BHP

Annual Environmental Protection and Management Program Report

Olympic Dam

1 July 2018 – 30 June 2019

Distribution

External Distribution	
Organisation	Contact Person
Department for Energy and Mining (DEM)	Director Mining Regulation Manager, Mining Compliance and Regulation
Department for Environment and Water (DEW)	Chief Executive Team Leader, Conservation and Mining Director, Water Science and Monitoring
Environment Protection Authority South Australia (EPA)	Director Operations Manager Radiation Protection
Great Artesian Basin Coordinating Committee	Chair
South Australian Arid Lands Natural Resources Management Board	Presiding Member
Internal Distribution	
Department	Contact Person
BHP	Asset President Olympic Dam General Manager Mine Olympic Dam General Manager Surface Olympic Dam General Manager Integrated Operations Olympic Dam Head of Corporate Affairs SA Olympic Dam Head of HSE Olympic Dam Principal Legal Olympic Dam Head of Environment A&I Manager Environment A&I

Contents

Figures

Tables

INTRODUCTION

Purpose and scope

This annual environmental protection and management program report (annual EPMP report) presents data relating to the environmental management of the BHP Olympic Dam operations for the period 1 July 2018 to 30 June 2019 (FY19).

The objectives are to:

- Meet the requirements of clause 11 of the Olympic Dam and Stuart Shelf Indenture (the Indenture).
- Report performance against environmental outcomes, compliance criteria and leading indicators presented in the 2018 Environmental Protection and Management Program (EPMP).
- Report performance against targets and continuous improvement actions also contained in the 2018 EPMP.
- Document the results of the deliverables presented in the monitoring programs (MPs) of the 2018 EPMP.

The 2018 EPMP was submitted to the Indenture Minister in May 2018 and subsequently approved.

Report structure

A description of the EPMP structure against which reporting is based is given below.

The reporting against outcomes is achieved through a hierarchy of data reporting (deliverables) and statements of compliance leading to an assessment of whether or not the environmental outcome has been met. The main chapters in the report are aligned to the key environmental aspect ID's contained within the EPMP.

The reporting hierarchy then takes the following form:

- Deliverables from the various MPs are included in the most relevant chapter, and a presentation of data and discussion of results is provided.
- The results of the deliverables contribute to the compliance statement for the compliance criteria under which they are reported (and in some cases to other compliance criteria, in which case appropriate cross-referencing is provided).
- These compliance criteria then provide a statement of achievement of the environmental outcome.

Performance against targets and continuous improvement actions is reported separately but still within the relevant ID chapter.

Table 1 contains a summary of each Environmental Management Program (EM Program) ID. This provides an overview of the outcomes and has the following elements:

- the environmental outcome to be achieved
- a 'traffic light' style indicator to indicate whether the outcome has been achieved.
- a statement that summarises whether or not the environmental outcome was achieved, and why.

EPMP STRUCTURE

Background

The structure of the EPMP report is closely aligned with the structure of the BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) 2018 EPMP, and in particular the EM Program contained within that document. The EPMP consists of a number of documents which form a portion of the Environmental Management System (EMS) requirements. A brief summary of each document within the EPMP is shown in Table 1.

Table 1: EPMP Structure

Document	Content summary
EMM	General overview of the EPMP. Purpose and scope. Regulatory framework. Background information about Olympic Dam. Overview of the structure and requirements of the Environmental Management System. Glossary of defined terms. Cross-referencing of EPMP content to approval conditions and the requirements of the Mining Code.
EM Program	Addresses potentially significant environmental aspects and impacts, identified through analysis and prioritisation of environmental risks, legal obligations and community concerns. Documents the processes, systems and actions used to manage the prioritised aspects and impacts.
MP(s)	Address assessment and performance of the EM Program's outcomes, compliance criteria and targets, control mechanisms and legal and other requirements.
Actions, Targets and Major Changes	Captures continuous improvement opportunities and development opportunities identified that can assist in meeting compliance criteria and environmental outcomes and improving ODC's environmental performance, environmental improvement targets and the action plan to achieve such targets.
Mine Closure and Rehabilitation Plan	A plan for closure and rehabilitation of the mine, including the environmental outcomes expected to be achieved indefinitely, and options for progressive rehabilitation.

The EM Program documents the processes, systems and actions used to manage prioritised aspects and impacts, including the incorporation of:

- the environmental values that may be impacted, and the key risks to those values;
- the environmental outcomes that BHP aims to achieve;
- clear, specific and measurable compliance criteria that demonstrate achievement of the outcome(s);
- leading indicator(s) criteria, providing early warning of trends that indicate a compliance criteria may not be met;
- the management and operational controls in place to deal with the environmental risk (aspects and impacts), including any regulatory conditions; and
- contingency options to be used in the event that identified risks are realised.

EXECUTIVE SUMMARY

Overview

The FY19 Annual EPMP Report demonstrates compliance and environmental improvements against the 2018 Environmental Protection and Management Program (EPMP).

Data from monitoring programs is presented as evidence against compliance criteria under the Environmental Management Program (EM Program) IDs.

Considerable progress against environmental outcomes and compliance criteria in the 2018 EMP and actions and targets was made during the reporting period.

Major Achievements

Major achievements for the reporting period include:

- Approximately 3,145 tonnes of recyclable material was transported offsite during FY19. Materials included plastics, metals, hydrocarbons, timber and tyres. This is a new record for total quantity of materials transported off site for recovery and reprocessing. ODC are continuing to investigate additional ways to segregate and recover more materials to decrease the operations reliance on landfill disposal.
- Cleaning and decontamination of structural waste has reduced the overall quantity of structural waste being disposed of to the contaminated waste storage facility (CWDF). FY19 recorded the lowest tonnage of disposal since opening in FY17.
- The number of radioactive process material spills declined significantly between FY11 and FY17, from approximately 75 spills down to less than 15. That low number of spills has been maintained in FY19 and as before is attributed to continuing efforts toward planned maintenance and work management through 1SAP.
- The Emerald Springs Significant Environment Benefit was approved to support future native vegetation clearances.
- In FY19 ODC completed projects within the Great Artesian Basin Infrastructure Investment Program (GABIIP) to replace GAB wells which were identified as a high failure risk and could lead to wastage of GAB water.

Compliance summary

Table 2 lists the environmental outcomes for each EM Program ID. Next to each outcome 'traffic light' style indicators have been used to allow for overview assessment of achievement of the outcome, as follows:

- ● Environmental outcome achieved
- ▲ Significant progress towards achieving the Environmental outcome
- ● Environmental outcome not achieved.

The approved 2018 EMP contained 22 environmental outcomes, 26 compliance criteria and 15 leading indicators. Additional to these the EPMP contained 10 targets, and 18 actions, which are aspirational and support the environmental outcomes and compliance criteria against which ODC is assessed. 21 of the 22 environmental outcomes (and the associated compliance criteria) were achieved or were within prescribed limits and all targets and actions were achieved or significantly progressed. The one outcome not met was for ID3.1 Particulate Emissions, caused by a PM_{10} result on one day exceeding the compliance criteria threshold. Although this one exceedance event did occur, on a day of regionally high dust levels, ODC does not consider this one off event to have caused adverse impacts to public health. Measured ground level dust concentrations derived from operations at Olympic Dam and recorded at sensitive receptor sites were below compliance criteria for PM_{10} at all other times during FY19. Consequently, this outcome has been classified as demonstrating 'significant progress towards achieving the environmental outcome'.

No leading indicators were triggered during the reporting period.

Table 2 provides a summary of the environmental outcomes assessed during FY19.

Table 2: FY19 Compliance Summary

ID 1 USE OF NATURAL RESOURCES	
ID 1.1 Land Disturbance and Rehabilitation	
Environmental outcome	Outcome Statement
● No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of the construction, operation and closure of Olympic Dam.	No significant adverse impacts to populations of listed species as a result of the construction and operation of Olympic Dam occurred. No closure activities were undertaken in FY19. No significant clearing of listed species or listed species potential habitat occurred in FY19. No significant adverse impact was detected for *Eriocaulon carsonii* as a result of aquifer level drawdown. The Red-necked Stint (*Calidris ruficollis*; N = 5), listed as Migratory under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and the Banded Stilt (*Cladorhynchus leucocephalus*; N = 19), listed as Vulnerable under the National Parks and Wildlife Act 1972 (NPW Act), were observed interacting with the TRS during FY19. Due to the low number of listed species encountered at the TRS, no significant adverse impact to a population of listed bird occurred as a result of the operation of Olympic Dam.

ID 1.2 Aquifer Level Drawdown	
Environmental outcome	**Outcome Statement**
No significant adverse impacts to existing third-party users' right to access water from within the GAB wellfield Designated Areas for the proper development or management of the existing use of the lands as a result of ODC activities.	Drawdown and percentage wellhead pressure loss at pastoral bores remains less than the predicted long-term impact as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016), and significantly less than the maximum drawdown area defined within the 10 m contour.
No significant adverse impacts to the availability and quality of groundwater to existing Stuart Shelf third-party users as a result of groundwater drawdown associated with ODC activities.	No significant impact to groundwater for existing Stuart Shelf third-party users has occurred. Regional groundwater levels are stable.
No significant adverse impact on groundwater-dependent listed species or ecological communities as a result of groundwater drawdown associated with ODC activities.	Drawdown remains less than the predicted long-term impact and was within compliance criteria limits for FY19. Environmental flow rates at GAB springs remained above predicted long term impacts as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016). Monitoring showed no indication of a significant adverse impact on groundwater-dependent listed species or ecological communities as a result of groundwater drawdown associated with ODC activities.

ID 2 STORAGE, TRANSPORT AND HANDLING OF HAZARDOUS MATERIALS

ID 2.1 Chemical and Hydrocarbon Spills	
Environmental outcome	**Outcome Statement**
No significant site contamination of soils, surface water or groundwater, as a result of the transport, storage or handling of hazardous substances associated with ODC's activities.	No significant site contamination of soils, surface water or groundwater occurred in undisturbed areas in FY19. All spills which occurred were appropriately contained and cleaned up as soon as practicable. Active monitoring and management of legacy hydrocarbon sites was continued during FY19.

ID 2.2 Radioactive Process Material Spills	
Environmental outcome	**Outcome Statement**
No adverse impacts to public health as a result of radioactive process material spills from ODC's activities.	ODC has consistently operated in a manner that limits radiation dose to members of the public, from operational activities and radioactive emissions, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1mSv/y limit. During FY19 there were no radioactive process material spills outside operational areas. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken by ODC.
No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive process material spills from ODC's activities.	No significant impacts to populations of listed species or ecological communities were recorded as a result of operational activities, including the effects from any radioactive process material spills. Impacts to listed species and ecological communities are avoided by ensuring that there is no uncontrolled loss of radioactive material to the natural environment. As there was no loss of radioactive material to the undisturbed environment in FY19, no impact to populations of listed species or ecological communities occurred.

ID 3 OPERATION OF INDUSTRIAL SYSTEMS

ID 3.1 Particulate Emissions

Environmental outcome	Outcome Statement
▲ No adverse impacts to public health as a result of particulate emissions from ODC's activities.	No adverse impacts to public health as a result of particulate emissions from operations conducted by ODC occurred during FY19. Although one exceedance event did occur, on a day of regionally high dust levels, ODC does not consider this one off event to have caused adverse impacts to public health. Measured ground level dust concentrations derived from operations at Olympic Dam and recorded at sensitive receptor sites were below compliance criteria for PM_{10} at all other times during FY19.

ID 3.2 Sulphur dioxide emissions

Environmental outcome	Outcome Statement
● No adverse impacts to public health as a result of sulphur dioxide emissions from ODC's activities.	National Environmental Protection Measure (NEPM) 1999, levels for ambient air quality are based on the protection of human health. Roxby Downs and Olympic Village ambient SO_2 analyser results for the reporting period showed no exceedance of the NEPM for ambient air quality SO_2 at either Olympic Village or Roxby Downs Township. An annual review of monitoring data collected at sensitive receptors (ambient ground level concentrations) has shown there were no adverse impacts to public health as a result of sulphur dioxide (SO_2) emissions from ODC's activities during FY19.

ID 3.3 Saline aerosol emissions

Environmental outcome	Outcome Statement
● No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of ODC's activities.	No significant adverse impact to populations of listed species from saline aerosol emissions was observed during FY19. Observations made during environmental inspections and supported by data collected during various flora and fauna monitoring programs, did not find any significant adverse impacts to listed species.

ID 3.4 Radioactive emissions

Environmental outcome	Outcome Statement
● No adverse impacts to public health as a result of radioactive emissions from ODC's activities.	ODC has consistently operated in a manner that limits radiation dose to members of the public, from operational activities, to less than a small fraction of the 1mSv/yr public dose limit prescribed by the International Commission on Radiological Protection (ICRP). As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at ODC.
● No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive emissions from ODC's activities.	There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODCs activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota (NHB) assessment sites is used as an indicator of the potential exposure of listed species to radioactive emissions. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

ID 3.5 Greenhouse gas emissions	
Environmental outcome	Outcome Statement
Contribute to stabilising global atmospheric greenhouse gas concentrations to minimise environmental impacts associated with climate change.	BHP's climate change strategy focuses on reducing our operational greenhouse gas (GHG) emissions, investing in low emissions technologies, promoting product stewardship, managing climate-related risk and opportunity and working with others to enhance the global policy and market response. As a BHP group asset, ODC operates under the BHP group strategy.

ID 4 GENERATION OF INDUSTRIAL WASTES

ID 4.1 Embankment stability of TSF	
Environmental outcome	Outcome Statement
No significant TSF embankment failure.	During FY19 the Tailings Storage Facilities (TSFs) were managed in accordance with the TRS Operations, Maintenance and Surveillance Manual (BHP Olympic Dam 2018d) and the Tailings Management Plan (BHP Olympic Dam 2018e) and no embankment failures of any magnitude occurred.

ID 4.2 Tailings seepage	
Environmental outcome	Outcome Statement
No significant adverse impact on vegetation as a result of seepage from the TSF.	No significant adverse impact to vegetation as a result of seepage from the TSF has occurred. Eighty metres AHD (20 m below ground level) is considered as the level below which groundwater cannot interact with the root zone of plants in the Olympic Dam region. Groundwater levels in the vicinity of the TSF remain below 80 mAHD.
No compromise of current and future land uses on the Special Mining Lease (SML) or adjoining areas as a result of seepage from the TSF.	No compromise of current and future land uses on the SML or adjoining areas has occurred. Groundwater levels in the vicinity of the TSF remain below 80 mAHD and sampling indicates that seepage is being attenuated.
No compromise of the environmental values of groundwater outside the SML as a result of seepage from the TSF.	No compromise of the environmental values of groundwater outside the SML has occurred. Sampling indicates that seepage is being attenuated within the SML, and groundwater levels of bores along the SML are consistent with other regional bores. Seepage modelling has been updated to demonstrate that there are no expected future offsite impacts.

ID 4.3 Fauna interaction with Tailings Retention System	
Environmental outcome	Outcome Statement
No significant adverse impacts to listed species (South Australian, Commonwealth) as a result of interactions with the Olympic Dam TRS	No significant adverse impacts to listed species as a result of interactions with the Olympic Dam Tailings Retention System (TRS) have occurred. The Red-necked Stint (Calidris ruficollis; N = 5), listed as Migratory under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and the Banded Stilt (Cladorhynchus leucocephalus; N = 19), listed as Vulnerable under the National Parks and Wildlife Act 1972 (NPW Act), were observed interacting with the TRS during FY19. Due to the low number of listed species encountered at the TRS, no significant adverse impact to a population of listed bird occurred as a result of the operation of Olympic Dam.

ID 4.4 Solid waste disposal

Environmental outcome	Outcome Statement
No significant adverse impacts as a result of management of solid waste.	The Resource Recovery Centre (RRC) effectively manages solid waste as per the EPA approved Landfill Environmental Management Plan 2016 (LEMP). No evidence of material environmental harm was identified through routine auditing or based on the reporting of materials disposed of to the landfill. Therefore, it can be concluded that no significant adverse impacts resulted from the management of solid waste at Olympic Dam during FY19. During January (9th to 21st) 2019 a fire occurred at the landfill facility and was reported to the EPA in line with Licence 1301 requirements. As a result of this event a change to on ground waste management practices was implemented within the RRC to further reduce the likelihood of a similar event occurring in the future. This included the implementation of a concrete sorting pad, circulation of quick guide reference cards for waste segregation and toolbox meetings across site.

ID 4.5 Radioactive waste

Environmental outcome	Outcome Statement
No adverse impacts to public health as a result of radioactive waste from ODC's activities.	ODC has consistently operated in a manner that limits radiation dose to members of the public from radioactive waste, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1 mSv/yr limit. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at Olympic Dam.
No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive waste from ODC's activities.	There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODCs activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota assessment sites is used as an indicator of the potential exposure of listed species to radioactive waste. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

ID 5 INTERACTION WITH COMMUNITIES

ID 5.1 Community interaction

Environmental outcome	Outcome Statement
Residents in Roxby Downs, Andamooka and Woomera have a favourable view of ODC.	Responses to the 2017 Olympic Dam Community Perception Survey indicate that ODC is a trusted organisation within its local communities. In addition to this, ODC provides employment to local and regional communities. The next Community Perception Survey is scheduled for 2020.

Note: Individual monitoring programs are referred to in this document with a two letter abbreviation as follows: Fauna – FA; Flora – FL; Great Artesian Basin – GA; Groundwater – GW; Environmental Radiation – ER; Airborne Emissions – AE; Energy Use and Greenhouse Gas (GHG) Emissions – EG; Waste – WA; Surface water – SW; Social Effects – SE

1 Use of natural resources

1.1 Land disturbance and rehabilitation

1.1.1 Environmental Outcome

No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of the construction, operation and closure of Olympic Dam.

No significant adverse impacts to populations of listed species as a result of the construction and operation of Olympic Dam occurred. No closure activities were undertaken in FY19.

No significant clearing of listed species or listed species potential habitat occurred in FY19.

No significant adverse impact was detected for *Eriocaulon carsonii* as a result of aquifer level drawdown.

No significant adverse impacts to listed species as a result of interactions with the Olympic Dam Tailings Retention System (TRS) have occurred.

The Red-necked Stint (*Calidris ruficollis*; N = 5), listed as Migratory under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and the Banded Stilt (*Cladorhynchus leucocephalus*; N = 19), listed as Vulnerable under the National Parks and Wildlife Act 1972 (NPW Act), were observed interacting with the TRS during FY19. Due to the low number of listed species encountered at the TRS, no significant adverse impact to a population of listed bird occurred as a result of the operation of Olympic Dam.

