017]);
- there are no obvious differences in the vegetation of the respective areas (Plates 1 to 4 and 5 to 9); and
- the vegetation in the paddock is subject to the same agricultural practises and thus has been subject to the same disturbances such as grazing by goats, introduction of non-native vegetation and clearing.



Plot 1 – PCT 57



Plot 4 – PCT 166

Plot 5 – PCT 166

Plot 8 – PCT 166

Plates 1 to 4 Modified Ivanhoe Rail Facility Surface Development Area

Plot 2 – PCT 57

Plot 3 – PCT 166

Plot 6 – PCT 166

Plot 7 – PCT 166

Plot 9 – PCT 166

Plates 5 to 9 Approved Ivanhoe Rail Facility Surface Development Area no Longer Required

4 CONCLUSION

The following conclusions are made:

- less native vegetation clearance would be required for the modified Ivanhoe Rail Facility, resulting in retention of 0.1 ha of PCT 57 and 11.9 ha of PCT 166 that would otherwise be cleared;
- the VIS calculated using the BAM Calculator indicate that there is a slight difference in the condition of the vegetation, however the apparent differences in the calculated VIS between the modified Ivanhoe Rail Facility surface development area and approved Ivanhoe Rail Facility surface development area no longer required is likely natural variation and not a material measure that the vegetation is in better condition in the modified Ivanhoe Rail Facility surface development area; and
- even if the apparent differences in the calculated VIS between the modified Ivanhoe Rail Facility surface development area and approved Ivanhoe Rail Facility surface development area no longer required are real, the approximate 12 ha reduction in native vegetation clearance required for the modified Ivanhoe Rail Facility would lead to an overall net reduction of impacts on native vegetation.

5 REFERENCES

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APPENDIX A

VEGETATION CONDITION PLOT DATA FOR THE MODIFIED IVANHOE RAIL FACILITY SURFACE DEVELOPMENT AREA

Vegetation Condition Data for the Modified
Ivanhoe Rail Facility Surface Development Area

Plot	Zone	PCT	Easting	Northing	Bearing	Patchsize	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic
1	55	57	242380	6355487	180	100	0	8	0	4	0	0	0	13.3	0	2.1	0	0	0	0	4	23	0	1	1	0	0	0	35.4
4	55	166	243204	6355269	185	100	0	12	0	1	0	0	0.0	21.2	0.0	0.1	0.0	0.0	0	0	3.8	0.0	0	0	0	0	0	0	14.0
5	55	166	243827	6355369	180	100	0	7	1	5	0	0	0.0	12.5	0.2	6.6	0.0	0.0	0	0	4.0	0.0	1	1	0	0	0	0	40.0
8	55	166	243259	6353835	270	100	0	5	0	5	0	0	0.0	9.9	0.0	6.1	0.0	0.0	0	0	1.0	0.0	0	0	0	0	0	0	24.0

APPENDIX B

VEGETATION CONDITION PLOT DATA FOR THE APPROVED IVANHOE RAIL FACILITY SURFACE DEVELOPMENT AREA

Vegetation Condition Data for the Approved Ivanhoe Rail Facility
Surface Development Area no Longer Required

Plot	Zone	PCT	Easting	Northing	Bearing	Patchsize	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic
2	55	57	242810	6355343	180	100	0	7	1	3	0	0	0.0	12.4	0.2	1.3	0.0	0.0	0	0	7.4	4.0	0	1	1	0	0	0	51.0
3	55	166	243099	6355167	180	100	0	10	0	1	0	0	0.0	10.3	0.0	0.5	0.0	0.0	0	0	2.8	0.0	0	0	0	0	0	0	41.0
6	55	166	243278	6354704	90	100	0	6	1	5	0	0	0.0	10.0	1.0	12.1	0.0	0.0	0	0	4.2	0.0	0	0	0	0	0	0	17.0
7	55	166	243516	6353867	260	100	0	7	0	4	0	0	0.0	4.6	0.0	12.3	0.0	0.0	0	0	1.0	0.0	0	0	0	0	0	0	12.1
9	55	166	243736	6353180	270	100	0	5	0	7	0	0	0.0	3.4	0.0	7.4	0.0	0.0	0	0	2.0	0.0	0	0	0	0	0	0	29.0