



**NSW
Resources
Regulator**

INVESTIGATION REPORT

REPORT INTO THE DEATH OF MR ANDREW BRAY

Snapper Mineral Sands Mine 12 August 2019

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at Snapper Mineral Sands Mine 12 August 2019

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Executive summary

On 12 August 2019, a 47-year old contractor, Mr Andrew Bray, was fatally injured when a Caterpillar D10T dozer (DZ 813) collided with his light vehicle (LV 778). The incident occurred in an active overburden tip head (Western Tip Head) at the Snapper Mineral Sands Mine located approximately 40 kilometres west of Pooncarie, in southwest New South Wales.

At approximately 4:30 pm, while at the Western Tip Head, the DZ 813 operator made a UHF radio communication requesting that Mr Bray retrieve his water bottle from the crib room. At around 4:45 pm LV 778 arrived at the tip head and, shortly after, contacted DZ 813 via radio communication arranging to meet at a light tower located at the tip head. It was common practice for heavy and light vehicles to use the lighting towers as park-up areas and meeting points.

The DZ 813 operator stopped the dozer, lowered its implements and, after further communication with Mr Bray, waited while he attended to another matter. Shortly after the DZ 813 operator received further radio communication from Mr Bray stating words to the effect “track back to the light tower”.

Before moving off, the DZ 813 operator checked his left, right and rear windows and rear-view mirror at which time he did not see the light vehicle. DZ 813 then reversed straight back approximately 10-15 metres before impacting with LV 778.

Immediately after the impact the DZ 813 operator stopped, moved the dozer forward, lowered its implements, shut down the engine and climbed down to render assistance. The DZ 813 operator observed that LV 778’s cabin had been extensively crumpled and Mr Bray (the sole occupant) was positioned in the driver’s seat. The DZ 813 operator immediately called an emergency using the dozer’s radio and a response was activated. Several co-workers attended the tip head and rendered assistance but it was apparent that Mr Bray’s injuries were fatal. Emergency services were notified and attended the scene.

NSW Resources Regulator investigators attended the mine the following day and commenced an investigation into the cause and circumstances of the incident.

Investigation findings

The investigation determined that:

- the primary cause of the incident was that the light vehicle operator failed to comply with procedures when he:
 - entered within the 50-metre restricted operating zone of DZ 813

- positioned the light vehicle directly behind, and within 10 to 15 metres of DZ 813 after instructing the operator to track back towards the light tower shortly before
- failed to establish positive communication before entering DZ 813's 50-metre work area (including not establishing and maintaining line of sight and clear UHF communication with the dozer).
- the relevant risk to workers' health and safety was death or serious injury caused by mobile plant collision within active mining areas at the mine
- the mine operator and contractor had identified the risk within operational risk assessments
- the mine operator and contractor were working under their own independent safety management systems
- to control the risk of mobile plant collision, the contractor primarily relied upon:
 - mobile plant separation distance, parking and communication requirements
 - trained and competent operators
 - mobile plant safety features
 - supervisory arrangements.
- both Mr Bray and the DZ 813 operator had been trained and deemed competent in the contractor's mobile plant operation, separation distance, parking and communication procedures.

The investigation identified the following factors:

- The contractor's procedures and work practices were inconsistent with mobile plant separation distance requirements prescribed within the mine operator's safety management system. Such a requirement had not been enforced by the mine operator.
- The contractor's mobile plant separation distance requirements were not consolidated into a single procedure that provided a clear set of step-by-step instructions for how light vehicles were to safely approach operating heavy vehicles.
- The contractor's parking procedures within active mining areas were not fully understood and followed, however the rule prohibiting parking behind heavy vehicles was.

- The contractor's procedures governing mobile plant separation distances did not adequately segregate light and heavy vehicles in active tip heads through the mandatory use of designated parking bays and/or bunded areas.
- UHF radio positive communication procedures were not adequately enforced by the mine operator and contractor and, as a result, workers routinely failed to follow requirements.
- The contractor's light vehicle operators were predominantly in supervisory roles, such as shift supervisors and leading hands. Their work practices while driving in active mining areas were not adequately monitored or assessed.
- The practicality of fitting proximity detection and / or collision avoidance systems to heavy vehicles had not been adequately assessed, and the contractor's dozers were not fitted with equipment, such as sideview mirrors and reversing cameras, to minimise the effect of operator field of vision blind spots at the rear of the machine.
- The mine operator was unable to produce evidence of its mobile plant introduction to site processes having been followed, and compliance inspections had not addressed blind spot areas which may impact operator's visibility from the dozer cabin.
- Lessons from previous mobile plant incidents had not been learned, in that proximity detection and collision avoidance systems, sideview mirrors and reversing cameras had not been trialled and their effectiveness had not been considered.

Recommendations

Mine operators and contractors have a duty to identify hazards and manage risks to health and safety associated with the operation of mobile plant and to provide safe systems for managing light and heavy vehicle interactions in accordance with the *Work Health and Safety Act 2011* and *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulations. It is recommended that mine operators and contractors:

- monitor, review and audit procedures to ensure that safety controls for managing light and heavy vehicle interactions are implemented in accordance with the principal hazard management plan for roads and vehicle operating areas
- where reasonably practicable, segregate light and heavy vehicles in active tip heads through the use of designated parking bays and/or bunded areas

- consider, and where reasonably practicable incorporate, the use of available technology to control mobile plant interactions such as proximity detection and collision avoidance systems
- consider, and where reasonably practicable, install visual aids in heavy vehicles such as reversing cameras, rear and sideview mirrors
- ensure procedures governing mobile plant separation and parking requirements provide clear instruction about how light vehicles are to safely approach operating heavy vehicles
- provide workers with appropriate instruction and supervision to ensure mobile plant positive communication procedures are followed
- provide workers with appropriate instruction and training in the location and extent of blind spots and areas of limited visibility from the cabin of heavy vehicles operated on site
- review supervision arrangements to ensure that the work practices of light vehicle operators in active mining areas are appropriately monitored and assessed
- ensure mobile plant introduction to site processes are followed with appropriate plant specific risk assessments conducted for heavy vehicles operated on site
- ensure the implementation of recommendations arising from incident investigations are monitored by officers through to finality.

Workers required to operate mobile plant must:

- comply with mobile plant separation, parking and positive communication procedures, and never enter and / or park within the prohibited work zones of operating heavy vehicles.

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1. Purpose of the report

This report sets out the mining workplace incident investigation (the investigation) conducted by the NSW Resources Regulator into the cause and circumstances of the death of Mr Andrew Bray at the Snapper Mineral Sands Mine located at Nob Road, Pooncarie via Wentworth NSW on 12 August 2019.

2. Investigation overview

2.1. Major Safety Investigations

The Regulator investigates major workplace incidents in the NSW mining, petroleum and extractives industries. The Regulator carries out a detailed analysis of incidents and report its findings to enhance industry safety and to give effect to our [Compliance and enforcement approach](#).

2.2. Legislative authority to investigate

Investigators are appointed as government officials under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and are deemed to be inspectors for the purposes of the *Work Health and Safety Act 2011* (WHS Act). The Regulator has also delegated some additional functions to investigators including the power to obtain information and documents for the purpose of monitoring compliance with the WHS Act.

2.3. Regulator response

The incident was reported to the Regulator on 12 August 2019. Investigators were immediately deployed to the site and commenced an investigation the next day.

On 6 September 2019, an investigation information release ([IIR19-11](#)) was published that reminded mine operators of the requirement to identify hazards and manage risks to health and safety associated with the operation of mobile plant in accordance with provisions of the *Work Health and Safety Act 2011* and *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulations.

3. Involved parties

3.1. The mine

The Snapper Mineral Sands Mine is located approximately 40 kilometres west of Pooncarie, between Wentworth and Menindee, in southwest New South Wales. The mine forms part of Tronox Mining Australia Limited's Murray Basin operations which comprises the Snapper and nearby Ginkgo mineral sands mines, Crayfish project and a mineral separation processing plant located in Broken Hill. The Snapper mine is a 24-hour per day, 365 days per annum operation extracting mineral ore including Rutile, Zircon and Ilmenite via surface and dredge mining. Tronox Mining Australia Limited's Murray Basin operations employs over 200 staff and 350 contractors.

3.2. Mine operator and holder

Tronox Mining Australia Limited was the nominated mine operator for the Snapper and Ginkgo mines. Tronox Mining Australia Limited is a subsidiary of ultimate holding company Tronox Holdings PLC. Between 28 September 2012 and 25 July 2019, Cristal Mining Australia Limited was the nominated mine operator. In 2019, Tronox Holding PLC acquired Cristal Mining Australia Limited, changed its name to Tronox Mining Australia Limited (TMA) and continued its operations under the same Australian company number.

Mining operations at the Snapper mine were conducted within mining lease ML1621 for which TMA was the mining lease holder.

3.3. Contractor and employer

Basin Sands Logistics Pty Ltd (BSL) are a contracting company based in Broken Hill NSW and a subsidiary of ultimate holding company Consolidated Broken Hill Investments Pty Ltd. Since 2011, BSL have provided mining, civil, haulage and earthmoving services to the mine operator of the Snapper and Ginkgo mines. The commercial relationship between BSL and TMA was primarily governed by a series of service agreements. In accordance with these agreements, BSL's scope of works notably included:

- pit construction, development and maintenance of all lay-down areas and haul roads
- removal and transportation of overburden material from mining pits to stockpile areas
- reinstatement of removed overburden to the rear of the advancing mine path.

At the time of the incident, BSL operated under its own safety management system, supplying and utilising its own labour resources, mobile plant and equipment. BSL maintained full control of the

operation, service, maintenance and repair of its fleet of mobile plant which included light vehicles, dozers, graders, dump trucks, excavators and water carts.