1.1.2 Compliance criteria

No significant impact to the size of an important population of a community of native species dependent on natural discharge of groundwater from the Great Artesian Basin, including *Eriocaulon carsonii*. *NOTE: Significant impact is as defined in the Significant Impact Guidelines and greater than predicted in the EIS.*

Potential impacts to communities of native species dependent on natural discharge of groundwater from the Great Artesian Basin (GAB) are discussed in Chapter 1.2 on Aquifer Level Drawdown. Within the region studied, populations of *Eriocaulon carsonii* were restricted to 19 spring vents in the Hermit Hill, North East and Lake Eyre springs complexes in FY19. It was again absent from one spring (HHS074) where it was recorded in FY17. *Eriocaulon carsonii* was recorded again on HHS122 after not being recorded in FY18. It was recorded at this spring in FY17, so it's likely that it was present but missed in FY18. The average abundance of *Eriocaulon carsonii* observed in FY19 (14±3) was slightly higher than FY18 (13±2). Therefore, it is concluded that no significant impact to the size of an important population of a community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (GAB) has occurred in FY19.

No loss of an important population of Plains Rat (*Pseudomys australis*).

No loss of an important population of Plains Rat occurred as a result of land disturbed by ODC activities. No known critical habitat was cleared during FY19. Vegetation clearance was primarily restricted to the SML with small amounts of disturbance occurring in the near vicinity.

Clearing of vegetation not to exceed the total area of 17,269 hectares as indicated in the EIS (DEIS and SEIS).

As the figure of 17,269 hectares is from the 2009 EIS for the Olympic Dam expansion project that did not proceed (BHP Billiton Olympic Dam 2009), BHP is currently reviewing this compliance criteria. For the purpose of addressing this compliance criteria, as at 30 June 2019, the total area of disturbance related to Olympic Dam activities was 4,881.9 ha. Disturbance and offset activities are discussed in further detail in Section 1.1.6.

1.1.3 Deliverables (FA 2.1)

An annual report of monitoring and control actions undertaken within the SML and surrounding areas.

During FY19, a total of 143 traps were set with an average of 12 traps set per month. Over this period, eight traps failed (i.e., trap closed without cat capture). A total of 45 cats were caught. Therefore, the overall trap success rate was 33%. The overall trap success rate was greater than last financial year. Areas of focus included Roxby Downs Village, Olympic Dam Village, the Resource Recovery Centre and office buildings on the SML.

Throughout FY19, four wild dogs were observed opportunistically on the SML, near the desalination plant. ODC remains committed to work in conjunction with the South Australian Arid Lands Natural Resources Management Board (SAAL NRM) to opportunistically control wild dog numbers (see SA Arid Lands Wild Dog Management Plan 2015).

In FY16, ODC together with Arid Recovery re-established an historical spotlight transect program that monitors the density of rabbits, cats, foxes and kangaroos in the Olympic Dam region. ODC worked with the Department of Primary Industries and Resources South Australia (PIRSA) to facilitate the release of a Korean strain of rabbit haemorrhagic disease virus (RHDV) known as K5 in the Roxby region in March FY16 (Figure 1). From July 2016 to April 2019, a significant decline in rabbit density has been observed at the Andamooka transect ($F_{1, 18} = 14.92$, $p = 0.001$; $R^2 = 0.453$) and at the Roxby Downs transect ($F_{1, 18} = 13.67$, $p = 0.002$; $R^2 = 0.432$; Figure 1). While it appears that the release of the K5 virus may have had a negative impact on rabbit densities in the region, it must be noted that no additional evidence was observed (e.g., no rabbit carcasses were observed that could have been laboratory tested for evidence of the K5 virus). It is more likely that a reduction in available resources as a consequence of low rainfall in the region may have resulted in fewer rabbit sightings.

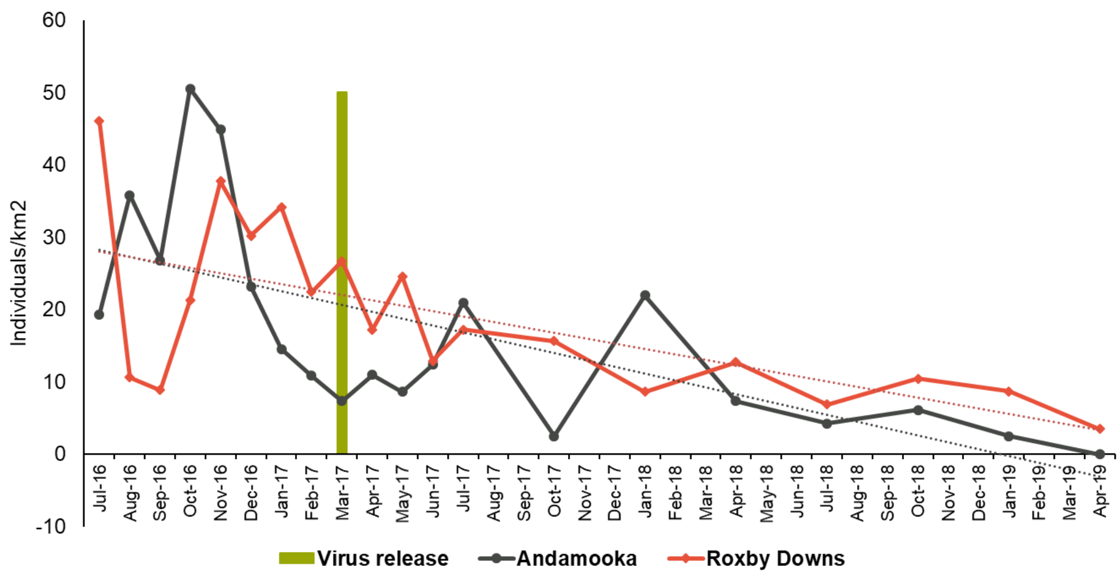


Figure 1: The density of rabbits observed pre- and post- K5 virus release.

An assessment of the abundance of specific feral and abundant species within the region.

Quarterly spotlight counts of two transects within the Olympic Dam region showed that rabbits and kangaroos exist in the highest density compared to other introduced or abundant species (i.e., foxes, cats and wild dogs) during FY19 (Figure 2). While kangaroo numbers remain stable, rabbit numbers

have visibly declined and remain below pre-RHDV1 release in 1995 (Pedler et al. 2016). Due to the cautious nature of wild dogs, it is recognised that the spotlight transect method may not be the best for capturing wild dog abundance data.

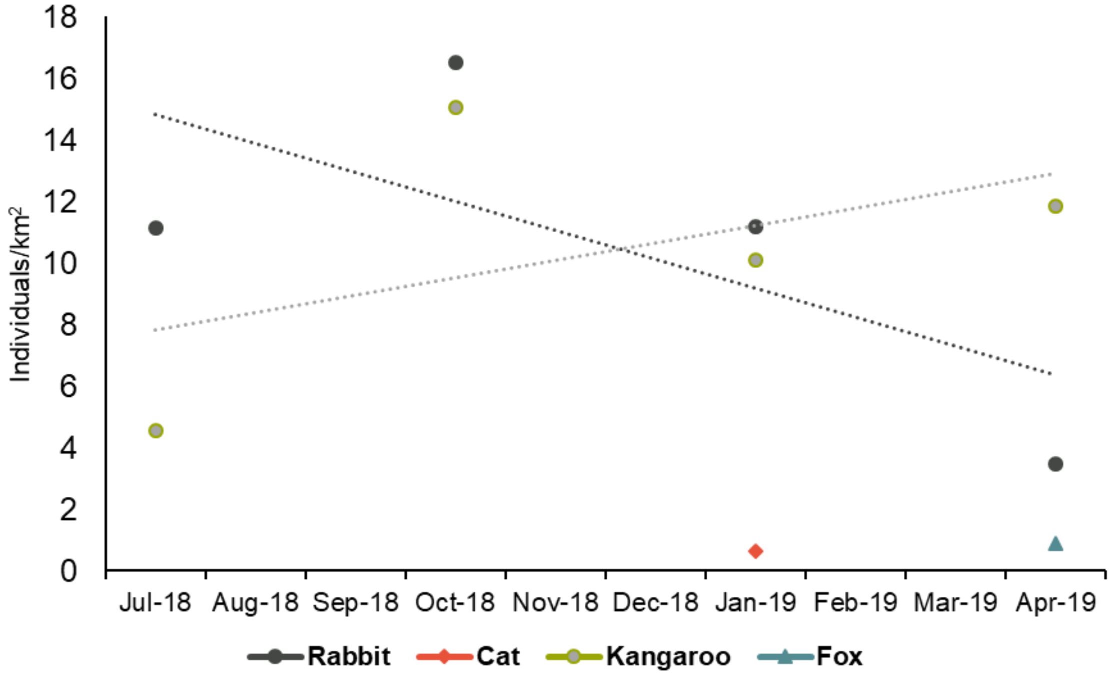


Figure 2: Density of rabbits, cats, foxes and kangaroos observed in the Olympic Dam region in FY19.

1.1.4 Deliverables (FL 2.3)

Define and map the current distribution of extreme and high risk weed species within the Olympic Dam region, Roxby Downs Municipality, the expanded SML and Gosse Springs SEB areas.

Identification of whether measures are required to control declared weeds and plant pathogens in the operations area.

Routine and opportunistic observations were undertaken throughout the reporting period. A total of 13 pest plant species were recorded during FY19, comprising of nine declared species. This is in addition to seven other declared species known to persist in the SML/Municipal lease region (i.e., infestations recorded FY15 to FY19 that are known to still be active; Table 3). Control efforts for a number of these species were undertaken throughout FY19. Previously unrecorded populations of buffel grass were observed and controlled in the Andamooka region. Thereby, it was determined that control measures were still required for the continued management of pest plants.

A baseline weed assessment undertaken within the Gosse Springs SEB area during FY16 recorded no declared species and two species, Common sowthistle and Ruby dock, listed as ‘significant’ by the South Australian Arid Lands Natural Resources Management Board. No new pest plant species were recorded within the SEB area in FY19.

The FY19 distribution of declared and other high risk pest plant species is shown in Figure 3 - Figure 5. In many cases a single GPS location may reference a large infestation area, and as such distribution of weeds such as Ruby dock, Salvation Jane, Caltrop and Blackberry nightshade may be more extensive than appears on the map below.

Table 3: A list of declared and other high risk weed species observed in the SML, Municipal lease region during FY19.

Declared weed species	High risk weed species
African boxthorn	Blackberry nightshade
Athel pine	Couch grass
Buffel grass	Onion weed
Caltrop	Paddy melon
Fountain grass	Potato weed
Gazania	Prickly lettuce
Innocent weed	Ruby dock
Prickly pear	Saffron thistle
Salvation Jane	Stemless thistle
	White cedar
	Wild oats

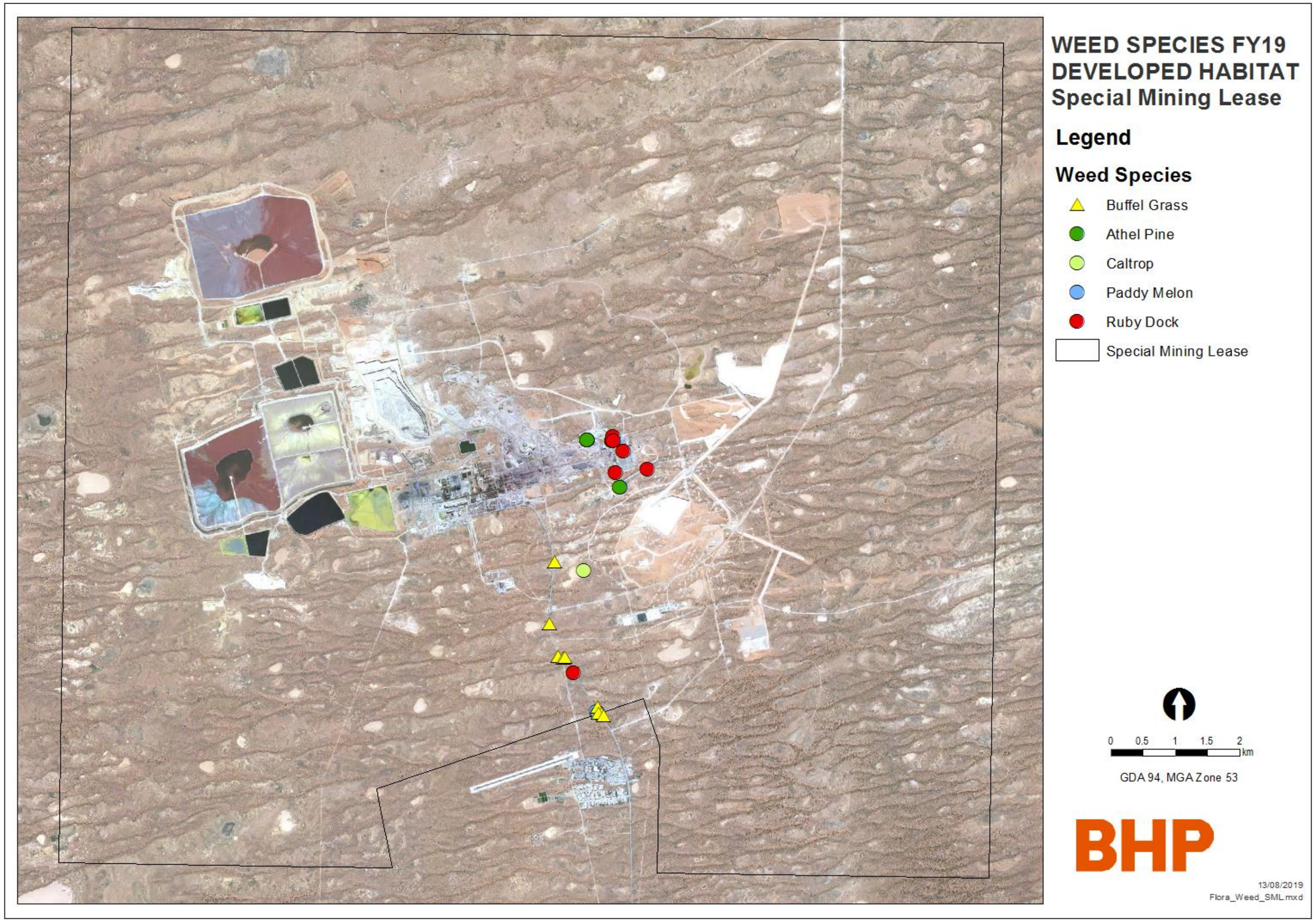


Figure 3: Locations of declared and high risk weed species on the SML in FY19

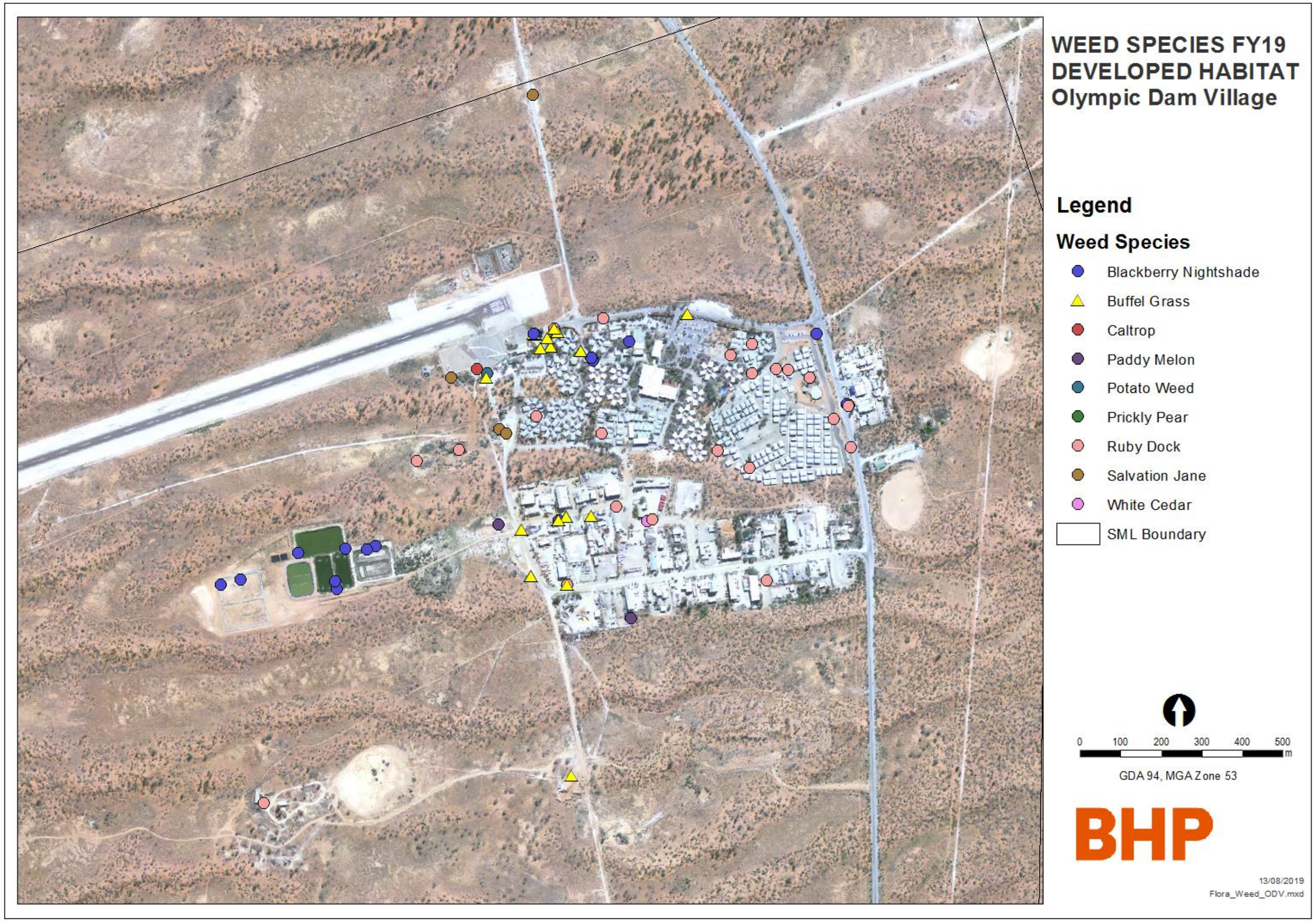


Figure 4: Locations of declared and high risk weed species at Olympic Dam Village (within the Municipal Lease) in FY19

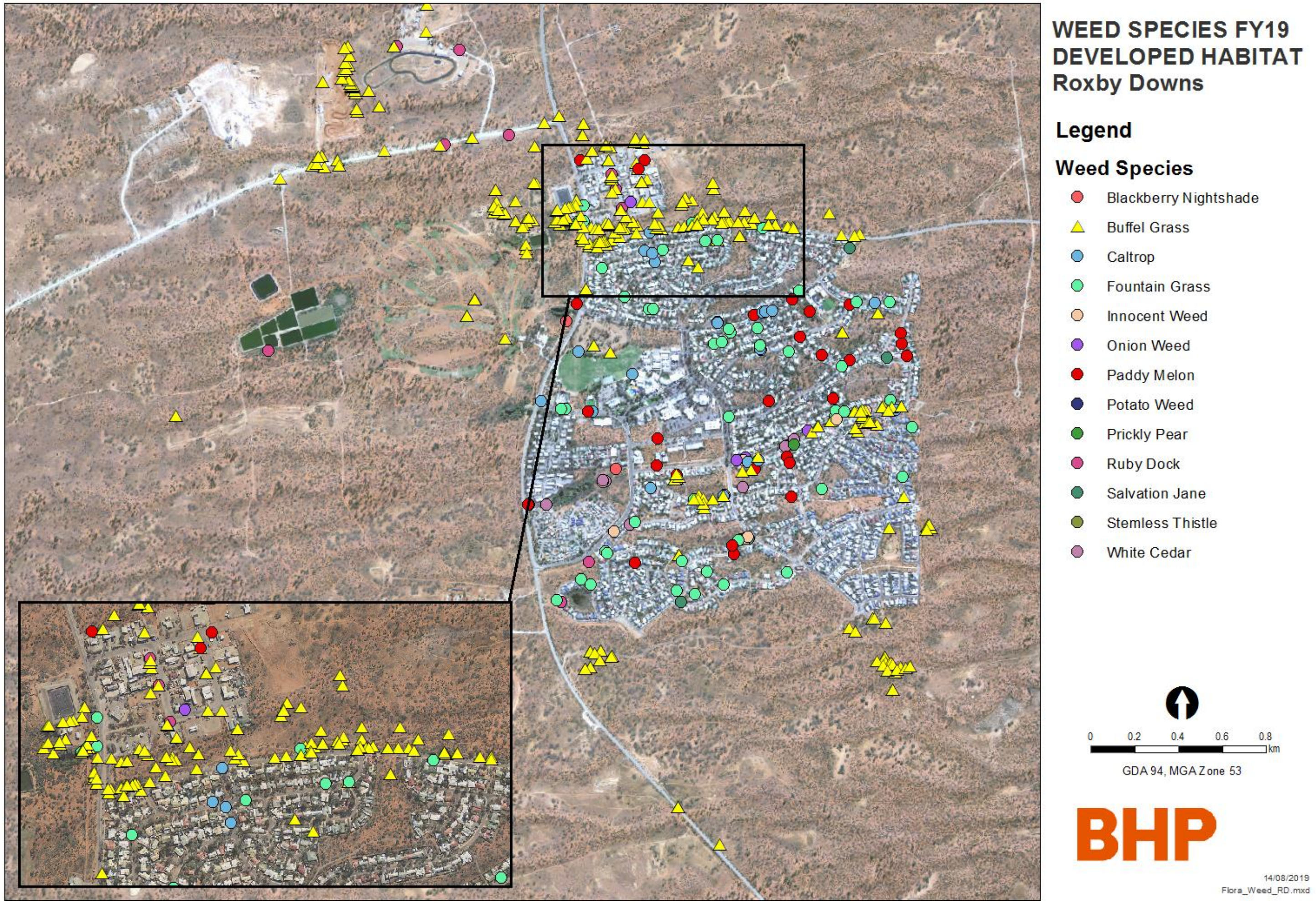


Figure 5: Locations of Declared and high risk weed species in the Roxby Downs urban area (in the Municipal Lease) in FY19.

1.1.5 Deliverables (FL 2.4)

A map of the known locations of listed species within the impact area of the Olympic Dam operation.

A statement of impacts to, and measures undertaken to avoid listed species.

Listed species include species known to occur in the region that are either listed as threatened or greater under state, national and/or international legislation and have the potential to be adversely impacted by operations. This includes species that have a wider distribution within the state, interstate or overseas and are therefore not considered to be critically dependent on existing populations within the potential impact area.

A desktop assessment determined that no listed flora species of international significance, one listed flora species of national significance and 19 listed flora species and one listed community of state significance were identified as potentially occurring in the impact area of the Olympic Dam operation. Western Tarvine (*Gilesia biniflora*), listed as Rare, and the threatened ecological community (TEC) Mulga (*Acacia aneura*) low woodland on sand plains, listed as Vulnerable under the NPW Act are known to exist on the SML (Figure 6). No known listed flora species were impacted by disturbance activities during FY19 (Figure 6). Efforts are made wherever possible to avoid these species during the Environmental Disturbance Permit (EDP) process.

Furthermore, a desktop assessment determined that three listed fauna species of international significance, four listed fauna species of national significance and 24 listed fauna species were identified as potentially occurring in the impact area of the Olympic Dam operation. Fauna species re-introduced to Arid Recovery or species known to interact with the TRS were excluded from this assessment. Nomadic and migratory species known to interact with the TRS are discussed separately in chapter 4.3 Fauna Interaction with the Tailings Retention System. An important population of Plains Rat is known to inhabit the Arid Recovery reserve and during favourable conditions it is known to expand its population into the SML. Vegetation types that are considered potential habitat for the Plains Rat include, chenopod shrublands (*Atriplex vesicaria* / *Maireana astrotricha*), cotton bush (*Maireana aphylla*) gilgais, canegrass (*Eragrostis australasica*) swamps and ephemeral dominated plains (Figure 7). These vegetation types are often associated with large swale areas greater than 1 km^2 that have drainage lines and cracking clays, which constitutes critical habitat for the Plains Rat. To determine the presence of Plains Rat critical habitat and activity, two surveys were undertaken in FY19; one to the west of TSF5 and the other to the south of EP3. No evidence of Plains Rats was observed. Efforts are made wherever possible to avoid potential Plains Rat habitat using the EDP process.

Figure 6: Potential and confirmed habitats of listed flora species.

Figure 7: Listed fauna species potential and confirmed habitats.

1.1.6 Deliverables (FL 2.4)

A map of the direct disturbance impact footprint of ODC's Olympic Dam activities.

A statement of comparison between the impact footprint of ODC's Olympic Dam activities (i.e. within and outside the SML) and the offset areas under SEB processes, to track progress towards a life of mine ratio of 8 ha set aside for each hectare disturbed.

In 2010, the Gosse Springs Native Vegetation Management Plan was approved to establish a Significant Environmental Benefit (SEB) offset area of 10,963 ha. All land disturbance that is subject to an environmental offset under legislation is tracked though the EDP procedure and allocated an appropriate SEB offset ratio.

In 2019, the Emerald Springs SEB Native Vegetation Management Plan (Barron 2018a) was approved to establish a SEB offset area of 38,022 ha that is equivalent to 267,143 SEB points. The Native Vegetation Clearance Proposal for the SML accompanied the submission, which determined that 58.36 SEB points are required to be deducted from the Emerald Springs SEB credit for each hectare of native vegetation clearance (Barron 2018b). Points will only be subtracted from the Emerald Springs SEB credit once credit from the Gosse Springs SEB has been exhausted.

For Gosse Springs SEB, the offset area is subtracted from the total SEB offset area that has been approved by the Native Vegetation Council, and a remaining SEB offset is reported in Table 4.

Spatial analysis techniques were utilised on geo-referenced orthoimagery for FY19. During this reporting period, satellite imagery of the vast majority of the SML was captured on a quarterly basis (captured in September 2018, December 2018, March 2019 and June 2019), offering an accurate account of the timing of land disturbance. Disturbances identified as occurring between these dates were digitised and are represented in Figure 8. The total area of disturbance that occurred during FY19 is 43.2 ha (Table 4).

The majority of disturbance for FY19 is attributed to works associated with the Tailings Retention System and southern mine area.

As at 30 June 2019 a total area of 767.3 ha of land has been offset, resulting in an SEB offset of 6,538.7 ha, with an average offset ratio of 8.4. A balance of 4,424.3 ha remained in the Gosse Springs SEB offset area.

The total area of disturbance related to Olympic Dam activities is currently 4,881.9 ha. This figure is inclusive of rehabilitation areas and Roxby Downs town facilities, water pipelines and other associated infrastructure.

Table 4: Areas of Disturbance and SEB Offset Areas as at June 2019.

	FY19 Clearance (ha)	Total Clearance Area (ha)	Gosse Springs SEB offset (ha)	Average Gosse Springs SEB Ratio	Emerald Springs SEB Points	Emerald Springs SEB Points Required (58.36 per Ha[IV])
Emerald Springs Offset Area (38,022 ha)	-	-	-	-	267,143	-
Gosse Springs Offset Area	-	-	10,963	-	-	-
Land disturbed subject to an SEB offset*	8.3	767.3	6,538.7	8.4	-	0
Land disturbed not subject to an SEB offset*	35.0	4,114.6	-	-	-	-
Total Land Cleared**	43.2	4,881.9	-	-	-	-
SEB Balance Remaining in Reserve ***	-	-	4,424.3	-	267,143	-

* This figure includes areas where permission was granted to clear under the SEB offset policy prior to the approval of the EIS in 2011. It is based on a conservative calculation where the higher offset value of any permit issued over the area is used, which can result in small co-mission errors.
** This figure includes all land cleared to date as a part of ODC activities since the commencement of operations.
*** Slight variations will occur from year to year due to continuous improvement of the mapping layer.
[IV] Applies only to vegetation on the SML that was assessed as a part of the 2018 SML Data Report (Barron 2018b). SEB Points from Emerald Springs SEB will only be deducted once Gosse Springs SEB has exhausted its credit.

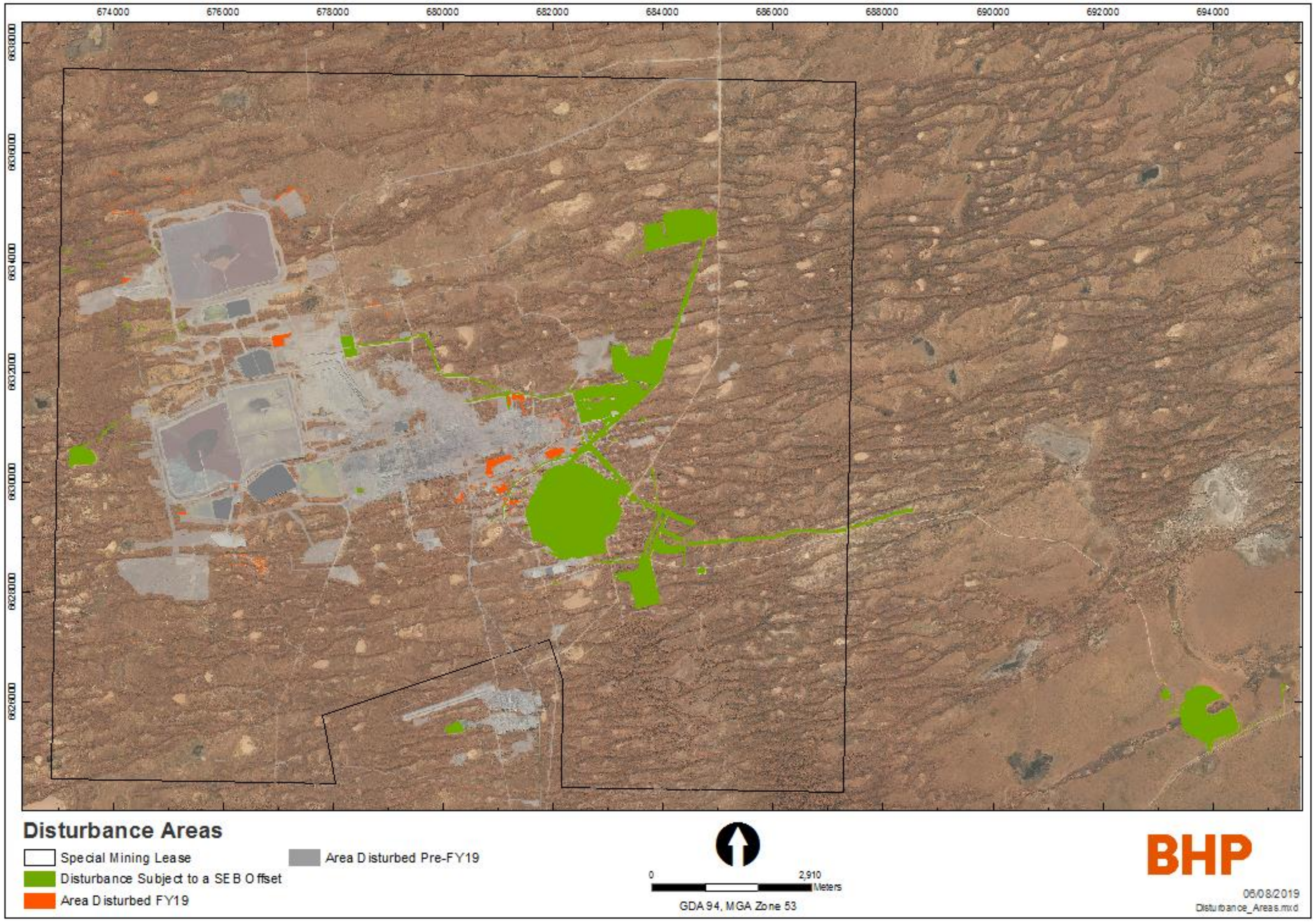


Figure 8: Areas of disturbance as at June 2019 (SML).

1.1.7 Deliverables (FL 2.5)

A summary of actions achieved from the SEB implementation plans within the fiscal year through the Annual EPMP Report.

An annual report to the government on SEB management outcomes through the Annual EPMP Report.

Shapefiles of the SEB areas for inclusion in relevant departmental databases.

Emerald Springs SEB

In FY19, ODC obtained approval for the Emerald Springs SEB in accordance with Schedule 1, Part 5 (Mining and petroleum activities), Division 1 – Mining Operations, 28 - Operations of the Native Vegetation Regulations 2017 under the Native Vegetation Act 1991. The Heritage Agreement has not yet been secured and is with the State for assessment. Table 3.2.1 of the Emerald Springs SEB Management Plan (Barron 2018a) outlines the management actions and timing of the agreed actions. Table 5 below outlines key once-off actions. Ongoing management will be captured through 1SAP Work Management and reported here once in progress (FY20-21).

Table 5: Once-off management actions required for the Emerald Springs SEB in FY20-21.

	Action	Timing
1.	Cattle are to be mustered and removed.	FY20
2.	Fence along the northern side of the Oodnadatta Track (~50km), including behind the Curdimurka Siding, including a gate at the main access points for springs and monitoring bores.	FY20-21
3.	Improved signage, including at the Lake Eyre Lookout, Curdimurka Siding and at regular intervals along the Oodnadatta Track to encourage tourists to remain in controlled areas	FY20-21

Gosse Springs SEB

Prior to FY18, a number of actions were undertaken by ODC within the Gosse Springs SEB area. The Heritage Agreement was ratified by the Lands Titles Office, formalising this tenure aspect over the Gosse Springs SEB area. A new fence was also installed along the eastern boundary of the Gosse Springs SEB area and three dedicated parking areas have been constructed within the SEB area encouraging visitors to park prior to approaching the spring vent.

ODC commissioned a baseline vegetation survey of the Gosse Springs SEB area to record species cover and abundance using landscape representative quadrats. The baseline survey also targeted known threatened species locations and land systems to aid in the identification of priority management areas. The baseline survey also recorded the location of introduced species to guide weed management processes. The weed species locations have been added to ODC's weed management database and the Gosse SEB area has been included into the latest ODC Weed Management Work Instruction. A targeted survey for pest plant species within the SEB area was undertaken in September 2015. This data improves upon the broader assessment undertaken in an earlier vegetation survey and will be used to prioritise pest plant management within the SEB area.

During FY19:

- Monitoring of the cover and abundance of vegetation on the mound springs within the SEB area continued in FY19 and now forms part of the vegetation monitoring programme for Olympic Dam.
- Routine inspections were undertaken of car parks at Gosse, McLachlan and Fred Springs and SEB tracks.
- The SEB area was monitored for pest plants and animals. Horses and camels were removed from Gosse Springs SEB.

A shapefile of both the Gosse Springs and Emerald Springs SEB area has been provided to the Native Vegetation and Biodiversity Management Unit of the South Australian Government. The shapefiles of existing and proposed SEB offset areas are available in a standard GIS format that can be made available for other departmental databases as required.

1.1.8 Leading Indicators

- None applicable.

1.1.9 Targets

- None applicable.

1.1.10 Actions FY19

Align pest plant and animal control with SAAL NRM objectives.

ODC has worked with the SAAL NRM Board to align our pest plant and animal control efforts with SAAL NRM regional objectives. As a result, ODC is working towards expanding its influence to pastoral lease holders in regards to pest plant and animal management (BHP Olympic Dam 2019a; BHP Olympic Dam 2019b). In FY20, ODC plan to deliver an Environmental Management Plan specific to the Stuart Creek Pastoral lease.

Continue to develop pest plant and animal management (monitoring and control) effort guidelines.

During FY19, the Pest Animal Monitoring and Control Work Instruction (BHP Olympic Dam 2019b) was updated in an annual process to ensure continuous improvement of our processes. The Work Instruction encompasses an effort-based approach for feral cat management and targets problematic areas such as Roxby Downs Village, Olympic Village and the Resource Recovery Centre. Adherence to the strategy is measured through 1SAP to ensure that management targets are met.

Continue to implement actions and identify progressive rehabilitation opportunities in the site Rehabilitation Strategy.

Several actions associated with the cessation of the 2011 Olympic Dam expansion pre-commitment works continued throughout FY19. The Rehabilitation Strategy actions associated with these works are described in Table 6. Regular photo point monitoring has shown that in some areas where specific stabilisation measures were adopted, an increase in vegetation coverage has occurred. See Figure 9 to Figure 12 as examples. Areas where compaction and saline water was used to minimise passive dust generation have showed signs of natural re-vegetation.

The open pit area is now surrounded by works associated with the underground expansion of the Southern Mine Area. Therefore, no further rehabilitation plans are in place for areas associated with pre-commitment works. Access to the pit itself and the immediate surrounding areas remains restricted.

Due to the underground mining method used at Olympic Dam, large scale rehabilitation works were not required during FY19. The EDP process requires temporary disturbances (i.e. excavation for pipe maintenance and cable installations) to be remediated through topsoil replacement and scarification to promote natural re-vegetation.

The Old Gold Room was successfully demolished in FY19. Planning for demolition of redundant equipment will continue in FY20.

Table 6: Rehabilitation Strategy actions undertaken in FY19.