BSL's production operations at the Snapper mine comprised three crews of about 20 to 30 mobile plant operators. Each crew had an appointed leading hand and shift supervisor reporting to the Snapper production superintendent who, in turn, reported to the operations manager.

3.4. Light vehicle operator

Mr Andrew Bray commenced employment with BSL in November 2013. Upon commencement, he underwent a pre-employment medical with no underlying health issues identified. Mr Bray was an experienced worker and had undertaken various roles at both the Snapper and Ginkgo mines which included WHS officer, dump truck operator, shift supervisor and leading hand.

At the time of the incident, Mr Bray was a leading hand within BSL's Snapper Production Crew 2. In this role he was required to drive light vehicles within active mining areas where heavy vehicles such as dump trucks and dozers operated.

Mr Bray was 47-years old at the time of his death. He was operating light vehicle LV 778.

3.5. Dozer operator

Prior to starting with BSL, the DZ 813 dozer operator had worked at various mine sites throughout Australia. The DZ 813 operator was an experienced mobile plant operator with over 15 years' experience in dozer operation. He was familiar with mobile plant separation distances and exclusion zones in active mining areas.

At the time of the incident, DZ 813 operator was 58-years old and formed part of BSL's Snapper Production Crew 2.

3.6. Mobile plant involved in the incident

3.6.1. Caterpillar D10T dozer

The involved dozer was a Caterpillar designed and manufactured D10T model track-type dozer fitted with a front blade and rear ripper implement (see Figure 1). The D10T dozer has an operating weight of about 70,000 kg. The dozer was manufactured in June 2007 and purchased by BSL from a mining equipment reseller in March 2017.

In August 2017, the dozer underwent the mine operator's introduction to site processes, was assigned mine identifying number 813 'DZ 813' and incorporated into BSL's operations. BSL maintained ownership and full control of the operation, maintenance, service and repairs of DZ 813.

Figure 1: Caterpillar D10T dozer DZ 813



3.6.2. Toyota Landcruiser

The involved light vehicle was a 2002 Toyota Landcruiser 4WD single cab tabletop utility with NSW road registration (see Figure 2). The light vehicle formed part of BSL's operations and had been assigned mine identifying number 778 'LV 778'. At the time of the incident, BSL maintained full control of the operation, maintenance, service and repairs of LV 778.

Figure 2: Toyota Landcruiser LV 778

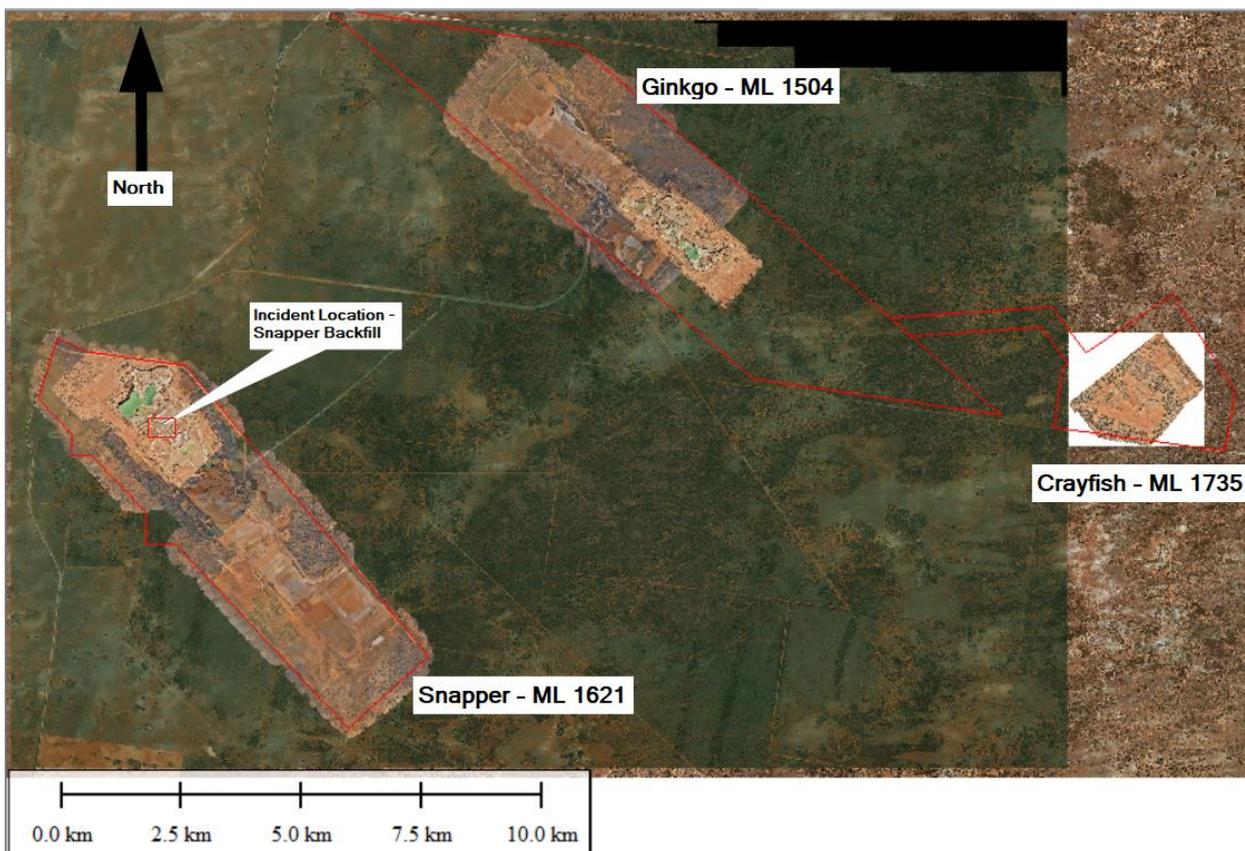


4. The incident

4.1. Incident location

The incident occurred at the Snapper mine within the mining lease boundaries of ML1621 (see Figure 3). The incident location was within an active mining area identified as the Snapper Overburden Western Tip Head, referred to as Snapper Backfill in Figure 3.

Figure 3: Incident location and mining lease boundaries



The main work activities conducted at the Western Tip Head involved:

- dumping of overburden material by BSL Caterpillar 785 dump trucks
- shifting of the dumped overburden material by BSL Caterpillar D10T dozers.

At the time of the incident, lighting towers were positioned at the Western Tip Head to provide additional lighting and aid visibility during low light hours and night shift (see Figures 4, 5 and 6). In addition to BSL's dump trucks and dozers, light vehicles were also required to access tip head areas to conduct various tasks.