Rehabilitation Strategy Action	Comment
Set-up photo monitoring points for the area cleared for the proposed contractor's village on Andamooka Station to visually monitor soil stability.	Six monitoring sites were established in May 2012 and continue to be monitored on a biannual basis through photo points. The area continues to show progressive re-establishment of local plant species (Figure 9 to Figure 12).
Regular inspection of proposed contractor's village area for erosion.	The site of the proposed contractor's village is inspected during biannual photo point monitoring and other time-in-field excursions. Minor erosion from high rainfall events is visible within the Hiltaba area but does not warrant corrective action.

Review closure risks and assumptions through annual workshop.

The FY19 Annual Closure and Rehabilitation Plan review included a Closure Planning Workshop in February 2019. This workshop was held with the relevant internal stakeholders.

The following were implemented to update the Closure Estimates for the Current and Life of Asset Disturbances and associated Closure Risk Register:

- The mine closure date remained constant at FY2094;
- The Life of Asset 2021 (LoA21) Optimised Base Plan will update any changes.

Figure 9: Photo point ENV 492 at Hiltaba taken May 2013.

Figure 10: Photo Point ENV 492 at Hiltaba taken March 2019 showing natural re-vegetation is occurring.

Figure 11: Photo Point ENV 490 at Hiltaba taken May 2013.

Figure 12: Photo Point ENV490 at Hiltaba taken March 2019.

1.2 Aquifer level drawdown

1.2.1 Environmental Outcome

No significant adverse impacts to existing third-party users' right to access water from within the GAB wellfield Designated Areas for the proper development or management of the existing use of the lands as a result of ODC activities.

No significant impact to third-party users has occurred. Drawdown and percentage wellhead pressure loss at pastoral bores remains less than the predicted long-term impact as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016), and significantly less than the maximum drawdown area defined within the 10 m contour.

No significant adverse impacts to the availability and quality of groundwater to existing Stuart Shelf third-party users as a result of groundwater drawdown associated with ODC activities.

No significant impact to groundwater for existing Stuart Shelf third-party users has occurred. Regional groundwater levels are stable.

No significant adverse impact on groundwater-dependent listed species or ecological communities as a result of groundwater drawdown associated with ODC activities.

Drawdown remains less than the predicted long-term impact and was within compliance criteria limits for FY19. Environmental flow rates at GAB springs remained above predicted long term impacts as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016). Monitoring showed no indication of a significant adverse impact on groundwater-dependent listed species or ecological communities as a result of groundwater drawdown associated with ODC activities (see Section 1.2.4).

1.2.2 Compliance criteria

A 4 m drawdown limit at the point on the designated area for Wellfield A that is mid-way between GAB8 and HH2 based on the 12-month moving average (GA 2.5).

At the end of FY19 average drawdown between GAB8 and HH2 was 1.35 m (BHP Olympic Dam 2019c).

A 4 m drawdown limit for Wellfield B at the point between monitoring bores S1 and S2 (measured as the average drawdown of the two bores) and based on the 12-month moving average (GA 2.5).

At the end of FY19, the average drawdown between S1 and S2 was 1.5 m (BHP Olympic Dam 2019c). The sudden increase in drawdown to 3.2m at S1 is localised to the monitoring well. Other wells closer to wellfield B do not record a similar response. The cause of the anomalous drawdown is under investigation but is suspected to be a partial failure of the well casing underground. Investigations have commenced to identify the cause of the failure.

A drawdown footprint for Wellfield B, measured as the area contained within the 10 m drawdown contour, that is less than or equal to 4,450 km^2 (GA 2.5).

At the end of FY19, the area contained within the 10 m drawdown contour line was 2,294 km^2 (BHP Olympic Dam 2019c).

No material change in the availability and quality of groundwater at existing bores in the Stuart Shelf area operated by third-party users.

Monitored water levels and quality in the Stuart Shelf area are consistent with historical levels, and do not indicate any change in the availability of groundwater at existing bores (see sections 1.2.8 and 1.2.9).

1.2.3 Leading Indicators

No leading indicator trigger values were reached. Drawdown trends at monitoring bore S1 remain below threshold values, as does the drawdown footprint area for Wellfield B. A sudden increase in drawdown

to 3.2m has been identified at S1 and is localised to the monitoring well. Other wells closer to wellfield B do not record a similar response (OB1, OB3, OB6, and WCB2) (BHP Olympic Dam 2019c). The cause of the anomalous drawdown is under investigation but is suspected to be a partial failure of the well casing underground. Investigations have commenced to identify the failure.

Flow and water quality parameters at GAB springs, and drawdown trends at GAB pastoral bores, are stable and remain within the predictions of the 1997 EIS (BHP Olympic Dam 2019c). Water quality in the Stuart Shelf area remains unaffected.

1.2.4 Deliverables (FL 2.2)

An evaluation of the composition of vegetated wetlands within the GAB springs.

In total, 30 flora species were observed, not including Atriplex (HOW025) and Frankenia (HOW015) that could not be identified down to a species level. The greatest number of species observed on one spring was 10 (HHS157), while the least number of plants observed on one spring was zero (WWS013).

Four species that were not previously recorded were observed during FY19 monitoring. These species included *Melaleuca glometra*, Osteocarpum sp., *Sclerolaena obliquicuspis* and *Stenopetalum nutans*. This is largely because six new springs from the Walkarinna group were added to the monitoring program.

The abundance of plant species observed was plotted against the occupancy, where occupancy is calculated as the percent of springs on which a species occurred and abundance is the percent of quadrats, for each spring, on which a species occurred, averaged over all springs (Figure 13). Similar to FY16, FY17 and FY18 monitoring results, *Cyperus laevigatus* and *Phragmites australis* were the most abundant species (Figure 13). Followed by *Fimbrostylis dichotoma*, *Sporobolus virginicus* and *Baumea juncea* (Figure 13). *Eriocaulon carsonii* was also moderately abundant, however, springs with *Eriocaulon carsonii* are targeted in this survey.

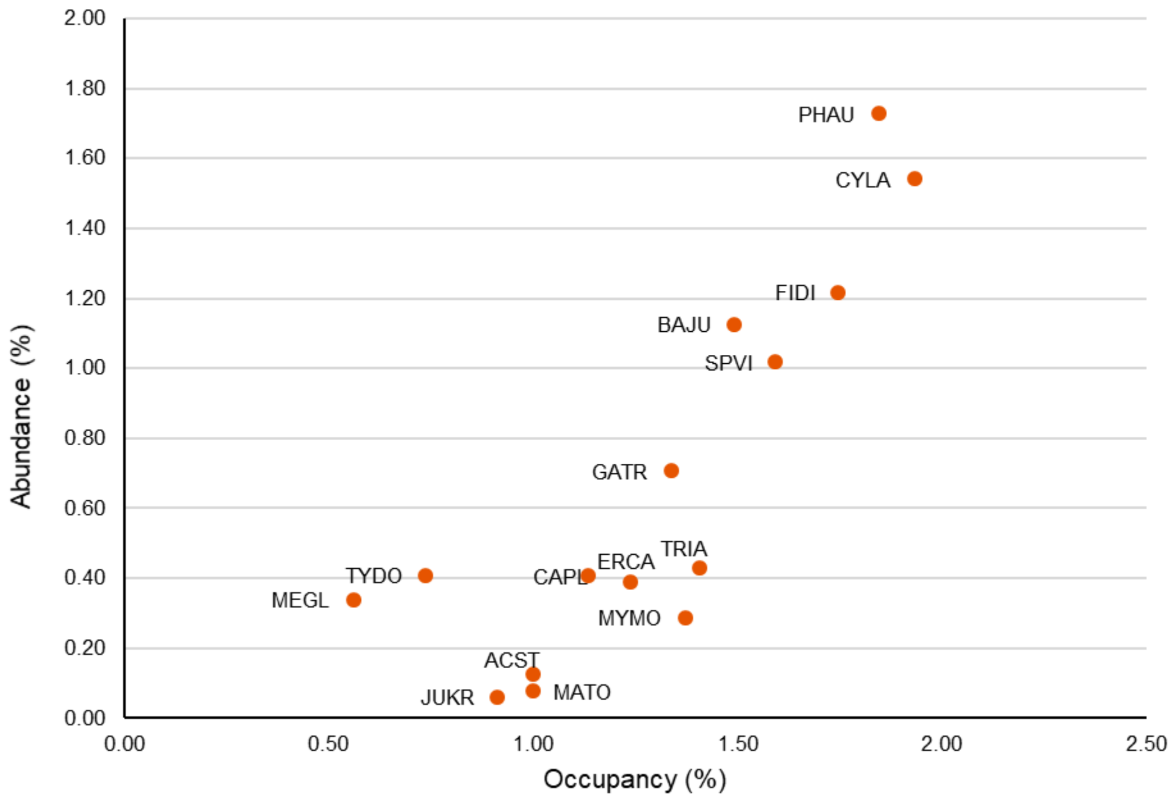


Figure 13: Distribution of 15 of the most abundant species recorded on all GAB springs monitored as a log function of the percent of springs occupied (x-axis) and the mean quadrat percent frequency (y-axis). The four letter codes refer to species names.

Using the Bray-Curtis dissimilarity metric, springs with a species composition greater than 50 % similarity were grouped together. Spring WWS013 was excluded from the analysis as it had no flora species present (FY16-FY19). Monitoring results from FY19 identified 9 dendrogram groups (Figure 14). In comparison, the FY16 analysis identified 10 dendrogram groups, the FY17 analysis identified 12 dendrogram groups and the FY18 analysis identified 9 dendrogram groups. Modifications to the Bray-Curtis metric used by Datasticians (Griffin and Dunlop 2016) and GHD (2017) were not documented and are therefore impossible to recreate. This could then result in discrepancies in dissimilarities presented in years prior to FY18.

Spring LGS003, which constituted its own group in 2016 and 2017 was grouped with LGS006 in 2018 (i.e., Group 1; Table 7). Three of the Walkarinna springs were clustered together (i.e., Group 2) characterised by their relatively high abundance of *Melaleuca glometra* (Table 7). A species, which has not been recorded previously as it has only been observed within the Walkarinna group of the Lake Eyre complex, which were added to the monitoring program in 2018. Group 3 consisted of three spring vents that were characterised by their relatively low species diversity and relatively high abundance of *Typha domingensis* (Table 7). Group 4 consisted of 25 spring vents characterised by their relatively high species diversity and relatively high abundance of *Cyperus laevigatus* and *Eriocaulon carsonii* (Table 7). Group 5 consisted of two spring vents that were characterised by their relatively high abundance of *Sporobolus virginicus* (Table 7). Spring HSS171 was also clustered to its own group (i.e., Group 6) characterised by its relatively high frequency of *Atriplex nummularia* comparative to other spring clusters (Table 7). Two springs both in the Fred spring group were clustered together (i.e., Group 7) due to their relatively high abundance of Trianthema sp. The largest group (i.e., Group 8) comprising of 63 spring vents was characterised by their relatively high species diversity and relatively high abundance of *Phragmites australis* (Table 7). Finally, Group 9 consisted of four spring vents and was characterised by a relatively high abundance of *Eriocaulon carsonii* (Table 7).

Overall, Group 8 had the greatest species diversity (N=23), followed by Group 4 (N=22), and Group 1 (N=11; Table 7). In addition, *Eriocaulon carsonii* occurred in three groups, Group 4, 8 and 9 (Table 7). The occurrence of *Eriocaulon carsonii* is explored further in the next section.

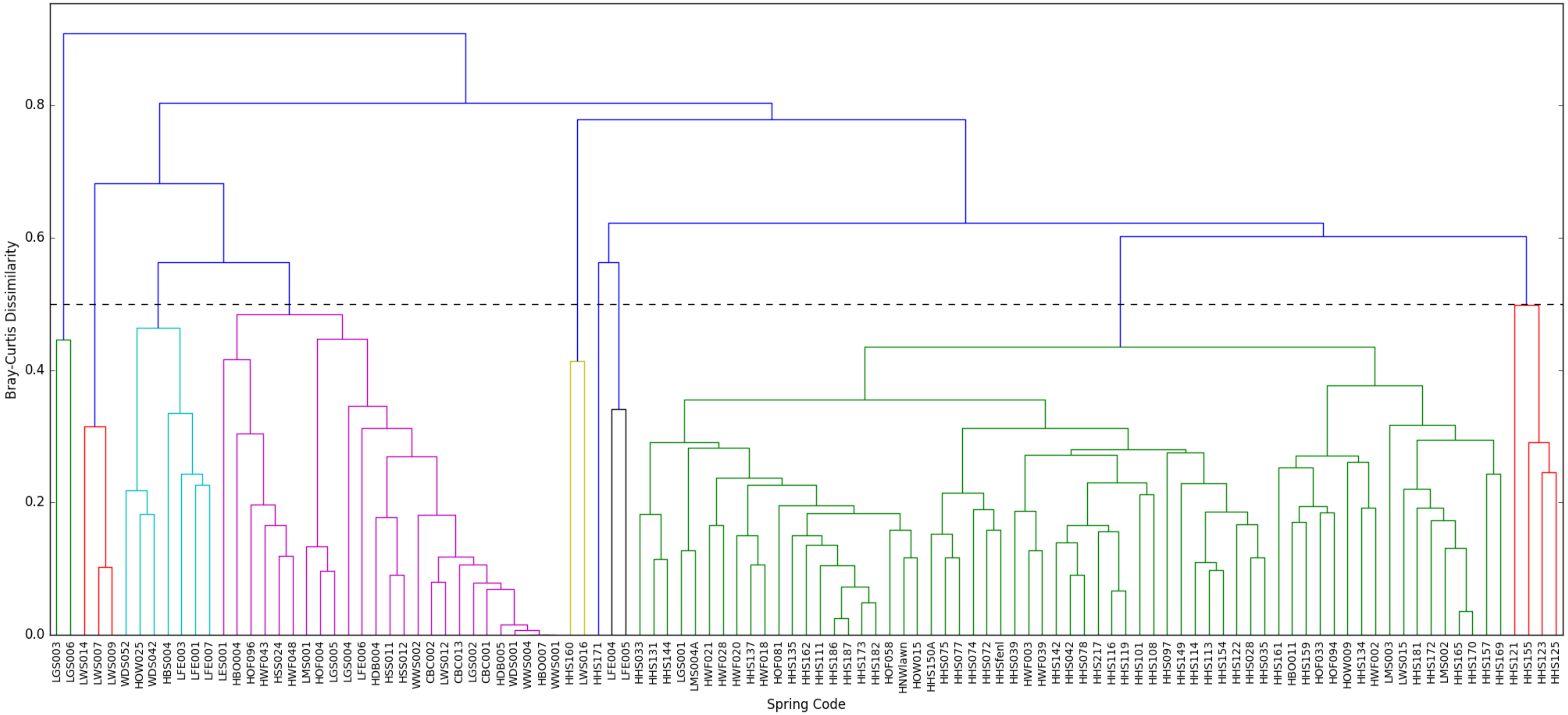


Figure 14: Springs grouped according to species composition (>50 % similarity) using hierarchal clustering. Springs groups are labelled from 1-9 from left to right.

Table 7. Average abundance (%) of species within each dendrogram group.

Species	Dendrogram groups (FY19)								
	1 LGS003-LGS006	2 LWS014-LWS009	3 WDS042 - LFE007	4 LES001-WWS001	5 HHS160-LWS016	6 HHS171	7 LFE004-LFE005	8 HHS033-HHS170	9 HHS121-HHS125
Acacia stenophylla		33	6		19	14		9	
Atriplex limbata	9								
Atriplex holocarpa				4					
Atriplex nummularia			7	3		51		6	
Atriplex sp.			3						
Baumea juncea								42	55
Calocephalus platycephalus	40		14	35				6	3
Chenopodenia nitrariaceum				3				3	
Cyperus laevigatus	23	38	57	85				20	18
Enchylaena tomentosa	11			3			7	7	
Eragrostis dielsii	8			4				2	
Eriocaulon carsonii				31				9	26
Fimbrostylis dichotoma				38				27	41
Frankenia foliosa				7					
Frankenia sp.								5	
Gahnia trifida				20				24	
Halosarcia indica				9				18	
Juncus kraussii								14	14
Maireana tomentosa	18			8				11	20
Melaleuca glometra		70						29	
Myoporum montanum	5		7	2	11	8	23	8	
Osteocarpum sp.				3					
Phragmites australis			40	36	44	51	57	84	43
Salsola australis	5								
Schoenoplectus litoralis				3					
Sclerolaena diacantha	8							3	

Species	Dendrogram groups (FY19) 1 LGS003-LGS006	2 LWS014-LWS009	3 WDS042 - LFE007	4 LES001-WWS001	5 HHS160-LWS016	6 HHS171	7 LFE004-LFE005	8 HHS033-HHS170	9 HHS121-HHS125
Sclerolaena obliquicuspis	6			5					
Spergularia rubra				30				2	
Sporobolus virginicus			52	8	83			19	36
Stenopetalum nutans								15	14
Trianthema sp.	24		5	7	6		60	4	
Typha domingensis			59	23					
Species diversity	11	3	10	22	5	4	4	23	10

A comparison of the abundance and distribution of *Eriocaulon carsonii*, per impact zone, with previously reported values, to determine impacts to the GAB springs.

Within the region studied, populations of *Eriocaulon carsonii* were restricted to 19 spring vents in the Hermit Hill, North East and Lake Eyre springs complexes in FY19. *Eriocaulon carsonii* occurred on the Hermit (14 springs), Gosse (2), West Finniss (1), North West (1) and Sulphuric (1) spring groups (Table 8). *Eriocaulon carsonii* was uncommon and limited in abundance where it did occur. It ranged in percentage abundance on any one spring vent on which it occurred from 2 – 53 %. *Eriocaulon carsonii* occurred on both spring mounds/springs and spring tails. *Eriocaulon carsonii* was recorded again on HHS122 after not being recorded in 2017. It was recorded at this spring is 2016, so it's likely that it was missed in 2017.

Using a Chi Square analysis for dependent samples, the average abundance of the 26 springs identified as suitable *Eriocaulon carsonii* habitat from FY16-FY19 has shown that there has been no significant negative impact to the size of an important population of *Eriocaulon carsonii* ($X^2 = 13.016$, df =3, p = 0.005; Figure 15). Rather differences observed between FY16 and other years is likely to do with a difference in observers.

Table 8: Comparison of *E. carsonii* results in FY15 – FY19.

Spring group	Spring vent	Units monitored in 2014[2]	2014 (cover class)	2015 (percent abundance)	2016 (percent abundance)	2017 (percent abundance)	2018 (percent abundance)
Hermit Hill	HHS028	-	-	8.7	13.5	29.7	21.6
	HHS033	-	-	1.6	2.7	5.4	5.4
	HHS035	-	-	0.0	2.8	11.1	8.3
	HHS072	M	1	1.4	0.0	0.0	0.0
	HHS074	M	1	2.7	5.1	0.0	0.0
	HHS075	M	0	1.4	0.0	0.0	0.0
	HHS077	-	-	0.0	7.7	7.7	7.7
	HHS078	-	-	5.5	20.5	11.8	2.9
	HHS114	S	1	1.7	0.0	0.0	0.0
	HHS116	M	2	1.4	8.3	8.3	8.3
	HHS119	S	2	0.0	0.0	22.2	8.3

	HHS121	-	-	0.0	2.9	17.1	31.4
	HHS122	M	2	0.0	2.8	0.0	16.7
	HHS123	-	-	6.3	30.5	8.3	25
	HHS131	M	1	1.8	4.7	2.4	7.1
	HHS144	S	1	0.0	0.0	0.0	0.0
	HHS150A	M/S/T	1	2.6	5.4	8.1	10.8
	HHS154	T	1	0.0	0.0	0.0	0.0
	HHS155	-	-	3.9	15.0	17.5	20
	HHSfenl	T	6	13.0	10.5	17.5	7.1
North West	HNWlawn	T	1	1.7	0.0	2.9	2
Old Finniss	HOF058	S	1	0.0	0.0	0.0	0.0
Sulfuric	HSS012	M	2	3.2	2.7	5.4	5.4
West Finniss	HWF043	S/T	3	9.8	11.5	9.6	15.4
Gosse	LGS002	M/T	2	12.3	18.0	8.0	14
	LGS004	S/T	3	18.9	26.7	45.0	53.0

Notes:

1. Because of the change in monitoring program, not all of the results are directly comparable.
2. Up until (and including) 2014, springs units were monitored separately: A spring unit is a morphological component of a spring: the vent, mound, or tail. The vent is the source of most of the water. The vent is usually set in the top or side of the mound ('m') (if the spring has a mound). The tail ('t') is an area with an outflow of water away from the vent. A spring ('s') may possess some or all of these components. For monitoring *E. carsonii* and grazing impacts, the mound and tail have generally been treated separately (no monitoring occurs on the vent). Over 2005-2014, we followed the procedure established by Kinhill Stearns (1984) and Fatchen and Fatchen (1993). However, past monitoring has been inconsistent: PPK (2002) and Badman (2004; 2005) treat an "undifferentiated spring plus any tail" as a single unit (Badman, 2005:16).
3. Up until (and including) 2014, the monitoring was targeted at finding and recording *E. carsonii*. While the 2015 monitoring included all identifiable springs where *E. carsonii* has ever been recorded, the method quantifies species abundance for all species present on the site, rather than focussing on searching for the generally very small *E. carsonii* populations.
4. Up until (and including) 2014, cover was estimated using the Domin-Krajina rank score (see Griffin and Dunlop, 2014). In 2015 and 2016, abundance was calculated directly from the percentage of quadrats on which a species occurred.

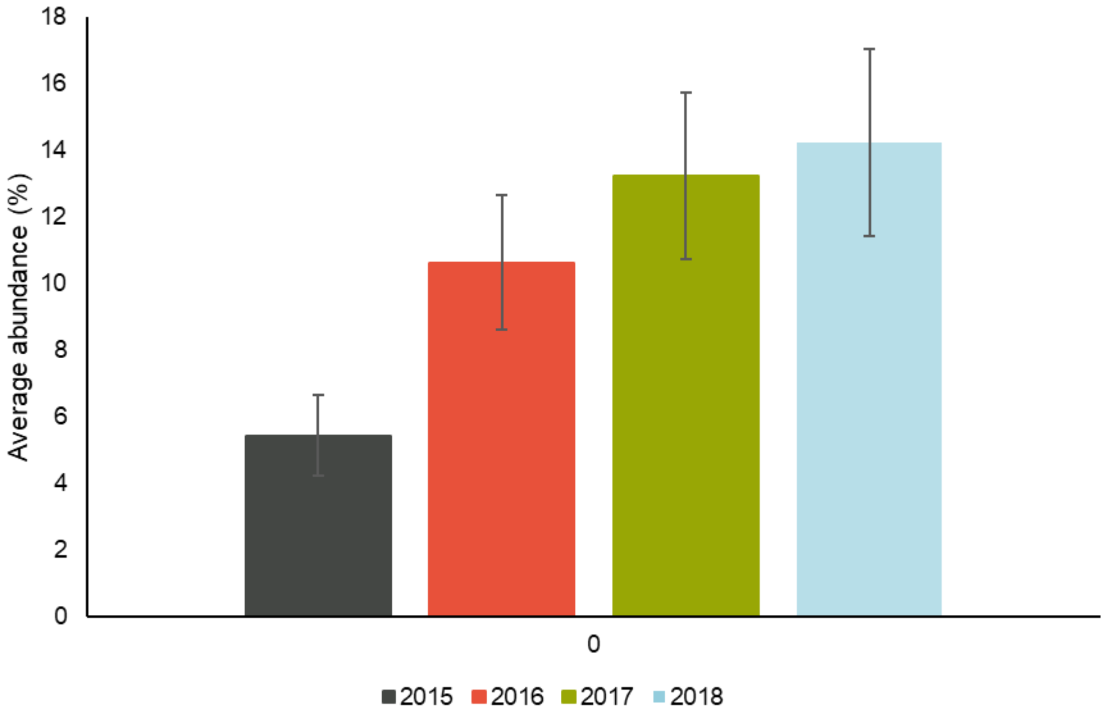


Figure 15: The abundance (mean ± SEM) of *Eriocaulon carsonii* from 2015-18 across the 26 springs identified as suitable *Eriocaulon carsonii* habitat.

Comparison of the abundance of Hydrobiid species against baseline data to quantify population change.

Completed in FY18. Will be reported again in FY21.

1.2.5 Deliverables (GA 2.5)

Collated domestic and industrial water use efficiency data, to assess performance against improvement targets.

In FY19 the GAB Industrial Water Efficiency of the operation was 1.1 kL/t compared to the target of 1.18 kL/t and 1.19kL/t for FY18. Despite a decrease in kL of GAB water per tonnes milled compared to FY18, overall water efficiency was impacted by the Acid Plant Outage in early FY19 and decreased production efficiency during this time. Historical GAB industrial water efficiency is given in Figure 16.

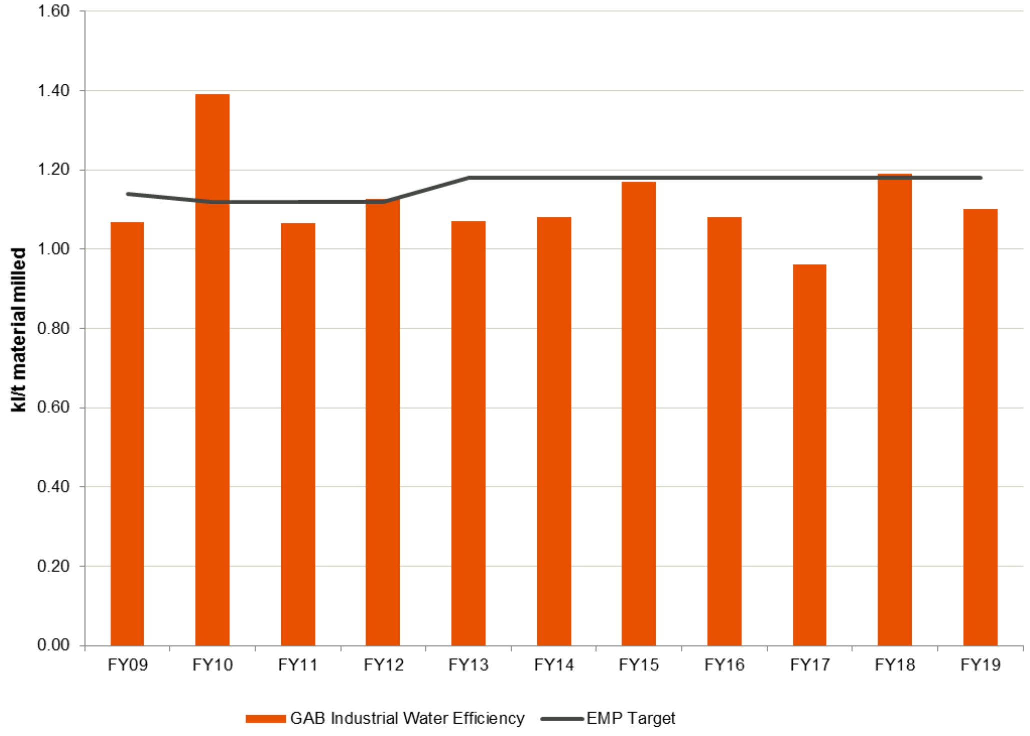


Figure 16: Historical industrial GAB water efficiency.

Domestic water use during FY19 averaged 2.4 ML/d compared to 2.3 ML/d in FY18, below the target of 3.2 ML/d. Historical domestic water use is given in Figure 17.

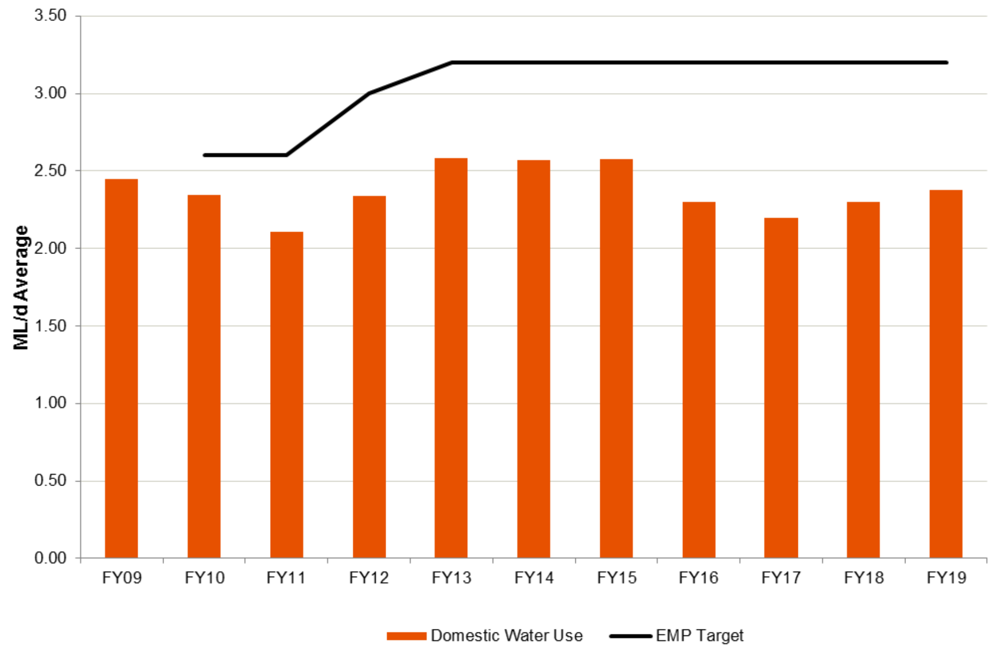


Figure 17: Historical domestic water use (note there was no target in FY09).

1.2.6 Deliverables (GA 2.5)

Ten-year water use schedule to be submitted to the Indenture Minister by 1 January annually.

The current 10-year water use schedule, as provided to the Minister for Mineral Resources Development in January 2019, is presented in Appendix 9 of the FY19 Annual Wellfields Report (BHP Olympic Dam 2019c). An updated schedule will be provided by 1 January 2020.

Further development of existing wellfield infrastructure may be required to supply additional capacity to the operation as part of the 10 year water forecast. The 10 year forecast includes current business as usual (Bau) operations only and does not include the water demand of up to 50 ML/d being studied as part of the Olympic Dam Resource Development Strategy (OD-RDS).

The 10-year Bau forecast predicts total wellfield abstraction to reach 41.7 ML/day by 2023 and remain constant to 2029. Abstraction rates for Wellfield A are expected to remain at an annual average of 5 ML/d and at 36.7 ML/d for Wellfield B. A detailed water forecast beyond 2023 is not available, however production and therefore water demand is forecast to increase.

The OD-RDS GAB water demand of up to 50 ML/d is being studied and is subject to State, Federal and BHP Board approval. To realise the abstraction rate of 50 ML/d to support the OD-RDS additional production wells and associated pipeline infrastructure will be required. This additional water take is expected to come from Wellfield B and no exploration for additional wellfields is currently planned.

1.2.7 Deliverables (GW 2.1)

A review of abstraction rates and trends and an assessment with respect to groundwater levels.

Saline water was abstracted from the Arcoona Quartzite throughout FY19 from the Saline Wellfield located south of the Mine offices. Additional saline water was sourced from the Andamooka Limestone aquifer within the vicinity of the TRS facility to manage underground seepage rates.

Some of this saline water was used in construction projects throughout the operations, whilst the remainder was discharged to the mine water disposal pond for evaporation. An average of 1.9 ML/d was abstracted over the period, compared to 3.4 ML/d during the previous reporting period as shown in Figure 18.

Groundwater levels in the Saline wellfield Area and TRS area are shown in section 1.2.8, Figure 24 and Figure 25.

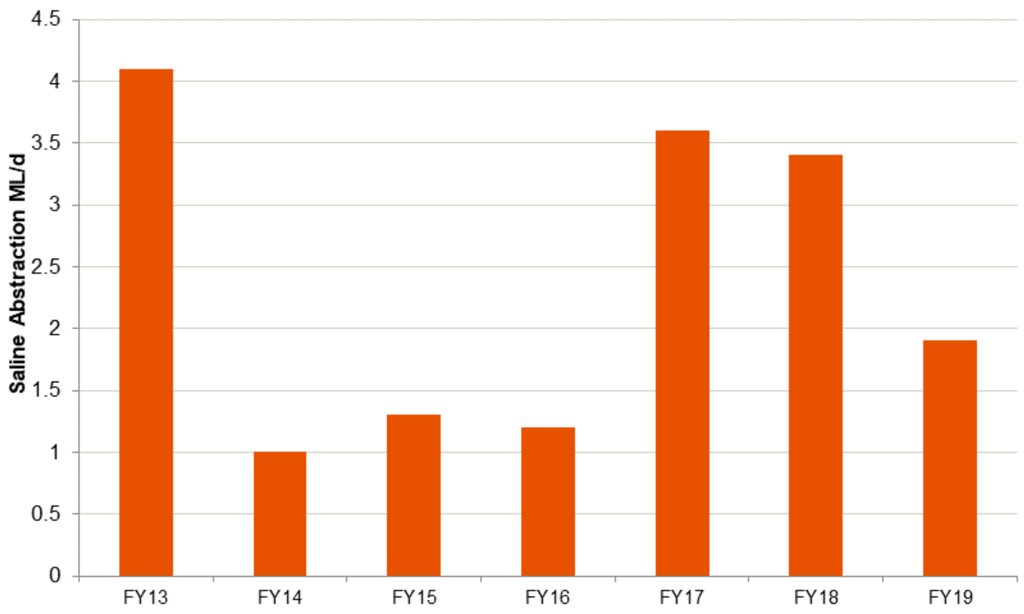


Figure 18 : Historical saline abstraction rates (ML/d)

A definition and map of the underground mine water balance.

The mine water balance is a summary of the volume of water going into and out of the underground mine. It includes saline water abstracted from local bores that is added to surface storages and used around site. The balance (presented in Figure 19) is generated from a combination of measured, derived and estimated data.

An estimate of the volume of groundwater discharge to underground.

Groundwater inflow to the mine occurs at several intersections with the underground operations (Figure 19). Total natural inflow is estimated to be approximately 3.9 ML/d, the majority entering via upcast raise bores. Additional natural inflow comes into the mine via other entry points, including downcast raise bores, exploration drill holes and shafts. Much of the total inflow to the mine is transported to the surface as ore content or exhausted to the atmosphere as saline aerosols or moisture-laden air via upcast raise bores, estimated at around 2.5 ML/d.

Categories of Surface usage are different compared to what was shown in last year's report. This is due to a review of the water balance which resulted in an update.

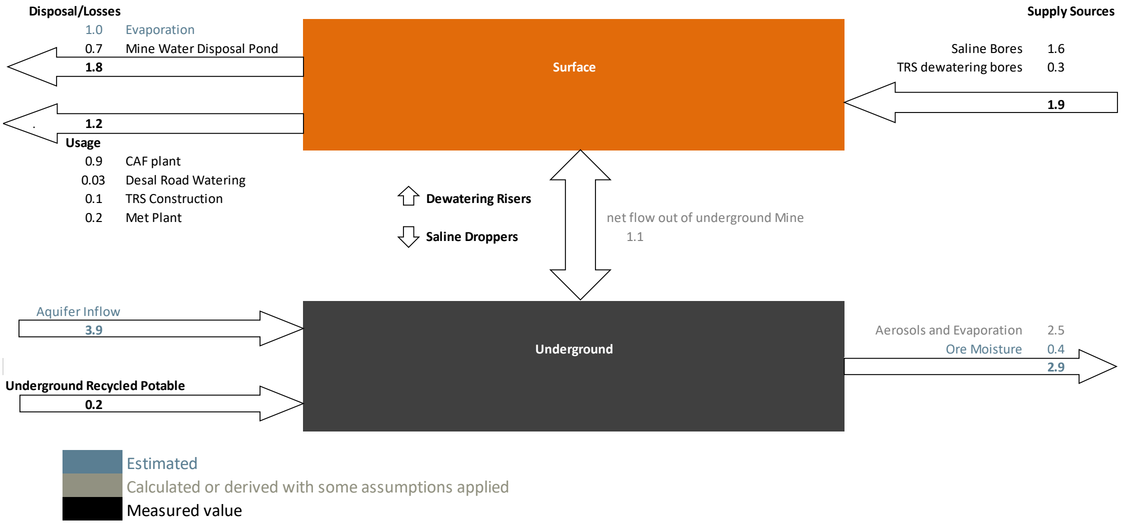


Figure 19: FY19 Saline (Mine) water balance summary (ML/d).

1.2.8 Deliverables (GW 2.2)

A review of the trends in local and regional groundwater levels and a comparison with historical groundwater levels.

The mine groundwater monitoring network is shown in Figure 20. A slight downward trend in local and regional groundwater levels is evident over the last three years. The groundwater cross section (Figure 21) and hydrograph (Figure 22) confirm the limited changes in groundwater levels beneath the TSF between June 2018 and June 2019. Monitoring bore LT18 has been decommissioned and redrilled with LT18A to the south-eastern of the original well which is reflected in the change in water level monitored.