Figure 4: Snapper Overburden Western Tip Head

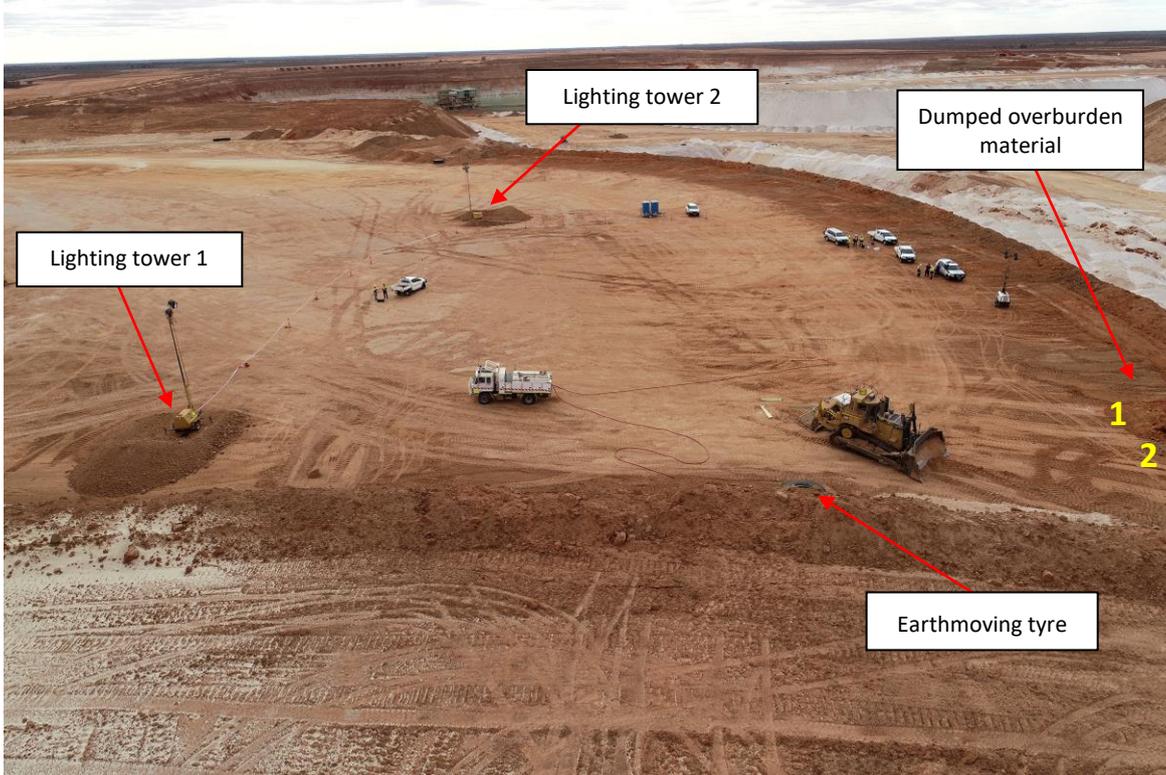


Figure 5: Overhead view of Snapper Overburden Western Tip Head

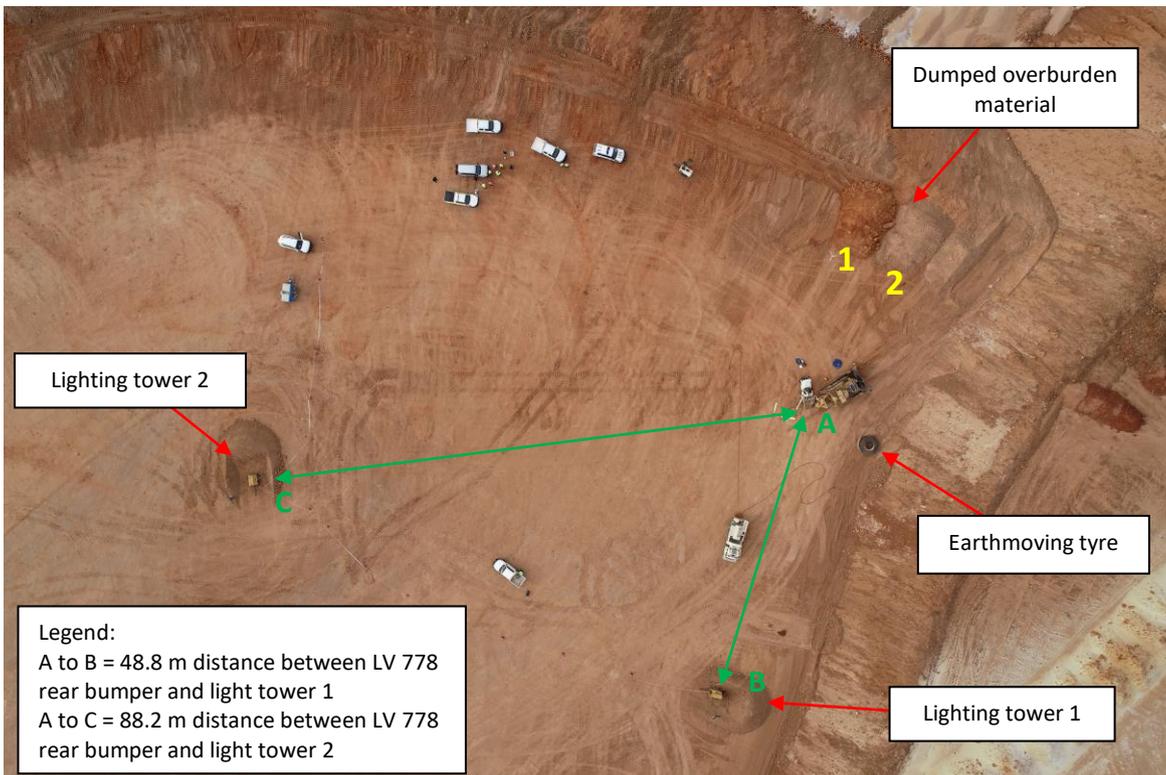


Figure 6: Lighting tower 1 positioned at Western Tip Head



4.2. Start of shift

Between 6:00 am and 6:30 am on 12 August 2019, BSL Production Snapper Crew 2 (Crew 2) attended the production crib room in preparation for commencement of dayshift. Crew 2 consisted of 30 workers including a shift supervisor, leading hand, dump truck, excavator, grader, water cart and dozer operators. Prior to the shift commencing, members of Crew 2 participated in a random alcohol breath test analysis. The test records establish that all workers tested, including DZ 813 operator and Mr Bray, returned negative results with no alcohol detected.

Crew 2 then participated in a routine pre-shift meeting facilitated by the shift supervisor. During the meeting, the Crew 2 members discussed the planned work activities for the shift, were assigned mobile plant items to operate and tasks to complete. At the conclusion of the meeting, Crew 2 left the meeting and attended their assigned work tasks.

4.3. Leading up to the incident

4.3.1. Work activities of Mr Bray

After the pre-shift meeting, Mr Bray commenced his normal leading hand duties. During the shift he operated BSL light vehicles including LV 778 to undertake various tasks which included:

- pick up/drop off of mobile plant operators for the start of shift, rest breaks and vehicle swaps
- general supervision of BSL workers in active mining areas
- switching on/off and repositioning of lighting towers in preparation for night shift.

Co-workers who had interacted with Mr Bray while he undertook these tasks observed that he appeared to be in good health and had not given any indication that he may have been preoccupied, distracted, stressed, feeling rushed or under any kind of work or time related pressure.

4.3.2. Work activities at Western Tip Head

At the conclusion of the pre-shift meeting, BSL commenced its work activities at the Western Tip Head, with two dozers (DZ 599 and DZ 655) working together shifting loads of dumped overburden. At about 11:00am, DZ 655 was relocated to another area of the mine, leaving DZ 599 as the sole dozer working in the area. Initially the DZ 813 operator was operating DZ 599 but was swapped to DZ 813 at around the lunchtime break, sometime between 2:00 and 3:00 pm. The DZ 813 operator continued to bulk push loads of dumped overburden, operating DZ 813 up until the incident occurred.

Leading up to the incident, several BSL dump trucks attended the Western Tip Head at regular intervals to dump loads of overburden material. The dump trucks would establish radio communication with DZ 813, enter the tip head via the access ramp, drive up to and reverse into position and dump the overburden material. Once unloaded, the dump trucks would drive off and leave the tip head via the access ramp.

4.4. Details of the incident

4.4.1. Request for water bottle

At about 4:30 pm while at the Western Tip Head, the DZ 813 operator made a UHF radio communication, on BSL Snapper channel 17, requesting if Mr Bray could retrieve his water bottle from the crib room. Mr Bray acknowledged the communication, retrieved the water bottle and made his way

to the area in LV 778. During this time, DZ 813 continued to operate at the tip head shifting overburden material.

4.4.2. LV 778 arrival at Western Tip Head

At around 4:45pm the DZ 813 operator received a UHF radio communication from Mr Bray in LV 778 reportedly stating words to the effect of “LV in your area” which he understood to mean that Mr Bray was at the top of the access ramp and heading onto the Western Tip Head. The DZ 813 operator responded via radio communication acknowledging Mr Bray’s presence.

Around this time, the DZ 813 operator moved the dozer to the area near location 1 and 2 depicted on Figures 4 and 5 where he continued to shift the dumped loads of material. The DZ 813 operator then observed a light vehicle parked in the vicinity of light tower 1 (see Figures 4 and 5) and a person who he recognized to be Mr Bray outside of the car turning on the light tower.

4.4.3. LV 778 and DZ 813 radio communication

At some stage between 4:45 pm and 4:55 pm, the DZ 813 operator received a radio communication from Mr Bray reportedly stating words to the effect of “I have your water bottle I will meet you at the light tower, drop down to radio channel 16 I need to talk to you and there is too much radio chatter.” The DZ 813 operator stopped the dozer, lowered its implements, changed to channel 16 and proceeded to have a conversation with Mr Bray.

During the conversation Mr Bray reportedly stated words to the effect of “...when you pull up we’ll have a talk about the take five and I’ll show you the hazards and how to write the book up, just give me a minute.” The conversation ended shortly after and the DZ 813 operator changed back to channel 17 and remained stationary in the dozer awaiting further communication from Mr Bray.

The DZ 813 operator estimated that at this time the dozer was approximately 20 metres back from the tip face, in an area close to a large earthmoving tyre lying flat on the ground (see Figures 4 and 5).

4.4.4. Dump truck 844 at western tip head

Between 4:45pm and 4:55pm, dump truck 844 (DT 844) entered the Western Tip Head and observed that DZ 813 was stationary and positioned at the approximate location described above.

DT 844 dumped a load of overburden material at, most likely, location 1 depicted on Figures 4 and 5 and then commenced leaving the tip head area, heading towards the access ramp. At this point, the DT 844 operator observed Mr Bray driving a single cab light vehicle on the tip head in the vicinity of light tower 2 (see Figures 4 and 5).

4.4.5. Communication to track back to light tower

The DZ 813 operator recalled that as DT 844 was finishing tipping off and leaving the tip head area, he received another radio communication from Mr Bray stating words to the effect of "...track back to the light tower." Two other BSL mobile plant operators similarly recall hearing the radio communication.

4.4.6. DZ 813 and LV 778 collision

The DZ 813 operator recalled that after receiving the "track back to the light tower" radio communication, he raised the dozer's blade and ripper implement while waiting around 10 to 15 seconds for DT 844 to exit the access ramp. At some stage, most likely between 4:50 pm and 5:00 pm, Mr Bray, driving LV 778, entered within the 50-metre zone of DZ 813. The DZ 813 operator stated that shortly before moving off, he checked his left, right and rear windows and rear-view mirror but did not see a light vehicle.

The DZ 813 operator recalled that, at the time of the incident, visibility from the rear of the dozer was very poor due to the glare from the low afternoon sun position and dust blowing around the area caused by the unloading of the dump trucks. The DZ 813 operator estimated that visibility from the rear of the dozer was two to three metres.

At this point, the DZ 813 operator reversed the dozer in a straight line, accelerating up to approximately 6 kilometres/hour. The DZ 813 operator stated that as he reversed, he continued to check his left, right and rear windows and rear-view mirror. DZ 813 travelled about 10 to 15 metres before colliding with LV 778.

Immediately after the impact, the DZ 813 operator stopped, moved the dozer forward, lowered its implements, shut down the engine and climbed off to render assistance. The DZ 813 operator observed that LV 778's cabin had been extensively crumpled, with Mr Bray in the driver's seat who had suffered catastrophic injuries. The DZ 813 operator immediately called an emergency using the dozer's radio and a response was activated. Several co-workers attended the tip head and rendered assistance but it was apparent that Mr Bray's injuries were fatal. Emergency services were notified and attended the scene.