The maximum groundwater level recorded below the TSF for the current reporting period was 67.47 mAHD at LT67. The rising trend at LT67 has been addressed with the installation of a dewatering system and changed supernatant pond control which has stabilised the water rise. Groundwater levels are not expected to exceed the agreed limit of 20 m below the ground surface (80mAHD).

Groundwater level contours in the Andamooka limestone aquifer beneath the perimeter of the TSF (Figure 23) have generally remained stable during FY19. A continued stable area above 60 mAHD in TSF 1-4 and no groundwater level above 65 mAHD has been maintained. There is a continued rise in groundwater levels beneath TSF 5 (Figure 24) which can be attributed to the ongoing use of this facility. Levels are below compliance limits of 80 mAHD however wells LT65 and LT67 is rising at a rate greater than expected. As noted above, a dewatering system has been installed and the supernatant management in the TSF modified which has stabilised the rise. The water level in this area will continue to be managed in FY20 to maintain compliance with agreed compliance levels.

Groundwater levels for bores in the vicinity of the underground mine (Figure 25) continue to show depressurisation of the geological units, consistent with ongoing mine depressurisation activities.

Limestone aquifer bores in the vicinity of Roxby Downs (Figure 26) demonstrate stable groundwater levels during FY19.

Historical level monitoring indicates steady groundwater levels over time with no overarching trends that would indicate material change in the availability at existing bores in the Stuart Shelf area operated by third-party users (section 1.2.3).

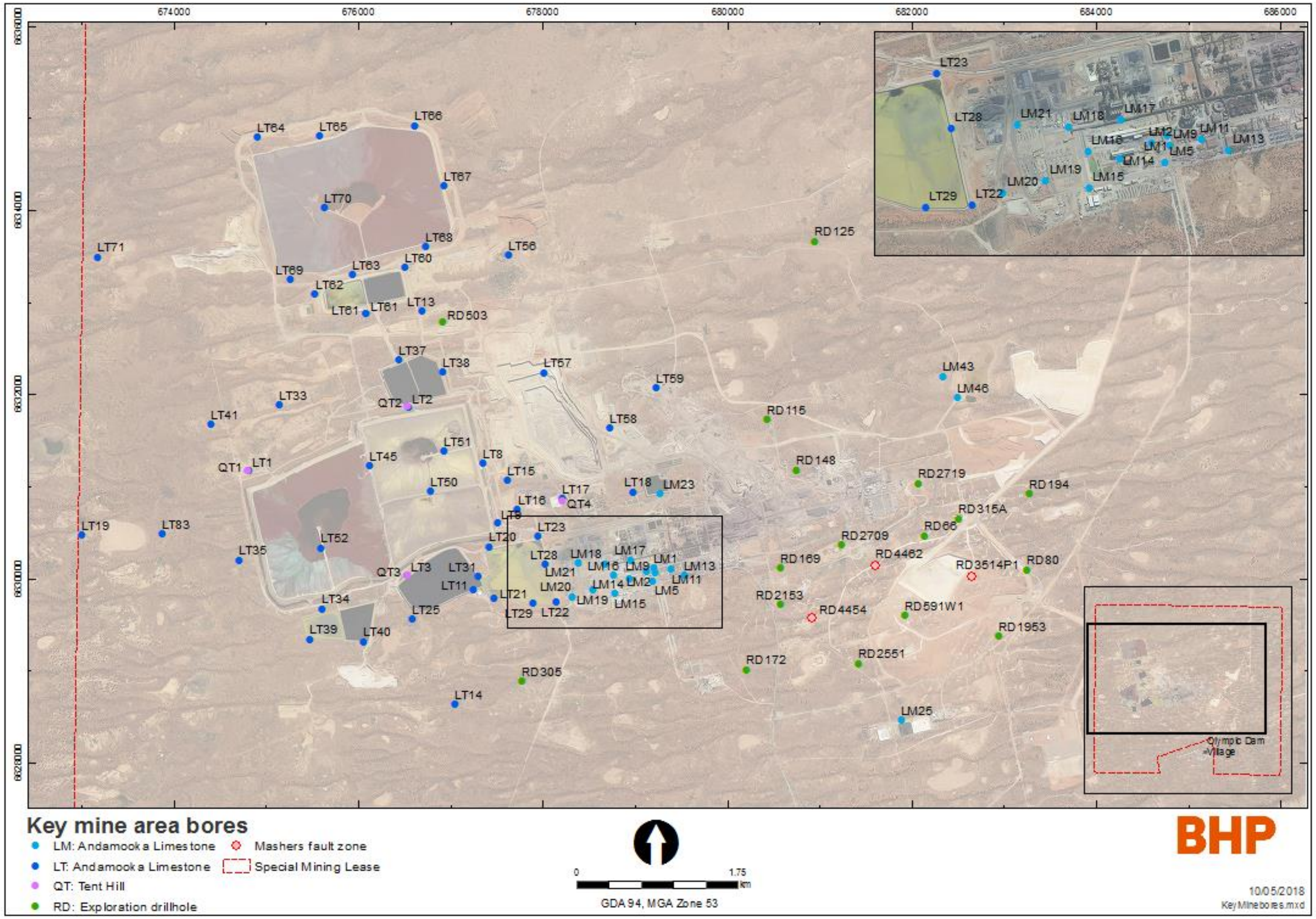


Figure 20: Location of key mine area bores.

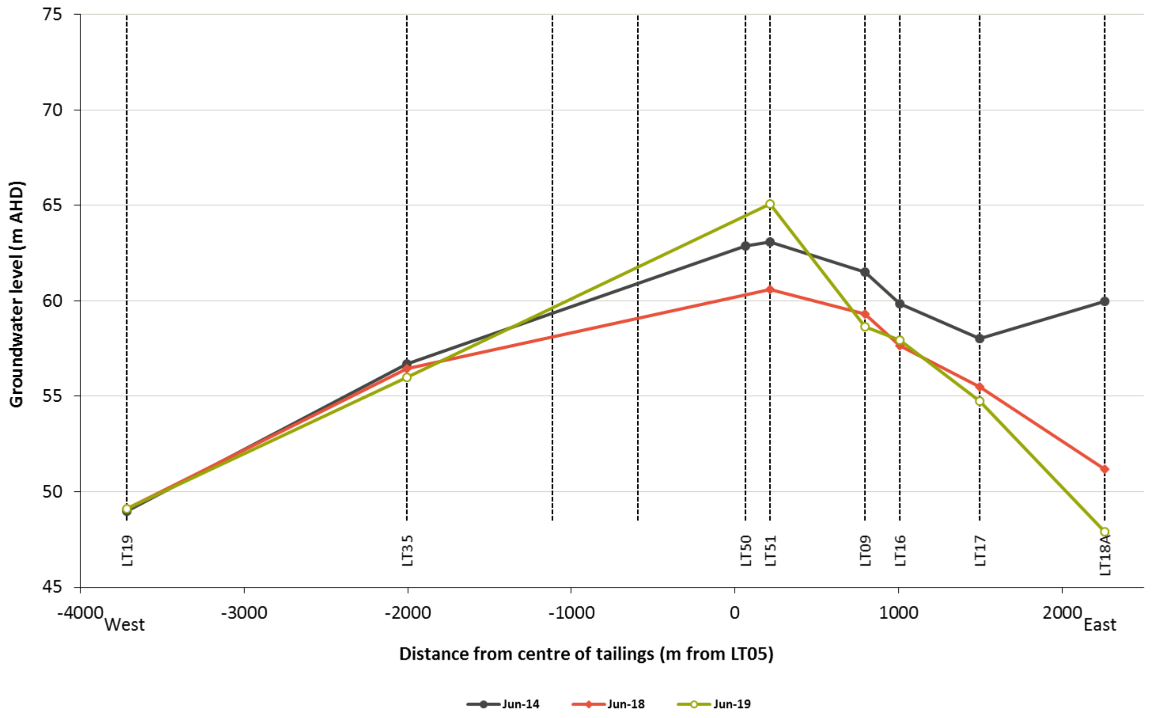


Figure 21: Change in groundwater elevation along an east-west cross-section from LT19 to LT18A, through the centre of the TSF.

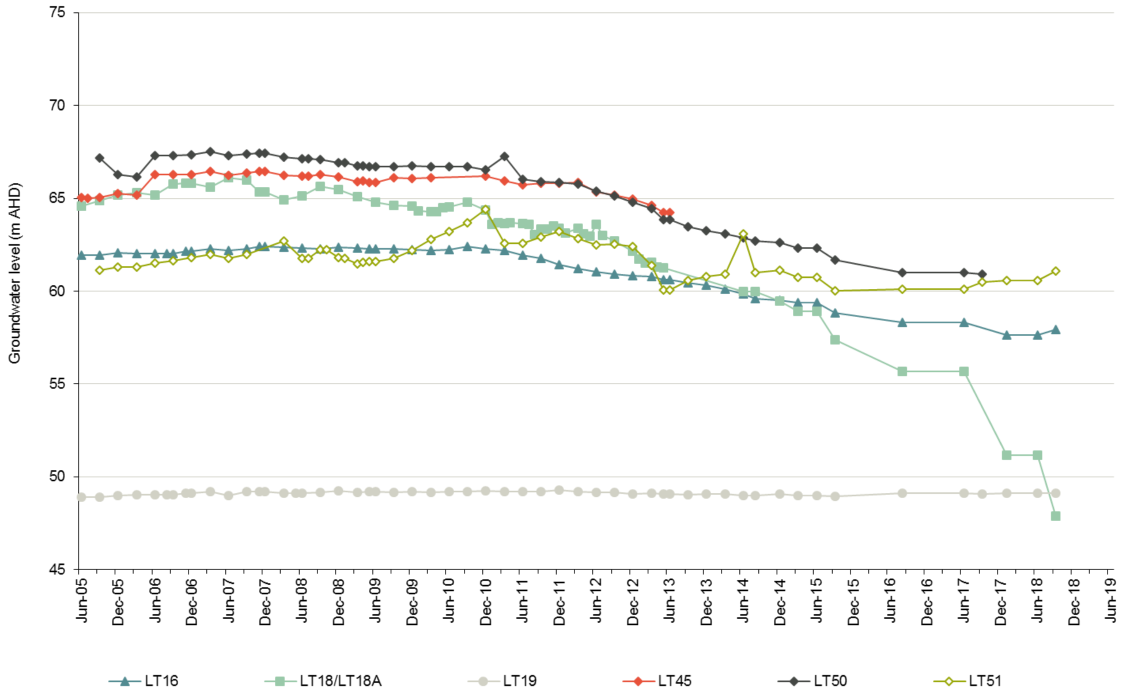
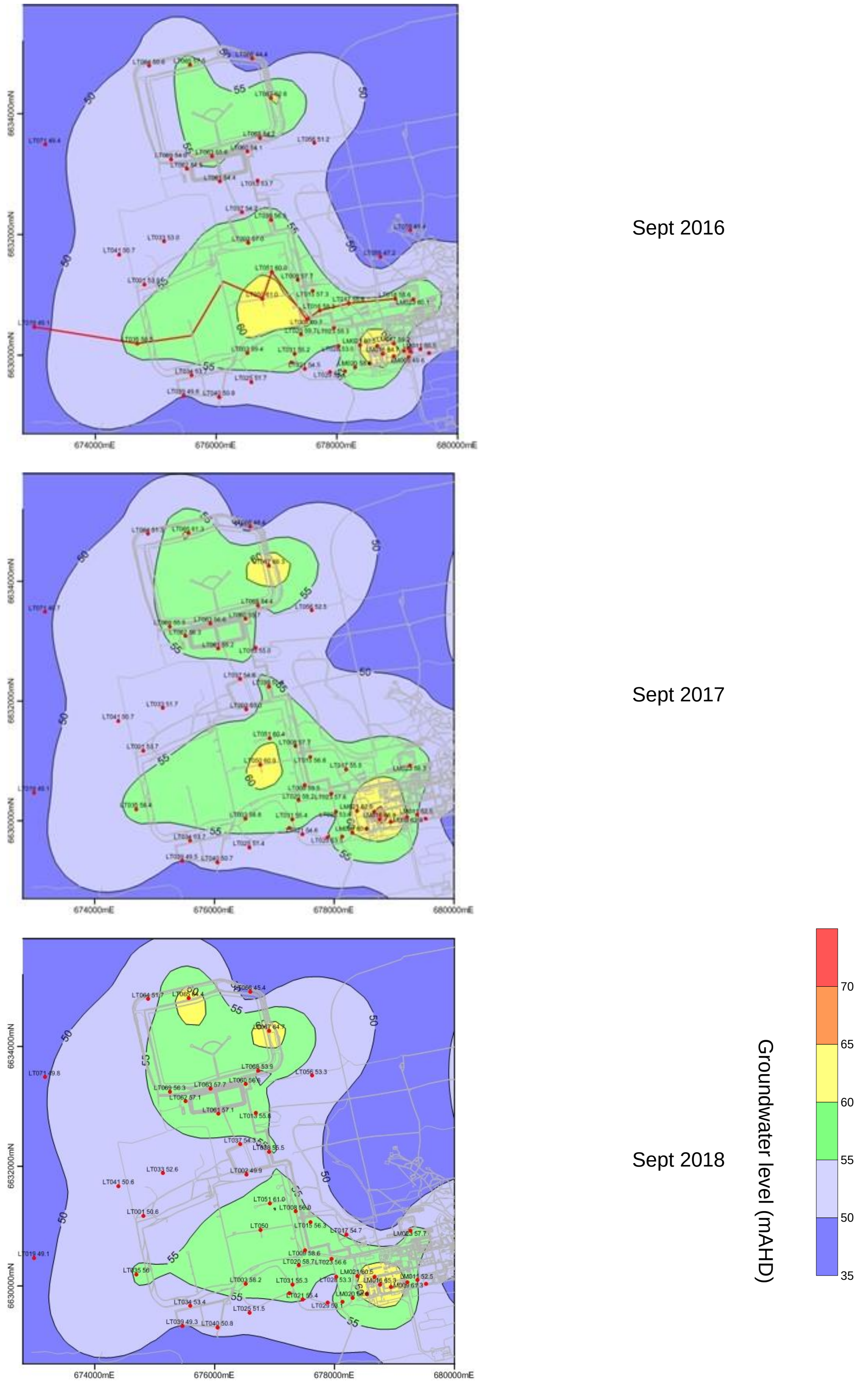


Figure 22: Groundwater levels for Andamooka Limestone bores in the vicinity of the TSF



Datum: GDA94

Projection: MGA94

Zone: 53

Figure 23: TRS area groundwater levels (mAHD) Andamooka Limestone Aquifer.

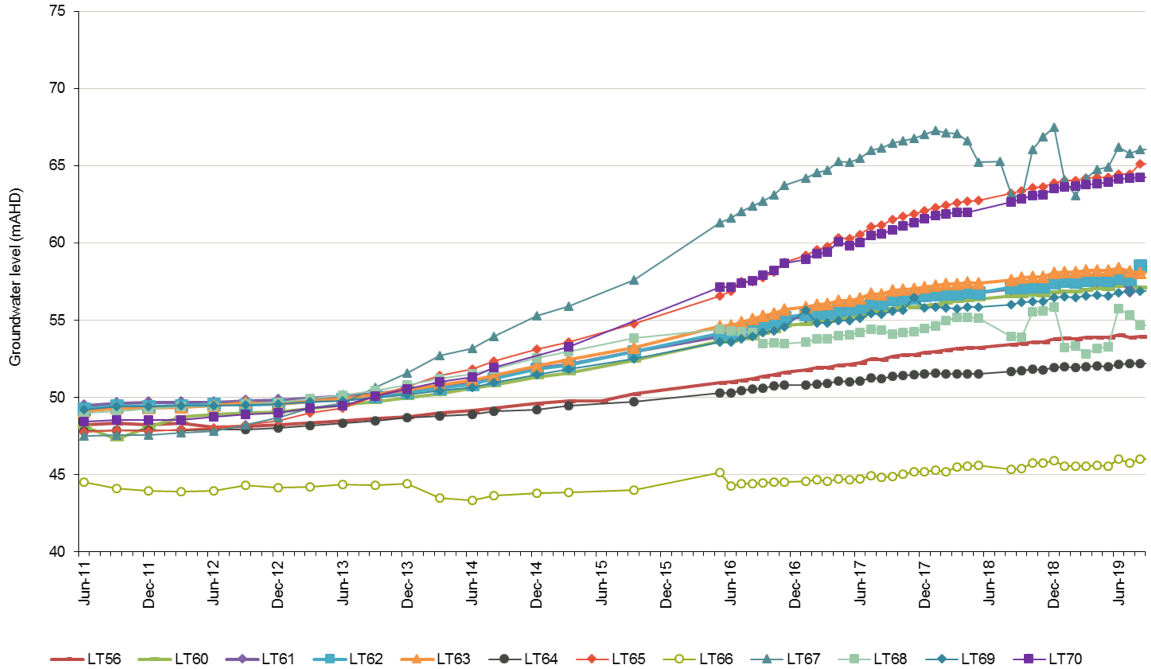


Figure 24: Groundwater levels for bores in the vicinity of TSF 5.

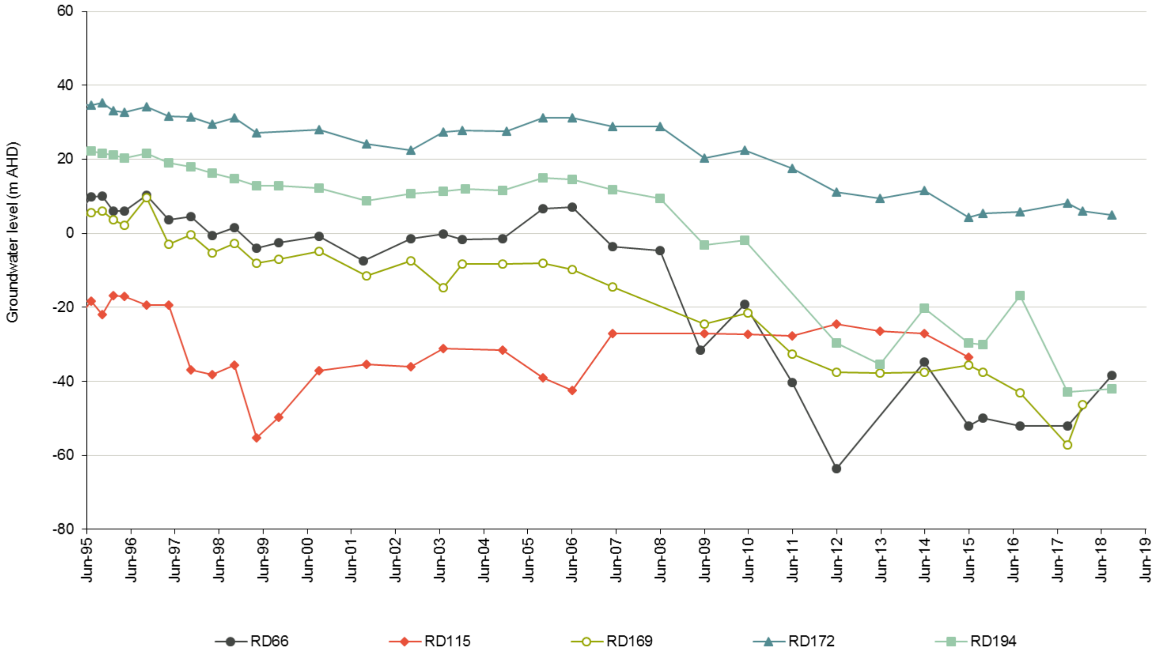


Figure 25: Groundwater levels for exploration drill holes in the vicinity of the underground mine.