4.4.7. Cause of death

At the scene, emergency services assisted with the recovery of Mr Bray's body. Mr Bray's body was conveyed to Mildura Base Hospital where a medical examination was conducted and certification of death provided.

A post-mortem was conducted, with the cause of death identified as resulting from multiple injuries.

4.4.8. Toxicology

4.4.8.1. Mr Bray

A number of screening and quantitative tests were conducted from which it was concluded that there were no traces of alcohol or drugs in Mr Bray's body.

4.4.8.2. DZ 813 operator

Shortly after the incident, the DZ 813 operator undertook drug and alcohol screening tests. The results indicated that there were no traces of alcohol or drugs in his body at the time of testing.

5. The investigation

5.1. Investigation activity

The investigation examined the incident including the circumstances leading up to it, the cause of it, the actions of the involved workers, contractor BSL and the operator of the mine, TMA.

The investigation activities included scene assessments, mechanical inspections, functionality and visibility testing regimes of the involved mobile plant, examination of TMA's and BSL's safety management systems (including policy and procedures) and formal interviews with relevant parties.

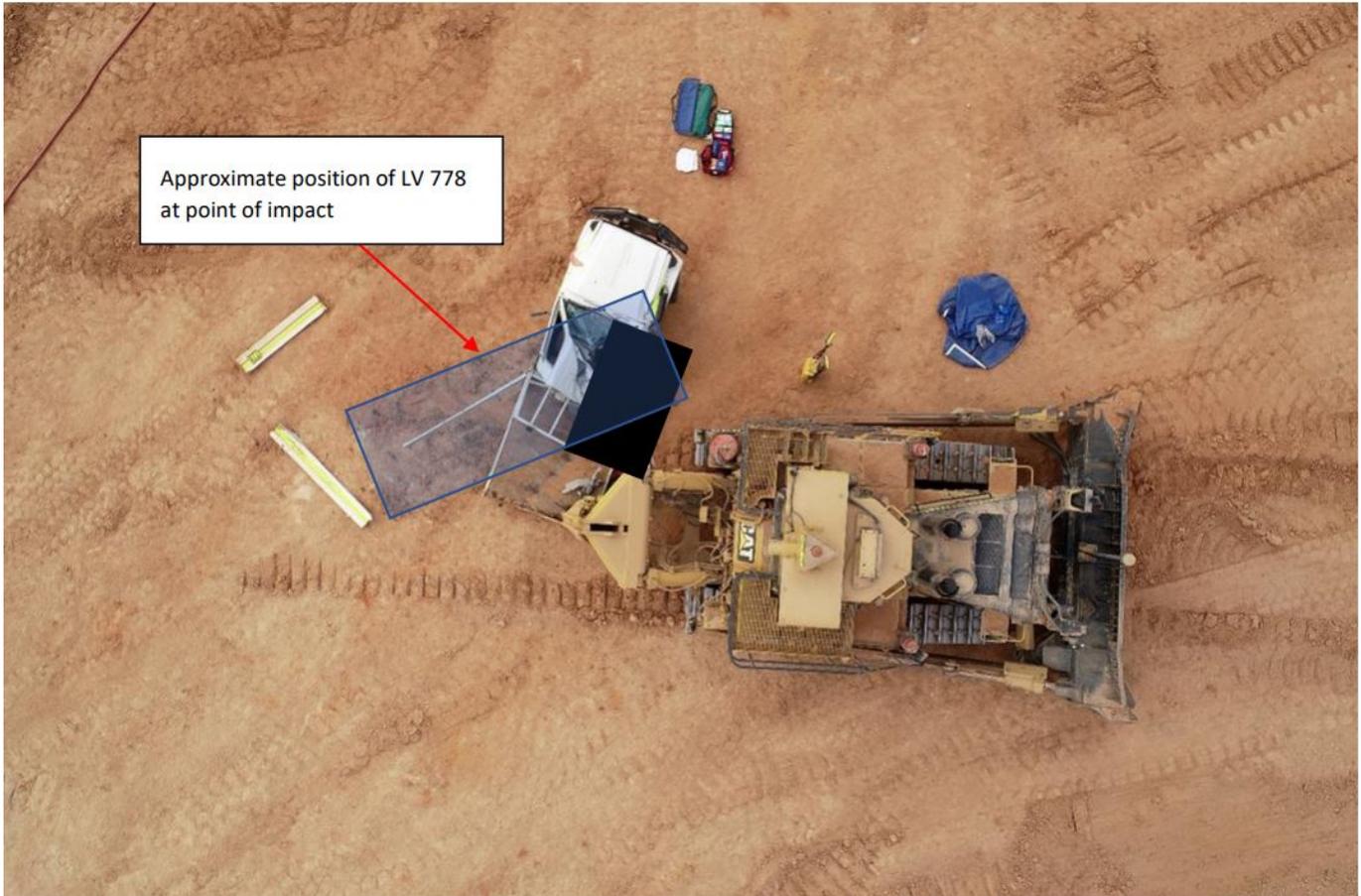
5.2. Examination of incident scene

The incident scene was examined by NSW Police officers and Regulator investigators. The examination confirmed that LV 778's drivers side cabin was impacted and crumpled by the left-hand side-track of dozer DZ 813.

It is not definitively known what travel path the light vehicle LV 778 had taken up to the point of impact because there were no direct witnesses and numerous tyre marks were left by vehicles that attended the scene post-incident. However, based upon the orientation of the light vehicle and ground impressions matching a similar section of LV 778's tray undercarriage, it is likely that LV 778 approached DZ 813 from behind and at the point of impact was positioned towards the back-left side, rear of the dozer at an approximate 30 degree angle (see Figure 7).

It is also not known if LV 778 was stationary or moving at the time of impact. After the incident, the light vehicle was found with its engine idling, gear stick in neutral position and park brake not applied, providing some indication that it may have been stationary at the time of impact.

Figure 7: Approximate position of LV 778 at point of impact



5.3. Examination of light vehicle

Mechanical inspection and functionality tests were conducted on light vehicle LV 778. Testing was undertaken by a NSW Police Mechanical Examiner and Wireless Technical Officer. The results of the inspection and testing did not identify any mechanical faults with LV 778 or its UHF radio system which could have contributed to the incident. Notable results include the following:

- LV 778 was fitted with a high visibility flag, vehicle mine identifier number and high visibility reflective striping consistent with TMA's mobile plant equipment minimum standard.
- Nil damage or faults were identified in the braking systems.
- Headlights, horn and amber flashing light attached to the tabletop were operational.
- Radio was found on channel 17 and clearly audible with the volume knob turned to 3/4 full.
- Radio transmissions were able to be sent and received clearly from a distance of 50 metres.

5.4. Examination of dozer

Visual inspection, mechanical safety checks and functionality testing were conducted on dozer DZ 813. The tests were coordinated by the Regulator and undertaken with the assistance of TMA and BSL. The results of the inspection and testing did not identify any mechanical faults with DZ 813 or its UHF radio system which could have contributed to the incident. Notable results include the following:

- DZ 813 was fitted with a vehicle mine identifier number and high visibility reflective striping consistent with TMA's mobile plant equipment minimum standard.
- Flashing amber flights and reversing lights were operational and visible from a 50-metre distance.
- Reversing beeper and horn were operational and audible from a 50-metre distance.
- UHF radio was operational with transmissions able to be sent and received clearly from a distance of 50 metres.
- DZ 813 was fitted with an in-cabin rear-view mirror but no post OEM external sideview mirrors, reversing camera or proximity detection/collision avoidance systems.
- DZ 813 operator's view out of the left side, right side and rear cabin windows was partially obscured by access platforms, ROPS, ripper implement and other componentry.

6. Investigation findings

6.1. Risk to health and safety

The investigation identified that the relevant risk to workers' health and safety was serious injury or death caused by mobile plant collisions within an active mining areas. The risk had the reasonable potential to cause multiple deaths in a single event, thereby meeting the definition of a 'principal hazard' prescribed by clause 5 of the Work Health Safety (Mines and Petroleum Sites) Regulation 2014 (WHSMPR) and, in turn, invoking requirements to develop and implement a principal hazard management plan and specific controls under Division 2 of the Regulation.

6.2. Identification and assessment of the risk

6.2.1. Basin Sands Logistics

6.2.1.1. On path backfill operations risk assessment

In November 2018, BSL conducted a review of its risk assessment for its Snapper operations including the hauling and dumping of overburden material as backfill. The risk assessment considered the hazards and risks associated with each stage of the process, including mobile plant interactions. A cross section of both BSL and TMA workforce participated in the review.

Element 4 of the risk assessment addressed the task of pushing overburden with a dozer. The risk of collision of machinery was identified. The assessment categorised the risk when uncontrolled with an extreme risk ranking being likely to occur within three years and the potential for a fatality or multiple fatalities. The assessment identified several measures to control the risk, specifically:

- radio communication and maintaining minimum safe distances
- driver awareness and flashing lights
- trained and authorised operators
- bund walls and delineation of roads.

The assessment categorised the risk when controlled with a medium risk ranking being unlikely to occur in normal situations with the potential for serious injury.

6.2.1.2. Track dozer operations risk assessment

In November 2018, BSL also conducted a review of its existing risk assessment into track dozer operations. The risk assessment considered the hazards and risks associated with general operations of its dozers on site and was reviewed by BSL's WHS Manager.

The risk of collision with other mobile equipment was identified for numerous operations, including tramming and pushing material over faces. The risk assessment categorised the risk with an extreme risk ranking when uncontrolled and medium ranking when controlled consistent with the On Path Backfill Operations risk assessment.

The assessment identified several measures to control the risk, specifically:

- radio communication
- driver awareness and flashing lights
- trained and authorised operators.