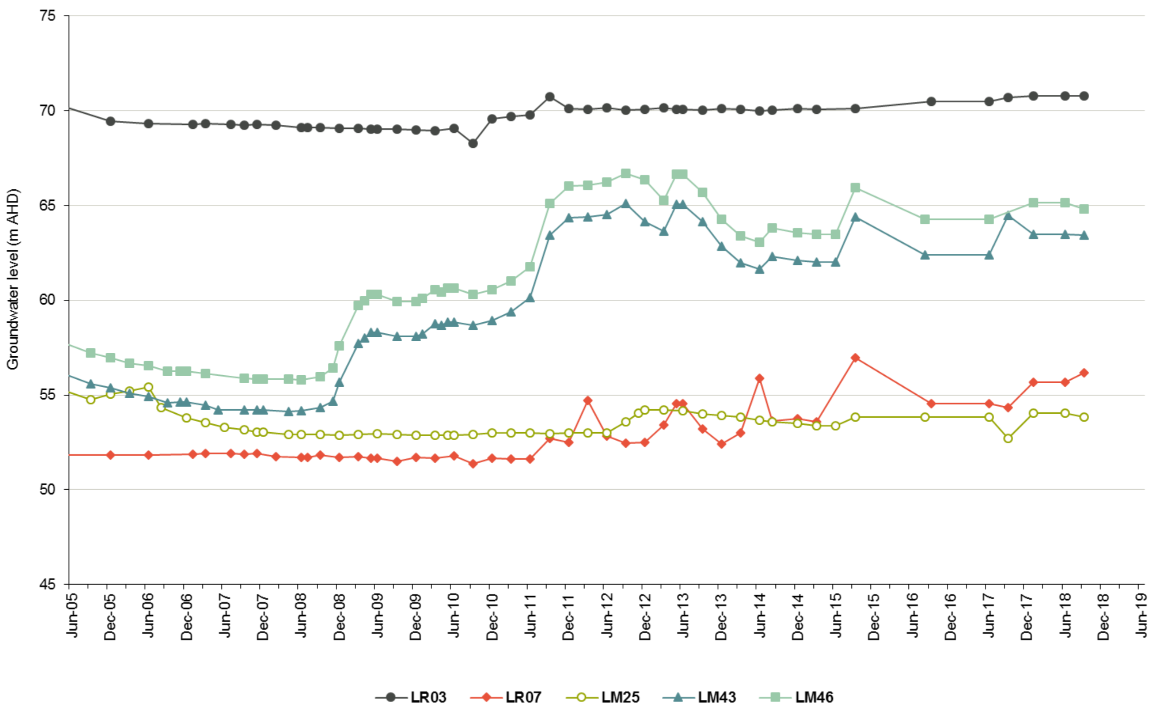


Figure 26: Groundwater levels for Andamooka Limestone bores in the vicinity of Roxby Downs (LR) and the Mine Water Pond (LM).

Data showing the tracking of trends towards leading indicators for groundwater impacts, and an alert to management when levels approach the leading indicators.

Data for groundwater level was collected, with a discussion of results in section 1.2.8. Leading indicator trigger levels were not reached.

1.2.9 Deliverables (GW 2.3)

A review of trends in groundwater quality and a comparison to ANZECC criteria.

Groundwater in the vicinity of the Olympic Dam Operation occurs at depth and is highly saline making it unsuitable for human or livestock consumption and largely inaccessible. The local groundwater does not meet any of the beneficial use categories listed under ANZECC guidelines.

Groundwater salinity has generally remained stable and within the range that could be reasonably expected for natural variation within the aquifer. Salinity levels across site vary slightly due to input sources from various areas of the mine.

Groundwater pH ranges from 6.46 at LT25 to 7.74 in LT60, within the range of historical monitoring results.

Concentrations of copper in all groundwater monitoring bores sampled during the FY19 monitoring program were reported below ANZECC (2000) guidelines for livestock consumption of 0.4 mg/L (Figure 27).

While slightly elevated concentrations of uranium continue to be detected in the groundwater in the vicinity of evaporation pond two, uranium concentrations remain within historical limits in the majority of bores. Uranium concentrations are lower than the adopted ANZECC (2000) guidelines for livestock consumption of 0.2 mg/L in all except three bores (Figure 28).

A uranium concentration in excess of the ANZECC livestock guidelines has been detected at bores LT15 (0.495 mg/L) LT17 (0.201 mg/L) and LT25 (0.619 mg/L). LT15, LT17 and LT25 are located at the base of the tailings facility and are highly susceptible to changes in tailings pond use rates. Other bores in the area do not show elevated Uranium levels.

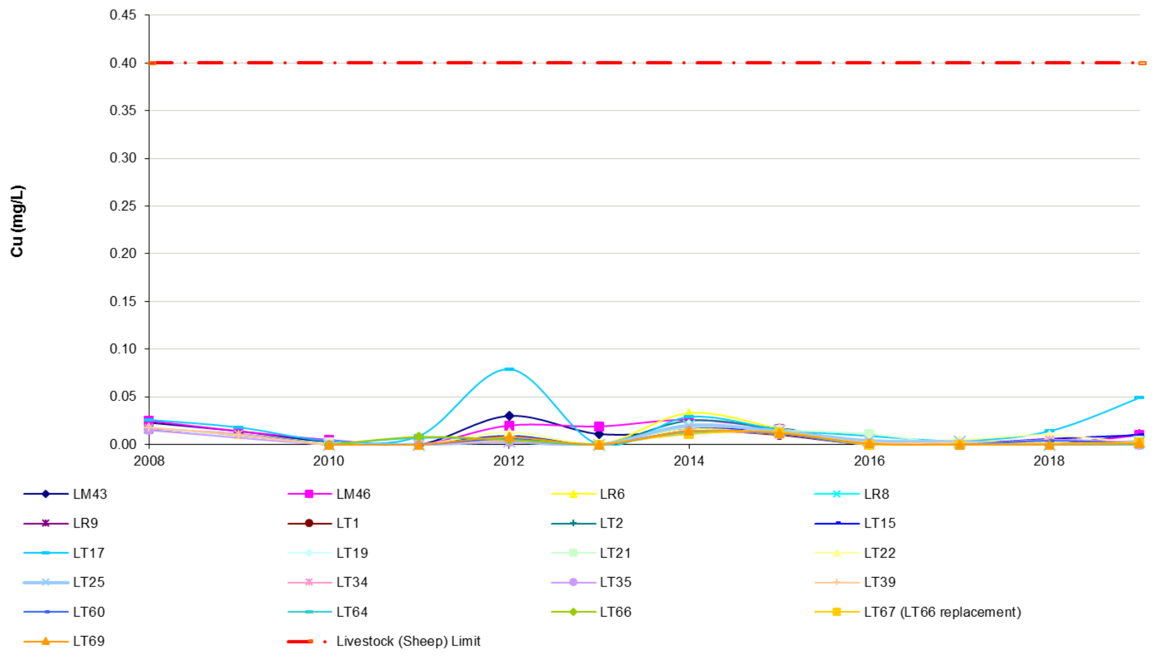


Figure 27: Olympic Dam on-site and regional groundwater monitoring bores: copper concentration.

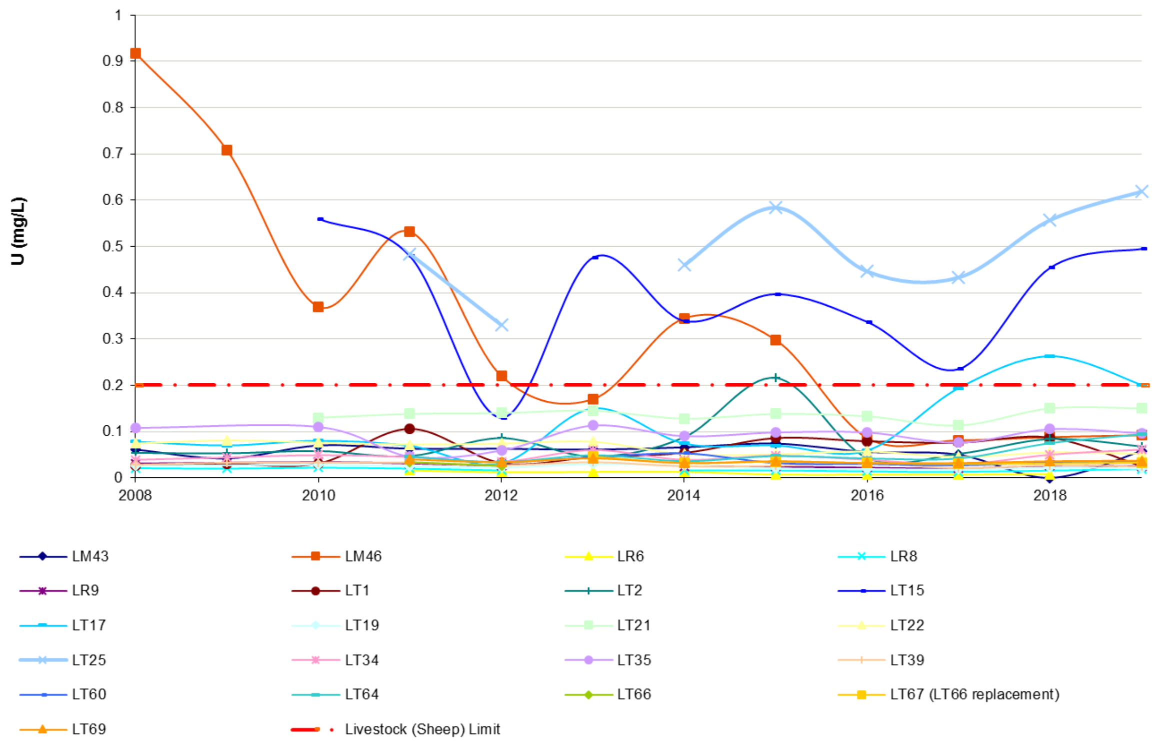


Figure 28: Olympic Dam on-site and regional groundwater monitoring bores: uranium concentration

1.2.10 Deliverables (WA 2.3)

Records of the water levels in the MWDP.

To determine any potential environmental impacts of the Mine Water Disposal Pond (MWDP), water levels were monitored via local groundwater bores. Stable groundwater levels at LM43 and LM46 were observed due to consistent water discharge rates into the pond during early FY19 (Figure 26).The groundwater level remains below the leading indicator level of 70 mAHD.

Records of quantities of water disposed of into the MWDP.

Quantities of water disposed of into the MWDP were measured and recorded each day, and reconciled monthly as part of the Saline Water balance (see Figure 19). An average of 0.7 ML per day was disposed into the MWDP during FY19.

1.2.11 Deliverables (WA 2.4)

Records of pond levels and pond wall condition (sewer ponds).

Sewage waste generated by Olympic Village (OV) is gravity fed to three on site chambers and pumped to the OV treatment facility west of the camp. The treatment facility consists of primary and secondary storage ponds and a permanent evaporation pan. The secondary ponds are mechanically aerated. Testing and monitoring of water quality continued throughout the FY under the programmed maintenance, with results remaining within guideline thresholds.

The OV treatment facility is inspected daily for security, inflow, wall integrity and available freeboard in storage ponds. Freeboard is reported daily and recorded. Inflow was recorded daily and averaged at ~185 kl/day for FY19. Pond wall condition was maintained in good condition during the reporting period.

Sewage waste generated by the Mine and Process plant is treated onsite. The onsite facility consists of a lined primary lagoon and lined evaporation pond. Inflow for FY19 averaged at ~209 kl /day which is greater than design capacity due to increased site activities and shutdowns.

Regulatory approval continued for emergency onsite irrigation to assist with risk mitigation and offsite disposal to manage these increased quantities of waste. All offsite disposals have since ceased whilst emergency irrigation events are due to cease in the first quarter of FY20. A project to upgrade and expand the onsite evaporation pond facilities commenced during the latter part of FY19 with the construction of a new evaporation pond in progress.

1.2.12 Deliverables (GW 2.5)

Data demonstrating that radionuclide concentrations are below upper limits.

Surface ponds which hold groundwater used for road watering were monitored and analysed during FY19 for specific radionuclides. Results from samples analysed in September 2018 were below the upper limit for radionuclide ^{238}U and ^{226}Ra of 50 Bq/L and 5Bq/L respectively (Table 9, Figure 29, Figure 30).

Table 9: Radionuclide analysis for dust suppression water.

	Analyte	^{238}U (Bq/L)	^{230}Th (Bq/L)	^{226}Ra (Bq/L)	^{210}Pb (Bq/L)	^{210}Po (Bq/L)
Upper Limits		50		5		
Sample site	Date					
A Block	Sept 2018	9.8	0.09	0.35	0.039	0.014
D Block	Sept 2018	3.3	0.034	0.5	0.095	0.023
F Block	Sept 2018	16.7	0.023	0.50	0.33	0.002
Saline Dam	Sept 2018	23.9	0.06	0.28	0.116	0.007

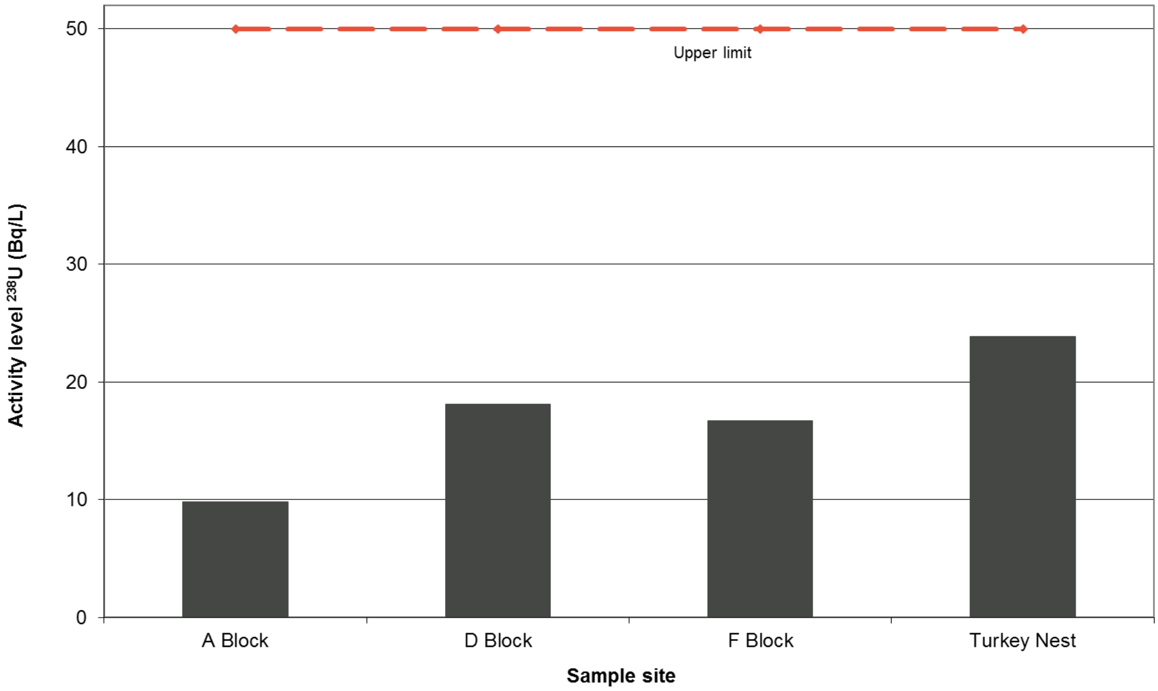


Figure 29: Mine water sample ^{238}U levels and upper limit FY19

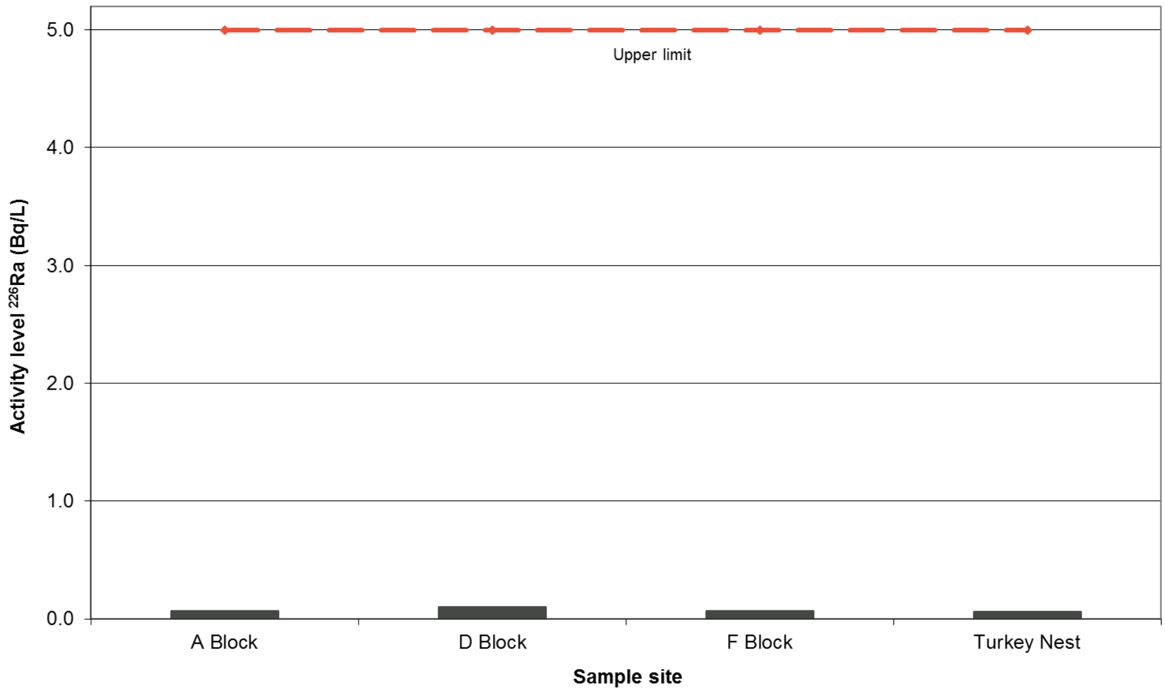


Figure 30: Mine water sample ^{226}R levels and upper limit FY19

A review of results and provision for increased monitoring frequency where concentrations are trending towards upper limits.