Notably the risk assessment did not identify maintaining mobile plant separation distances as a control.

6.2.2. Tronox Mining Australia

6.2.2.1. ROVOA risk assessment

In 2017, TMA engaged an external consultant to facilitate a risk assessment of the specific hazards and risks associated with its roads and other vehicle operating areas. The key objectives of the risk assessment were to protect people on site from hazards associated with vehicle interactions, including vehicle to vehicle collisions. The risk assessment was conducted utilising a cross section of TMA's workforce and included two BSL representatives. The assessment identified the potential for heavy vehicle and light vehicle interaction/collision in an active mining area.

The assessment categorised this as having an extreme risk ranking which was unlikely to occur but had the potential for 'catastrophic' consequences if it did. The assessment report identified a series of measures to control the risk including:

- workers provided operator training packages in adverse characteristics of mobile plant
- positive communication requirements for approaching/entering heavy vehicle working areas
- workers prohibited from parking light vehicles in truck blind spots
- mobile plant separation distance requirements of 50 metres when travelling, increased to 100 metres in adverse conditions.

6.2.2.2. Mobile and transportable risk assessment

In June 2017, TMA engaged the same external consultant to undertake a risk assessment of the core hazards and risks associated with the mobile plant and transportable equipment operated at the mine. The risk assessment was conducted utilising a cross section of TMA's workforce and involved the identification of relevant hazards, assessment of associated risks and qualifying suitable controls.

The assessment identified the risk of being struck by mobile plant caused by limited visibility from machine blind spots, implements/attachments and local fitted options (fire suppression systems). The assessment identified this risk for free steered earth moving equipment (EME) such as dump trucks but not tracked EME, such as dozers. The assessment categorised this as having an extreme risk ranking with a 'possible' likelihood and the potential for 'catastrophic' consequences.

The assessment report identified a series of measures to control the risk including:

- trial of reversing cameras
- vehicle introduction to site processes, reflective striping, flag, rotating light and reversing alarms
- positive communication and mobile plant 50-metre separation distance requirements
- operators being trained and competent in mobile plant operating procedures
- testing of visibility post installation of local equipment options such as fire suppression systems.

6.3. Safety management system

6.3.1. Basin Sands Logistics

At the time of the incident, BSL was operating under its own safety management system (SMS). The content of BSL's SMS was outlined within the documented plan entitled 'BSL Health & Safety Management Plan'. In accordance with the plan, periodic audits/reviews were required to be undertaken annually. BSL had not conducted an internal audit or review of its SMS in the two-year period prior to the incident.

In June 2017, TMA conducted its own review and approval of BSL's SMS, endorsing that its policies and procedures were consistent with its own.

6.3.1.1. Principal hazard management plan

Within BSL's SMS was a documented principal hazard management plan which set out a risk-based guideline on how principal mining hazards were to be managed at the Snapper and Ginkgo mines.

The plan identified both light vehicle and surface mobile equipment (SME) operations as principal mining hazards. To control these hazards and the risk of interaction between light vehicle and SME the plan identified a series of measures which included:

- separation of heavy and light vehicles where reasonably practicable

- training and competency of all vehicle operators
- 50/30 metre exclusion zone.

Notably, the 50/30 metre exclusion zone outlined within the plan was not consistent with BSL's operating procedures which implemented 50/20 metre mobile plant separation distance requirements as outlined in section 6.5.1 of this report.

6.3.2. Tronox Mining Australia

At the time of the incident, TMA had an implemented SMS pursuant to Clause 13 of the WHSMR. The SMS had been in place since its operations first commenced in 2005. The contents of the TMA's SMS were outlined within the documented plan 'Eastern Operations Mine Safety Management System'.

6.3.2.1. ROVOA principal hazard management plan

Within TMA's SMS was a roads and other vehicle operating areas principal hazard management plan (ROVOA PHMP) pursuant to *clause 24 of the WHSMR*. The ROVOA PHMP had been in place since November 2018 and was an overarching document which defined the minimum standards associated with controlling the key hazards and risks of mobile plant.

6.3.2.2. Vehicle operating distances

The ROVOA PHMP stated that the Snapper and Ginkgo mines adhered to 50/25 metre separation distance requirements for vehicle interactions as outlined in Figure 8 below.

Figure 8: ROVOA principal hazard management plan vehicle operating distances

Vehicle Operating Distances

Cristal sites adhere to a 50/25 rule for vehicle interaction. Vehicles must have a 50 metre spacing between operating vehicles including when following behind another vehicle.

In adverse conditions the following distance is extended to 100m. Traffic volume shall be managed to reduce adverse operating conditions from developing and preventing the density of traffic in an area leading to the 50/25 rule being breached.

To enter the 50 metre zone of mobile plant, positive communication shall be used in liaising with the heavy vehicle operator. The operator will then perform a controlled stop and then the 50 zone can be entered.

To enter the 25 metre perimeter of the heavy vehicle operator shall be outside on the ground. Road going vehicles are to park outside the 25 metre zone unless required for maintenance or similar tasks.

BSL's PHMP and operating procedures were not consistent with these requirements which implemented 50/20 metre separation distances and did not require operators to be out of the cabin and on the ground before light vehicles were permitted to approach within 25 metres of heavy vehicles.

Although TMA's ROVOA PHMP scope stated it applied to all employees and contractors associated with operations of mobile plant at the mine, TMA maintained that BSL was required to comply with its own SMS, including its own policies and procedures relating to in-pit communication, mobile plant separation distances and parking requirements.

During the investigation, TMA stated that BSL was provided a copy of the ROVOA PHMP and associated procedures to utilise in the development and implementation of their own policy and procedures. However, BSL maintained that it had not been made aware of, or given access to, TMA's ROVOA PHMP.

6.4. The task

At the time of the incident, Mr Bray was undertaking the task of driving a light vehicle (LV 778) within an active tip head in the vicinity of operating heavy vehicles to deliver a water bottle and speak directly with the DZ813 operator. BSL's light vehicle operators were frequently required to access active tip heads in the vicinity of operating heavy vehicles to undertake various tasks including:

- delivery of items and equipment to dozer operators (such as that at the time of the incident)
- conducting formal work site and pit inspections
- observing the work of equipment operators in the working tip head
- transporting personnel to and from operating dozers for the purpose of work breaks, comfort breaks and shift changeovers
- transporting mechanical and electrical staff to conduct equipment repairs and servicing.

BSL estimated that light vehicles would access active tip heads to undertake these tasks around 280 times during a typical two-week period throughout day and night shifts.

At the time of the incident, while there was no specific procedure which outlined a step-by-step process on how light vehicles were to undertake these tasks safely, workers were required to abide by BSL's general mobile plant separation distance, parking and communication requirements prescribed within its standard operating procedures (SOP).

6.5. Risk controls - Basin Sands Logistics

To control the risk of light vehicle and dozer collisions in active mining areas, BSL primarily relied upon the following key controls.

6.5.1. Mobile plant separation distances, parking and positive communication requirements

BSL's mobile plant separation distances, parking and positive communication requirements were outlined across a series of SOPs. Relevant procedures are addressed in section 6.6 of this report. For light vehicles to approach operating dozers in an active pit area, the applicable separation distance, communication and parking requirements implemented by BSL were:

6.5.1.1. Separation distances

- Light vehicles were prohibited from entering within 50 metres of an operating dozer.
- Light vehicles were prohibited from passing or approaching directly behind an operating dozer within its 50-metre work area.
- Once positive communication was established, with the dozer stopped and its implements lowered, the light vehicle could enter the 50-metre work area but not be positioned any closer than 20 metres to either side of the dozer.

6.5.1.2. Parking requirements

- Light vehicles were prohibited from parking within 50 metres of an operating dozer.
- Light vehicles were prohibited from parking directly behind or in front of a dozer.
- Once positive communication was established, with the dozer stopped and its implements lowered, the light vehicle could enter its 50-metre work area and park no closer than 20 metres to either side of it.
- Light vehicles operated by mechanic/maintenance personnel were permitted to park closer than 20 metres once 'all safety precautions' had been taken.

6.5.1.3. Positive communication

- Positive UHF radio/visual communication (hand signals in poor radio reception areas) was required to be maintained between all vehicles on haul roads and upon entering active pits.

- Vehicle operators were required to utilise the machine or vehicle asset identification number during radio communications.
- Before entering a pit area, light vehicle operators were required to make a UHF radio/visual communication informing heavy vehicle operators of the light vehicle's current location, intended route of travel and intended destination. The heavy vehicle operator was required to then respond acknowledging the light vehicle's presence.
- After entering the pit area, light vehicle operators were required to make a further UHF radio/visual communication informing the heavy vehicle operator/s of the intention to enter within its 50-metre work area.
- In practice, light vehicles would typically wait outside the 50-metre zone until the heavy vehicle operator had acknowledged the communication, stopped and lowered its implements.

Review of BSL's separation distances, communication and parking requirements identified the following:

- The separation distances were not consistent with the mine operator's ROVOA PHMP. Such a requirement had not been required or enforced by TMA.
- There was no requirement for dozers to be deenergised or stationary, with the operator out of the cabin, before a light vehicle was permitted to enter within the 50-metre work area. This meant a dozer had the potential to commence tracking backwards or forwards in a short period of time, providing little warning to an approaching light vehicle.
- There were no designated park-up areas at tip heads and no requirement for light vehicles and dozers to be parked up at locations where they were separated by a bund or similar kind of physical barrier. Despite this, there was a well-established practice whereby most operators parked up on either side of lighting towers.
- Although mobile plant separation distances were generally understood and followed by workers, instances of mobile plant operators driving inside the 50-metre work area of operating heavy vehicles had been raised and addressed during meetings.
- Parking requirements were not understood and followed by some workers who were of the view that a light vehicle could park as close as 10 metres from a dozer, with its engine running, when the operator was in the cabin, provided it was stationary with its implements lowered.

- Heavy vehicles did not always establish positive communication before entering within 50 metres of one another and it was common practice for mobile plant operators not to use machine identifying numbers during UHF radio communications.
- In the moments leading up to the incident, Mr Bray had breached BSL's separation distance, parking and communication procedural requirements by:
 - entering within the 50-metre work area of DZ 813 while it was operating
 - being positioned/parked directly behind and within 10 to 15 metres of DZ 813
 - not establishing positive communication before entering DZ 813's 50-metre work area (including not establishing and maintaining line of sight and clear UHF communication with DZ 813).

6.5.2. Inducted, trained and authorised operators

BSL only permitted authorised personnel to operate light and heavy vehicles at the mine. Upon commencement of employment, each BSL mobile plant operator was required to complete an initial induction process which included:

- TMA online contractor and site induction
- BSL worker induction
- formal training in a suite of BSL safety management plans and SOP's which notably included:
 - BSL Mine Safety Management Plan and Take 5 personal risk assessments
 - Light Vehicle Operations and Pre-start check protocols
 - Pit Entry Rules and Safe Access and Communication procedures.

In addition to the above, heavy vehicle operators were also provided plant-specific training in the procedures relevant to their employment. The training involved both theory and, in some cases, practical based competency assessments. Upon successful completion of the training and assessment processes, workers were authorised to operate the applicable mobile plant.

After initial induction and training, workers were periodically provided additional informal training and instruction in the procedures, typically during pre-shift meetings or when the documents were updated.

At the time of the incident, both Mr Bray and the DZ 813 operator had been trained and authorised to operate light vehicles and dozers respectively.

6.5.3. Mobile plant safety features

To manage the risk of light vehicle and dozer collisions in active mining areas, BSL also relied on the minimum site standard of visibility, communication and safety warning equipment fitted to its mobile plant. The requirements for this minimum standard equipment were prescribed within TMA's mobile plant introduction to site processes, addressed in section 6.7.3 of this report.

6.5.4. Supervision

6.5.4.1. Supervision arrangements

In accordance with its contractual agreement with TMA, BSL was responsible for providing direct supervision of its own workforce including the operation of mobile plant at active tip heads.

BSL's production operations were primarily supervised by its shift supervisors, assisted by leading hands, which typically involved driving light vehicles in and around site, observing crews' work practices and conducting formal job observations, tip head observations and pit inspections.

During the investigation, BSL's operations manager (at the time of the incident) stated that light vehicle operators were not supervised while driving in and around active mining areas. The operations manager stated that the reason for this was that people operating the vehicles were typically supervisors and managers themselves.

6.5.4.2. Tip head observations

Tip head observations were predominantly conducted by shift supervisors but also, occasionally, by leading hands, superintendents and WHS officers. The observer would drive onto the active tip head, position themselves at a suitably distanced location and observe the work practices of dozers and dump trucks operating in the area.

The observer would assess the heavy vehicles compliance with operating requirements against set criteria outlined on a documented checklist. Work practices assessed during these observations were:

- dozers maintaining a 20-metre distance from toe bench, 10 metres from tip edge and using correct UHF communication
- dump trucks maintaining correct tipping distance, a 50 metre distance from rear of dozers and using correct UHF communication.

The investigation identified:

- There was no set procedure governing the tip head observation process.
- Workers were not provided any specific formal instruction and training in how to conduct tip head observations safely. BSL relied on informal on-the-job training and instruction.
- Observations did not assess the work practices of light vehicles.
- There was no set quantity of observations required to be conducted each shift.
- There was no mechanism to monitor the quality or quantity of completed observations.

6.5.4.3. Job observations

Job observations were predominantly conducted by shift supervisors but also, occasionally, by leading hands, superintendents and WHS officers. The process utilised a documented form containing a series of questions relating to a task being performed and/or equipment being operated in active mining areas. The process required the person conducting the observation to ask questions, view equipment and paperwork to ensure compliance with work practices and operating procedures. Observations were predominantly conducted on heavy vehicle operators with two required for each crew per shift.

The investigation identified:

- The job observation form was inconsistent with BSL's mobile plant separation distance requirements. The form indicated a requirement of "10-metre separation maintained between stationary vehicles in the pit". BSL's procedures required a 20-metre separation.
- There was no set procedure governing the job observation process.
- Workers were not provided any specific formal instruction and training in how to conduct job observations safely. BSL relied on informal, on-the-job training and instruction.
- There was no mechanism in place to ensure that job observations were periodically conducted on the work practices of leading hands, shift supervisors and superintendents.
- There was no mechanism to internally review the quality of completed observations.

Table 1 outlines observations completed during the twelve months leading up to the incident.

Table 1: BSL job observations conducted at Snapper mine between 12 August 2018 and 12 August 2019

POSITION / PERSON	JOB OBSERVATIONS COMPLETED
Total	1923
Dozer operator (within active mining area)	137
Dump truck operator (within active mining area)	849
Light vehicle operator (within active mining area)	1
Production superintendent	0
Production supervisor	0
Production leading hand	0
Andrew Bray	0

6.5.4.4. Pit inspections

Pit inspections were conducted by shift supervisors but also, occasionally, by leading hands and WHS officers. The process required the worker conducting the inspection to drive in and around site, including within active mining areas, to conduct necessary checks. The inspection was conducted utilising a checklist document which was primarily focused on the physical aspects of the workplace rather than procedural compliance of personnel. Two inspections were required to be completed per shift.

The investigation identified:

- There was no set procedure governing the pit inspection process.
- Workers were not provided any specific formal instruction and training in how to conduct pit inspections safely. BSL relied on informal, on the job training and instruction.
- The inspection process required checking and commenting if light vehicles were following all “in pit & parking SOP’s”. Review of inspections conducted in the three months prior to the incident established that no significant issues or non-compliances were identified.

- During the two weeks prior to the incident, pit inspection paperwork completed for the Snapper mine commented that there was “...poor radio comms around the site.”

6.6. Review of relevant procedures

To manage light vehicle and heavy vehicle in-pit interactions, BSL relied on implementing separation distance, parking and communication requirements outlined within the following SOPs (see Table 2).

Table 2: Procedures governing light vehicle separation distances, parking and positive communication

TITLE	SOP OWNER	REVIEWED DATE	DESCRIPTION
Pit Entry Rules	BSL	Feb 2016 Feb 2019	Safety requirements when operating light vehicles in pit areas
Light Vehicle Operations	BSL	Feb 2019	Instructions for undertaking routine light vehicle tasks, including prestart checks, general parking, servicing and parking on go-lines, general driving and radio communications
Safe Access and Communications Around Machinery and Vehicles	TMA	Sep 2017	Prescribed standard for site access and UHF communications

Review of the procedures identified:

- Separation distances outlined within the procedures were not consistent with the mine operator’s ROVOA PHMP.
- Separation distance, parking and communication requirements were spread across the procedures and prohibited certain activities such as parking directly behind dozers. However, there was no single procedure consolidating these requirements into a clear set of step-by-step instructions directed toward how to safely approach heavy vehicles in active mining areas.
- Inconsistent terms were utilised, referring to heavy vehicles being in ‘active/working/operating’ states. These terms were not defined and it was unclear when a heavy vehicle was considered active, working or operating. For instance, stationary or not, implements lowered or not, engine running or not and operator inside the cabin or not.

- Visual aids were not included to identify safe areas/prohibited zones around heavy vehicles.
- The procedures did not stipulate a requirement for heavy vehicles to be stopped with implements lowered before a light vehicle could approach within its 50-metre work area.
- The procedures prohibited workers from parking in blind spots, but did not identify or refer to any material that outlined the location and extent of blind spot areas associated with the specific heavy vehicles operated on site.

6.7. Risk controls - Tronox Mining Australia

At the time of the incident, TMA relied upon the following to manage the risks of mobile plant collisions associated with BSL's operations:

- Safety management system reviews.
- Implementation of TMA's contractor management plan.
- Management of mobile plant introduction to site processes.

6.7.1. Safety management system reviews

TMA most recently reviewed BSL's SMS including its policy, plans and procedures in June 2017. The SMS review was conducted utilising the mine operator's contractor safety management system approval checklist document which was derived from the Regulator's Mex-010 Legislation audit tool.

At the conclusion of the review process, BSL's SMS was endorsed and approved as being consistent with the mine operator's SMS. Reviews were generally required to be conducted every two years and, at the time of the incident, BSL's SMS was due for re-evaluation.

6.7.2. Contractor management

TMA's contractor management plan had been in place since August 2006. The documented plan outlined requirements for the management of all types of contractors it engaged. In accordance with the plan, each contractor was appointed a TMA contractor supervisor who was responsible for overseeing its activities.

TMA's mine earthworks superintendent normally fulfilled this role in the case of BSL, but the position had been vacant since August 2018. Between August 2018 and the incident, the role was managed by TMA's mine manager and two earthworks and mobility team supervisors.

In accordance with the contractor management plan, BSL was classified as a 'resident contractor' who provided long-term day-to-day activities under a formal contract for work and were not required to be directly supervised.

TMA monitored and managed BSL's safety performance primarily through:

- daily contractor meetings (all contractors)
- weekly BSL individual contractor meetings
- monthly KPI meetings
- general supervision
- pit inspections and safety interactions.

6.7.2.1. Daily contractor meeting (all contractors)

TMA facilitated daily morning contractor meetings with representatives from all contractors invited. The meetings were normally chaired by TMA's earthworks and mobility team supervisors and ran for approximately 20 to 30 minutes. Safety incidents, hazard reports and safety notifications were raised, discussed and recorded as standing agenda items during the meetings with copies of the minutes later distributed to contractor supervisors and managers.

Review of obtained meeting minutes for the six months prior to the incident identified:

- Hazards were consistently raised regarding non-compliance, or a need to improve mobile plant positive communication work practices.
- Hazards/incidents regarding non-compliance with mobile plant separation distances were not raised on a consistent basis.

6.7.2.2. Weekly BSL contractor meeting (individual contractor)

TMA conducted a weekly individual contractor meeting with BSL managers and supervisors. The meetings were chaired by TMA and ran for approximately 10 to 20 minutes. The meetings were primarily production focused but safety topics and incidents were raised and discussed as standing agenda items during the majority of meetings. Notably, safety hazards were not included as a minuted standing agenda item until sometime around May 2019.

Review of the meeting minutes for the twelve months preceding the incident identified:

- Safety hazards, incidents or issues regarding non-compliance with mobile plant separation distances, parking or communication requirements were not raised on a consistent basis.

6.7.2.3. Monthly KPI meeting with BSL

TMA conducted a monthly KPI meeting with a senior BSL manager or supervisor. The meetings were typically chaired by TMA's mine manager or delegate. As part of this process, TMA would evaluate BSL's safety performance against set criteria utilising a KPI framework tool.

The KPI tool assessed sixteen safety elements including:

- incident and hazard reporting rates
- notified at risk behaviours and non-compliances levels
- inspection and job observation completion rates
- safety toolbox meetings and risk assessment completion rates.

As part of the evaluation process, BSL was required to provide TMA with supporting documentation regarding each of the sixteen assessable safety elements. TMA would review the supplied documentation during the meeting by conducting dip sample reviews. At the conclusion of the meeting, BSL's overall performance would be rated as either being poor, unsatisfactory, satisfactory or excellent. Review of the KPI reports for the twelve months preceding the incident revealed that BSL was generally meeting the overall safety performance targets set by TMA.

6.7.2.4. General supervision

TMA provided general supervision of BSL's operations in active mining areas by conducting 'drive throughs'. Earthworks and mobility team supervisors would conduct 'drive throughs' using a light vehicle to drive in and around active mining areas, observing BSL mobile plant operator's work practices. To address any identified issues, TMA supervisors would either directly contact the plant operator over UHF radio, raise it with their shift supervisor or during pre-shift meetings.

6.7.2.5. Pit inspections

TMA's supervisors also conducted periodic pit inspection and safety interactions of BSL's work practices at the mine. The pit inspection process was similar to BSL's and was conducted utilising a checklist document which was primarily focused on the physical aspects of the workplace rather than procedural compliance of personnel.

Pit inspections were required to be conducted daily but TMA was only able to produce records of 88 pit inspections conducted during the twelve months preceding the incident. Review of these records identified two separate occasions where dump trucks were observed not maintaining separation distances in active pits and overburden dumping areas. Instances of light vehicles not maintaining adequate separation distances with heavy vehicles in active mining areas were not identified.

6.7.2.6. Safety interactions

The safety interaction process was similar to BSL's job observations and involved a task observer reviewing a task being undertaken, asking questions and providing general feedback with regards to safe and unsafe behaviours observed. The results of the safety interaction process were recorded directly into an onsite computer system.

TMA had conducted approximately 66 task observations on BSL mobile plant operators at the Snapper mine during the twelve months preceding the incident. No issues were identified regarding non-compliance with mobile plant separation distances.

6.7.3. Introduction to site

TMA's mobile plant introduction to site (ITS) processes had been in place since at least 2016 with requirements of the process documented within the Introduction to Site Management Plan.

The ITS process was intended to provide a series of checks and inspections to ensure that the plant or equipment was 'fit for purpose' and, when operated within its design and performance criteria, would not present unacceptable risks to health and safety. In accordance with the ITS management plan contractor's equipment, including BSL dozers, were required to undergo the ITS process.

In accordance with the ITS management plan, operational and maintenance risk assessments were required to be undertaken in consultation between the 'requester' (BSL) and mine operator (TMA) with records retained by the mine operator. BSL maintain that this process had not been implemented by TMA until after the incident. During the investigation, TMA was unable to produce any records to verify if these risk assessments had been undertaken with respect to the dozers which formed part of BSL's Snapper operations (including DZ 813).

As part of the ITS process, TMA was also required to complete a commissioning inspection and approval process. This involved the plant being inspected by a competent person who would undertake various checks and tests to ensure the plant met TMA's minimum plant equipment and safety standards.

The commissioning inspection process did not require any kind of assessment or checks to be conducted to ensure clear vision and maximised visibility from the cabin of mobile plant and equipment including dozers. There was also no requirement for dozers to be fitted with sideview mirrors, reversing cameras, proximity detection or collision avoidance systems.

The minimum visibility, communication and audible warning standard safety equipment required to be fitted to light vehicles and dozers included:

- high visibility flag (light vehicles only)
- high visibility reflective striping and displayed unit numbers
- amber flashing light, UHF radio, horn, reversing beeper and reversing lights.

Both LV 778 and DZ 813 were fitted with the above equipment.

6.8. Fit for purpose plant

BSL operations at the Snapper mine comprised a fleet of four Caterpillar D10T dozers. The design and configuration of the dozers' access platforms, roll-over protection system, ripper implement and other componentry caused areas of limited visibility, particularly from both side and rear cabin windows. Figure 9 shows the visibility diagram contained within the CAT D10T OEM operator's manual with the shaded areas depicting the approximate areas with significant restricted visibility. Figure 10 depicts the view from the operator's cabin of DZ 813 at the incident location.

Figure 9: Caterpillar D10T OEM operator's manual visibility diagram

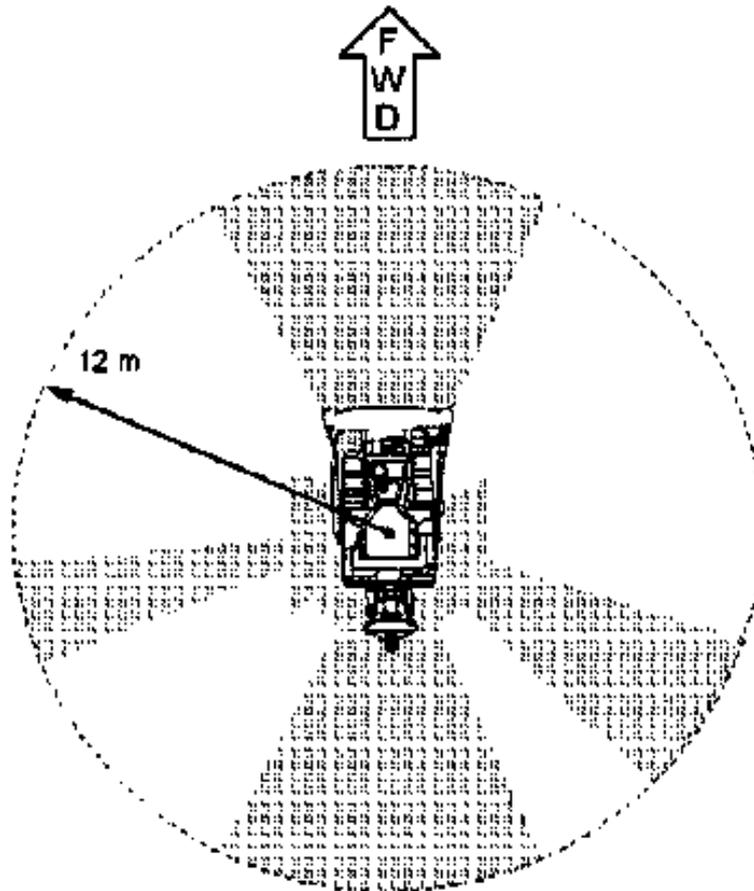


Figure 10: Caterpillar D10T dozer 813 in cabin view at incident location

View from right-hand side window



View from left-hand side window



View from rear window



To manage the risk of mobile plant and vehicle collisions *clause 36 of the WHS Act* requires mine operators and contractors to, where reasonably practicable, implement high-level controls by means of substitution, isolation and engineering before proceeding to low-level administrative controls. BSL and TMA relied heavily on the use of administrative controls via implemented SOPs and management plans.

At the time of the incident, while BSL's dozers operated at the Snapper mine had undergone TMA's ITS processes and were authorised to operate on site, none were fitted with any kind of sideview mirrors, operational reversing cameras, proximity detection or collision avoidance systems. Such equipment constitutes engineering controls available to industry that may reduce the risk of collisions through improved operator visibility/awareness and autonomously preventing vehicles from entering in proximity to one another.

As part of the investigation, inquiries were conducted into what prior consideration both BSL and TMA had given to the suitability of fitting this equipment to dozers operated at the mine.

6.8.1. Tronox Mining Australia

TMA maintained that it had considered the suitability of sideview mirrors, reversing cameras, proximity detection and collision avoidance systems during reviews and risk assessment processes. However, these processes did not progress to assessing specific models/equipment types or undertaking any formal equipment trials.

Based on the results of these general reviews and risk assessments, TMA had determined it was not reasonably practicable to fit sideview mirrors, reversing cameras, proximity detection or collision avoidance systems to the dozers operated at Snapper and Ginkgo mine sites.

6.8.2. Basin Sands Logistics

At the time of the incident, BSL did not utilise its own mobile plant equipment standards but rather worked to the minimum equipment standards prescribed by TMA's ITS processes and contracts between TMA and BSL. As such, BSL had not conducted any kind of review/assessment process to consider if sideview mirrors, reversing cameras, proximity detection or collision avoidance systems were suitable safety equipment for its dozers.

Notably, as detailed below in Section 6.9 Table 3 of this report, at least seven mobile plant collisions/near miss incidents involving BSL had occurred at the Snapper and Ginkgo mines between 12 August 2014 and 11 August 2019. Outcomes arising from TMA and BSL's joint investigations into five of the seven incidents recommended consideration be given to the suitability of fitting heavy vehicles with reversing cameras, proximity detection or collision avoidance systems.

Despite these recommendations, BSL had not undertaken its own review, assessment or trials into the suitability of fitting this equipment to its fleet of dozers.

6.9. Prior BSL mobile plant interaction incidents

Table 3 below provides a summary of prior incidents that occurred at the Snapper and Ginkgo mines involving BSL mobile plant collisions/near misses between 12 August 2014 and 11 August 2019.

Investigation reports relating to these incidents identified that workers had either failed to follow mobile plant operating, separation distance or communication procedural requirements.

Table 3: Recent BSL Mobile plant collisions and near miss incidents at the Snapper and Ginkgo mines

DATE	DESCRIPTION	CAUSAL FACTORS	NOTABLE RECOMMENDATIONS / CORRECTIVE ACTIONS
18/10/15	Dozer reversed into stationary dump truck at Ginkgo mine tip head	<p>Failure to follow procedures for separation distances between heavy vehicles</p> <p>Communication requirements between operators not performed</p> <p>Poor monitoring of direction of travel by dozer operator</p>	<p>Consider the use of proximity detection on heavy earthmoving equipment</p> <p>Review procedures to minimize vehicle interactions</p> <p>Supervisors to monitor compliance with tip head procedures</p>
10/02/16	Excavator slewed into parked unoccupied excavator at the Snapper mine overburden removal area	Excavators parked too close together	<p>Update excavator procedure requiring excavators to be parked outside 'swing radius' from other plant / structures</p> <p>Update parking competency training and retrain involved workers</p>
29/1/17	Dozer travelled behind dump truck which then reversed, resulting in collision at Snapper mine 40RL Bench	<p>Inconsistent loading practices</p> <p>Failure to follow procedures for equipment operation</p> <p>Poor communication between operators</p>	<p>Investigate collision avoidance systems and reversing cameras, with the view of implementing where reasonably practicable</p> <p>Review procedures and provide retraining in updates</p> <p>Segregate dump truck and dozer works during capping</p>
06/03/17	Dump truck collision with stationary dump truck at Snapper mine overburden clay pit	<p>Less than adequate dumping / loading procedures for dump truck waiting positions</p> <p>Operator error not looking in direction of travel</p>	<p>Conduct risk assessment and review procedures with retraining provided in updates</p> <p>Investigate collision avoidance / proximity detection systems as part of risk review, with the view to implement where reasonably practicable</p>

INVESTIGATION REPORT

Report into the death of Mr Andrew Bray
at Snapper Mineral Sands Mine 12 August 2019

DATE	DESCRIPTION	CAUSAL FACTORS	NOTABLE RECOMMENDATIONS / CORRECTIVE ACTIONS
29/05/18	Dump truck collided with parked light vehicle at Snapper go-line	Light vehicle operator (mechanic) breached procedure by parking directly in front of dump truck. Boarded dump truck to conduct repairs and drove dump truck into mechanic's own light vehicle	Review risk assessment and procedures with training in updates Investigate feasibility of fitting proximity detection alarms and convex mirrors to heavy vehicles
02/09/18	Dump truck and dozer near collision while reversing on Snapper mine tip head	Tip head procedure not followed, dump truck was working within the 50 m work area of the dozer with no positive communication Dozer operator's vision obstructed on the left-hand side due to ROPS location	Toolbox crews on positive communication requirements Retrain involved workers Review operating procedures
21/06/19	Dump truck collision with another dump truck at Gingko satellite pit	Dump truck operator failed to follow instructions, positive communications and operating procedures	Operator performance management Review operating procedures Retrain workers in updated procedures and positive communications Investigate feasibility of installing reversing cameras and proximity detection systems to dump trucks

6.10. Prior safety performance of Mr Bray

As part of the investigation, inquiries were conducted to gain an understanding of Mr Bray's prior safety performance. Those interviewed who had a work history with Mr Bray stated that he generally maintained separation/parking distances and was compliant with positive communication requirements. However, a former worker informed the investigation that he was aware of several occasions Mr Bray had driven a light vehicle within the 50-metre zone of a working heavy vehicle.

Prior safety breach

On 31 August 2018, Mr Bray received a first and final written warning from BSL for a safety breach, when he failed to follow existing procedures and breached his supervisory role and responsibilities.

Mr Bray selected the incorrect type of equipment to extract a bogged dump truck and did not conduct a risk assessment or hazard identification process prior to beginning the task.

Mr Bray was demoted from his shift supervisor role to a plant operator, which he undertook until March 2019, after which he was promoted to the role of leading hand.

6.11. Details of post incident remedial measures

Following the incident, both BSL and TMA undertook incident investigations and conducted a combined review of their procedures and risk controls. Notable changes that were introduced are detailed below.

6.11.1. Mobile plant separation distance requirements

Both BSL and TMA simplified its mobile plant separation distance requirements by modifying it to a single 50-metre rule rather than 50/20 metre rules. In accordance with the new requirement, light vehicles cannot enter within the 50-metre work area of a heavy vehicle until it has stopped, its operator has exited the cabin and is on the ground. BSL and TMA's SOP's were updated to be consistent with one another reflecting the updated requirements.

SOPs were also updated to contain a section which outlined a specific set of instructions directed toward how to safely approach a heavy vehicle in active mining areas.

These changes were implemented prior to BSL resuming its operations.

6.11.2. Heavy vehicle parking requirement

BSL introduced a new requirement for heavy equipment to be reversed up to and parked near bunds in active mining areas. BSL stated that this was done to provide "...a dedicated location and method for parking which is easily understood and visible to all employees."

At tip heads, a requirement was introduced for light vehicles to park within a designed parking bund (see Figure 11). These changes were introduced within a week of BSL recommencing its operations.

Figure 11: BSL Dozer and light vehicle parked up at light vehicle/light tower bund



6.11.3. Reversing cameras

Between March and September 2020, BSL installed reversing cameras to seven of its dozers operated at the mine at an average work order cost of \$1,951 per dozer. BSL stated that this was done to “..... ensure dozer operators have a better field of vision within identified blind zones at the rear of their equipment”. Figure 12 below depicts a BSL D10T’s dozers reversing camera view of a light vehicle positioned 4.7 metres from its rear left-hand side.

Figure 12: BSL Caterpillar D10T dozer 902 reversing camera view of light vehicle



6.11.4. Sideview mirrors

Between December 2019 and March 2020, BSL installed sideview mirrors to seven of its dozers operated at the mine at an average work order cost of \$1,637 per dozer. BSL stated that this was done to “..... trial a safety feature that may increase the range of a dozer operator’s view of the area behind the dozer being operated.” Figure 13 below depicts the view from the side mirror of a BSL D10T dozer of a light vehicle positioned 2.8 metres from its rear left-hand side.

Figure 13: BSL Caterpillar D10T dozer 902 side mirror view of light vehicle



6.11.5. Reinforced communication protocols

BSL provided training to its workforce, reinforcing the use of correct mobile plant communication protocols, including the use of asset numbers and clearly stating current location, intended destination and path of travel. The training was delivered prior to BSL recommencing its operations, at no additional costs.

6.11.6. Review of fire suppression system locations

BSL undertook a review of the location of post-original equipment manufacturer fire suppression systems fitted to its dozers. Sections of systems that were identified as possibly obscuring an operator’s vision were relocated where practicable. The review was completed in February 2020. Modifications were made to three of BSL dozers at a cost of about \$1,000 per dozer.

TMA have since introduced an assessment of operator visibility and consideration of relocation of such systems as part of the ITS compliance inspection.

6.11.7. Proximity detection system project

BSL and TMA committed to a joint project to trial a suitable proximity detection system for vehicles operating in active mining areas. The project's initial study was completed in May 2020 with a proximity detection system selected. Trials of the system are planned to be conducted on a range of mobile plant including excavators, dump trucks, service trucks, water carts, dozers and light trucks.

7. Recommendations

Mine operators and contractors have a duty to identify hazards and manage risks to health and safety associated with the operation of mobile plant and to provide safe systems for managing light and heavy vehicle interactions in accordance with the *Work Health and Safety Act 2011* and *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulations.

It is recommended that mine operators and contractors:

- monitor, review and audit procedures to ensure that safety controls for managing light and heavy vehicle interactions are implemented in accordance with the principal hazard management plan for roads and vehicle operating areas
- where reasonably practicable, segregate light and heavy vehicles in active tip heads through the use of designated parking bays and/or bunded areas
- consider, and where reasonably practicable, incorporate the use of available technology to control mobile plant interactions such as proximity detection and collision avoidance systems
- consider, and where reasonably practicable, install visual aids in heavy vehicles such as reversing cameras, rear and sideview mirrors
- ensure procedures governing mobile plant separation and parking requirements provide clear instruction about how light vehicles are to safely approach operating heavy vehicles
- provide workers with appropriate instruction and supervision to ensure mobile plant positive communication procedures are followed
- provide workers with appropriate instruction and training in the location and extent of blind spots and areas of limited visibility from the cabin of heavy vehicles operated on site
- review supervision arrangements to ensure that the work practices of light vehicle operators in active mining areas are appropriately monitored and assessed
- ensure mobile plant introduction to site processes are followed with appropriate plant-specific risk assessments conducted for heavy vehicles operated on site

- ensure the implementation of recommendations arising from incident investigations are monitored by officers through to finality.

Workers required to operate mobile plant must:

- comply with mobile plant separation, parking and positive communication procedures and never enter and / or park within the prohibited work zones of operating heavy vehicles.