No samples collected during FY19 showed levels approaching upper limits.

1.2.13 Targets FY19

Maintain an industrial water efficiency of 1.16kL/t at the budgeted production rate.

In FY19 the GAB Industrial Water Efficiency of the operation was 1.1 kL/t compared to the target of 1.16 kL/t and 1.19 kL/t for FY18. Despite a decrease in kL of GAB water per tonnes milled compared to FY18, overall water efficiency was impacted by the Acid Plant Outage in early FY19 and decreased production efficiency during this time. Historical GAB industrial water efficiency is given in Figure 16.

Maintain a domestic water use target of 3.2 ML/d average

Domestic water use during FY19 averaged 2.0 ML/d, below the target of 3.2 ML/d, as outlined in the Great Artesian Basin Wellfields Report (BHP Olympic Dam 2019c).

1.2.14 Actions FY19

Continue implementation of water use conservation and recycling initiatives.

In FY19 ODC completed projects within the Great Artesian Basin Infrastructure Investment Program (GABIIP) to replace GAB wells which were identified as a high failure risk and could lead to wastage for GAB water.

Continue substitution of saline water for high quality water where possible.

Saline water continues to be used in lieu of high quality water where feasible, including use in CAF, road watering, construction and underground drilling activities.

Saline water is not being used to augment the process water stream as this would result in an unacceptable increase in chloride in the system, which affects plant performance.

2 Storage, transport and handling of hazardous materials

2.1 Chemical / hydrocarbon spills

2.1.1 Environmental Outcome

No significant site contamination of soils, surface water or groundwater, as a result of the transport, storage or handling of hazardous substances associated with ODC's activities.

No significant site contamination of soils, surface water or groundwater occurred in undisturbed areas in FY19. All spills which occurred were appropriately contained and cleaned up as soon as practicable. Active monitoring and management of legacy hydrocarbon sites was continued during FY19.

2.1.2 Compliance criteria

No site contamination leading to material environmental harm (as defined in the EMM) arising from hydrocarbon/chemicals spills within the SML and wellfields designated areas.

During the reporting period, 36 chemical and hydrocarbon spills occurred across ODC operations. All spills were contained and cleaned up as soon as practicable.

Three legacy hydrocarbon spill sites exist (the 3ML tank on the SML; PS1 and PS6A in the Wellfields area), which are being actively monitored and managed. For example; the hydrocarbon plume at the 3ML tank shows minor migration in a south easterly direction, and limited natural attenuation of the plume is occurring. Annual monitoring was carried out in FY19 and a detailed monitoring event including laboratory analysis is due in FY20.

In addition, PS1 remediation has successfully treated a groundwater volume in excess of 4ML since commencing operation in late 2014. Finally, PS6A remediation has treated groundwater in excess of 12ML since commencing operation in mid-2014 and recovered approximately 39,800L of light non-aqueous phase liquid (LNAPL). The PS6A system was turned off during FY19 and the rebound response monitored. Monitoring results and an assessment of remediation effectiveness are being prepared in FY20.

Therefore, it is concluded that no new material environmental harm has arisen from hydrocarbon/chemical spills within the SML and wellfields designated areas.

2.1.3 Leading Indicators

- None Applicable

2.1.4 Targets FY19

Corrective actions for all reportable spills of chemicals and hydrocarbons are implemented in a timely manner and do not result in material environmental harm (as defined in the EMM). (Note: Spills are

reportable if they result in potential or actual material environmental harm in accordance with the EP Act 1993)

No externally reportable chemical or hydrocarbon spill events occurred in FY19.

2.1.5 Actions FY19

Maintain a register of recordable chemical and hydrocarbon spills and corrective actions. (Note: An internally recordable spill of chemicals and/or hydrocarbons is defined as a spill of 10 litres or greater, outside of a bund, in a single event.)

During FY19 a register of recordable chemical and hydrocarbon spills and corrective actions were maintained. In FY19 there were 36 internally recordable chemical and hydrocarbon spills across site. The majority (35) of the 36 spills occurred above ground in the plant smelter and processing areas with one of the 36 occurring at the mine end. The mine end spill did not impact or interact with groundwater. No spills occurred outside the plant area or off the SML or impacted environmental receptors such as flora, fauna or water bodies.

Of the 36 spills; nine were hydrocarbon spills with the majority of these spills resulting from loss of containment from plant equipment across site, and four were effluent spills caused by blocked or failing sewerage lines. The remaining 23 were chemical spills and consisted of mainly weak acid and electrolyte spills from leaking pipe racks and instrumentation failures resulting in bund and tank overflows.

Internally reportable chemical and hydrocarbon spills have increased compared with previous years as shown in Figure 31. The increase in effluent/sewerage spills across site is a result of aging equipment and system capacity. Substantial work is being undertaken to improve and upgrade the site sewerage system capacity with an upgrade of a new evaporation pond underway in FY19. Further investigation and scoping works are underway to map and assess the systems future capability.

Furthermore, substantial progress has been made towards developing a good reporting culture for spills and other environmental events to ensure all events are reported in a timely and accurate manner.

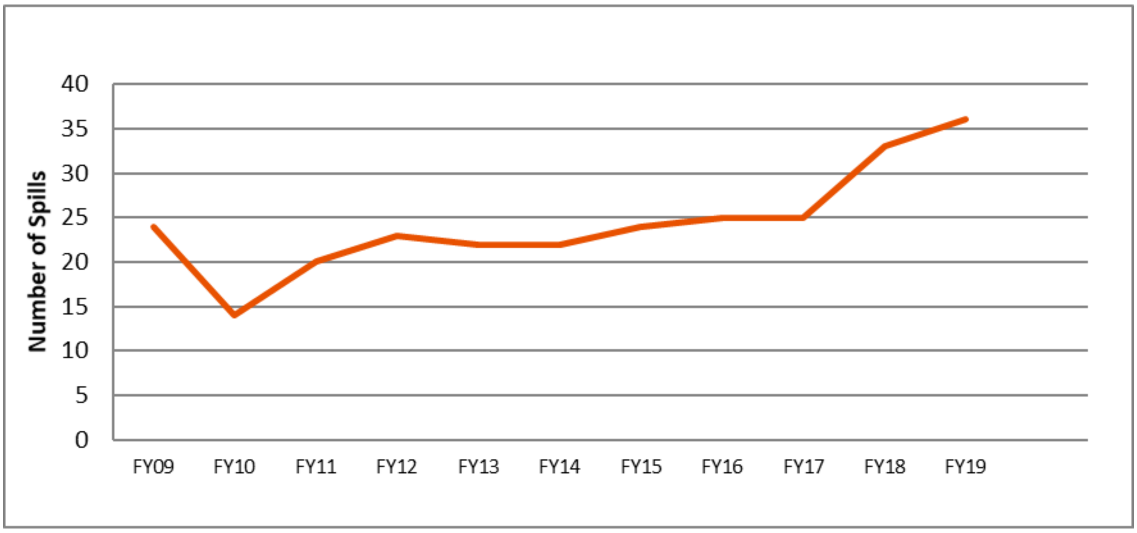


Figure 31: Historical hydrocarbon/chemical spills to FY19

Continue to implement environment improvement plans for areas of concern, as identified through the annual Aspect and Impact risk register review.

OD is continuing to implement inspections and maintenance on bunded areas to ensure spill management methodology is maintained. During FY19 bunding upgrades have been approved to increase holding capacities (example: CAF Plant) within some operational areas, while further operational areas for improvement have been highlighted for potential upgrading in the near future.

2.2 Radioactive process material spills

2.2.1 Environmental Outcome

No adverse impacts to public health as a result of radioactive process material spills from ODC's activities.

ODC has consistently operated in a manner that limits radiation dose to members of the public, from operational activities and radioactive emissions, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1mSv/y limit. During FY19 there were no radioactive process material spills outside operational areas. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken by ODC.

No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive process material spills from ODC's activities.

No significant impacts to populations of listed species or ecological communities were recorded as a result of operational activities, including the effects from any radioactive process material spills. Impacts to listed species and ecological communities are avoided by ensuring that there is no uncontrolled loss of radioactive material to the natural environment. As there was no loss of radioactive material to the undisturbed environment in FY19, no impact to populations of listed species or ecological communities occurred.

2.2.2 Compliance criteria

A dose limit for radiation doses to members of the public of 1 mSv/y above natural background.

The total dose to members of the public at Roxby Downs Monitoring Site (RDMS) and Olympic Village Monitoring Site (OVMS) due to contribution from ODC operations in FY19 was 0.033 mSv and 0.034 mSv, respectively. For more detail refer to section *3.4 Radioactive Emissions*.

No significant radioactive contamination arising from uncontrolled loss of radioactive material to the natural environment. *NOTE: Significant is defined as requiring assessment and remedial action in accordance with the NEPM 1999 or EPP 2015 and the Mining Code. Measurement and monitoring is carried out in response to a specific event.*

In FY19 there were 15 radioactive material spills within the surface operational area. The majority of these spills were in the SX and Hydromet areas and were a result of failed pipes and feed spools. Of the spills in FY19 none required assessment and remedial action in accordance with the National Environment Protection Measure (NEPM) 1999, Environment Protection (Water Quality) Policy (EPP) 2015 or the Code of Practice Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (the Mining Code). As stated in section 2.2.1 above, there was no uncontrolled loss of radioactive material to the natural environment in FY19.

2.2.3 Leading Indicators

- None applicable

2.2.4 Targets FY19

No spill of Radioactive Process Material into an undisturbed environment.

There was no uncontrolled loss of radioactive material to the undisturbed environment in FY19.

Corrective actions resulting from a reportable spill of radioactive process material are executed in a timely manner to ensure no adverse impacts to human health.

No reportable spills occurred in FY19.

2.2.5 Actions FY19

Maintain a register of recordable spills of radioactive process material resulting from operations at Olympic Dam. (Note: Reportable and recordable spills of radioactive process material as defined by the Criteria and Procedures for Recording and Reporting Incidents as SA Uranium Mines (DEM), known as 'Bachman Criteria'.

A register of recordable spills was maintained during FY19, there were 15 radioactive process material spills across site, which occurred at the SX, hydromet; concentrator and TRS areas. The number of radioactive process material spills shows a decreasing trend since FY11 as shown in Figure 32 This is attributed to planned maintenance and work management through 1SAP.

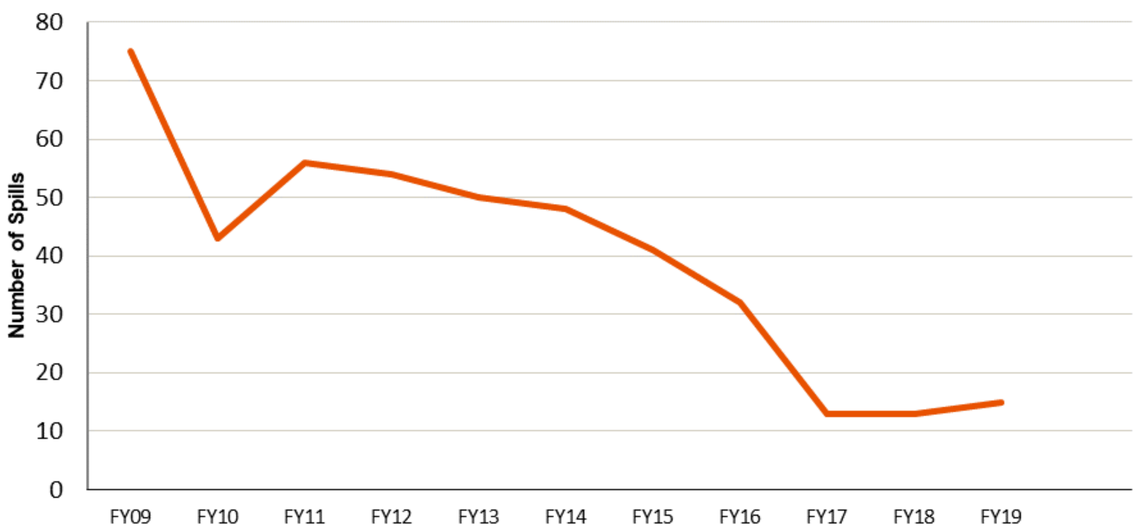


Figure 32: Historical radioactive process material spills to FY19

Continue to implement environment improvement plans for areas of concern as identified in the annual Aspects and Impacts risk register review.

All areas continued with planned maintenance tasks for tanks, pipes and bunds. These plans are captured and monitored through 1SAP. The adherence to planned maintenance ensures less radioactive process material spills as demonstrated in Figure 32.

3 Operation of industrial systems

3.1 Particulate emissions

3.1.1 Environmental Outcome

No adverse impacts to public health as a result of particulate emissions from ODC's activities.

No adverse impacts to public health as a result of particulate emissions from operations conducted by ODC occurred during FY19. Although one exceedance event did occur, on a day of regionally high dust levels, ODC does not consider this one off event to have caused adverse impacts to public health. Measured ground level dust concentrations derived from operations at Olympic Dam and recorded at sensitive receptor sites were below compliance criteria for PM_{10} at all other times during FY19.

3.1.2 Compliance criteria

Ground level PM_{10} dust concentrations at Roxby Downs derived from construction and operational sources at Olympic Dam must not exceed the PM_{10} 24-hour average of 50µg/m^3.

The highest 24-hour average PM_{10} recorded for operational contribution PM_{10} dust was 80.67µg/m^3 and 38.37µg/m^3 at Roxby Downs and Olympic Village respectively during this reporting period.

Olympic Village remained below the daily limit of 50µg/m^3 and is discussed further in section 3.1.4. However, Roxby Downs exceeded the daily limit of 50µg/m^3 on one occasion during September 2018. This event was proactively reported to the Environment Protection Authority (EPA). An investigation concluded that a regional weather event in September was the main cause of this exceedance event at Roxby Downs.

All remaining monitoring results for Roxby Downs 24hr average operational contribution PM_{10} dust were recorded below the 50µg/m^3 limit for FY19.

3.1.3 Leading Indicators

- None applicable

3.1.4 Deliverables

Records of particulate emissions from Smelter 2 to assess compliance with the emission limits of EPA Licence 1301 and to compare against schedule 4 of the Environment Protection (Air Quality) Policy 2016 as shown in Table 2.1 of the Monitoring Program – Airborne Emissions. (AE 2.1)

The Environment Protection (Air Quality) Policy 2016 prescribes a level for emissions of particulates from any process. This level is referenced in EPA Licence 1301 Authorisation Reference (37-43). Sampling of smelter stack emissions and analysis for particulate concentrations are undertaken periodically to assess the performance of gas cleaning systems (EPA Licence 1301 Authorisation Reference (37-43)). Particulate emissions from the Acid Plant Tails Stack (APTS), Concentrate Dryer Stack and Main Smelter Stack were tested during FY19. The results of this testing program are summarised in Table 10 and Table 11.

Emissions of particulates from the Main Smelter Stack and the Acid Plant Stack met requirements of the Environment Protection (Air Quality) Policy 2016 during the reporting period for isokinetic testing (Table 10). No exceedances of ground level concentrations (GLC) of PM_{10} as per schedule 2 of the Environment Protection (Air Quality) Policy 2016 occurred from Smelter 2 during FY19.

One event was reported to the EPA following visible particulates from the Concentrate Dryer Stack, however this event did not lead to an exceedance of ground level concentration monitoring and reporting.

Table 10: Measured particulate concentrations at the Main Smelter Stack and Acid Plant Stack (mg/Nm³)

	Main Smelter Stack (mg/Nm³)	Acid Plant Stack (mg/Nm³)
July 2018	11	1
April 2019	8	Na

Table 11: Measured particulate concentrations at the Concentrate Dryer Stack (mg/Nm³)

	Concentrate Dryer Stack (mg/Nm³)	Dryer 1	Dryer 2
November 2018	45		
19th April 2019		1,608**	
21st April 2019	30		

Note: Environment Protection (Air Quality) Policy 1994 Limit was 250 mg/Nm³. The Environment Protection (Air Quality) Policy 2016 Schedule 4 is 100mg/Nm³ and Schedule 2 GLC for PM_{10} is 0.05 mg/m³. The GLC was not exceeded at the locations of sensitive receivers (Figure 34 and Figure 35).

*** Event description included below.*

***EPA notification – Scheduled maintenance and replacement of baghouse was completed 13/04/2019, visible particulates noted and reported 19/04/2019, Dryer 1 shutdown and baghouse inspected and replaced as a result.*

On the 19th April 2019, following visual observation of particulates, isokinetic testing of the Concentrate Dryer Stack revealed that particulates were reported at 1,608mg/Nm³, exceeding the EPA compliance limit for ODC of 250mg/Nm³. Plant operation was ceased and following inspection it was demonstrated that the Dryer 1 bag house was the cause of the high particulates. A full baghouse replacement occurred and follow up isokinetic testing undertaken on 21/04/2019 demonstrated Dryer 1 was operating within particulate compliance limits at 30mg/Nm³ whilst feed was on. This event did not lead to an exceedance of ground level concentration limits.

Records of particulate emissions from Calciners A and B to assess against the relevant particulate pollutant level specified in Environment Protection (Air Quality) Policy 2016 (see Table 2.1 of the Monitoring Program – Airborne Emissions).

Particulate emissions from Calciner A and B are measured on a quarterly basis by isokinetic sampling, where possible, depending upon process reliability and plant availability (Table 12). Any measurement above 250mg/Nm³ is investigated and reported to EPA Regulation and Compliance. The isokinetic stack-sampling filters are used to capture particulates and are analysed for ^{238}U activity. Results from the uranium analysis, together with data obtained from the process control system, are used to estimate total uranium discharged from the stacks, and subsequently reported in the LM1 Radiation Annual Report.

Scheduled sampling of the Calciner gas cleaning systems occurred in July 2018, December 2018; February 2019 and May 2019. Emission of particulates from Calciner A and B met the requirements of the Environment Protection (Air Quality) Policy 2016 during the reporting period and did not result in GLC exceedance of particulates at sensitive receivers (Table 12). The particulate emission trend for the Calciner is presented in Figure 33.

Table 12: Measured particulate concentrations in Calciner emissions (mg/Nm³)

	Calciner A (mg/Nm³)	Calciner B (mg/Nm³)
July 2018	50	14
Dec 2018	136	75
Feb 2019	86	99
May 2019	101	135

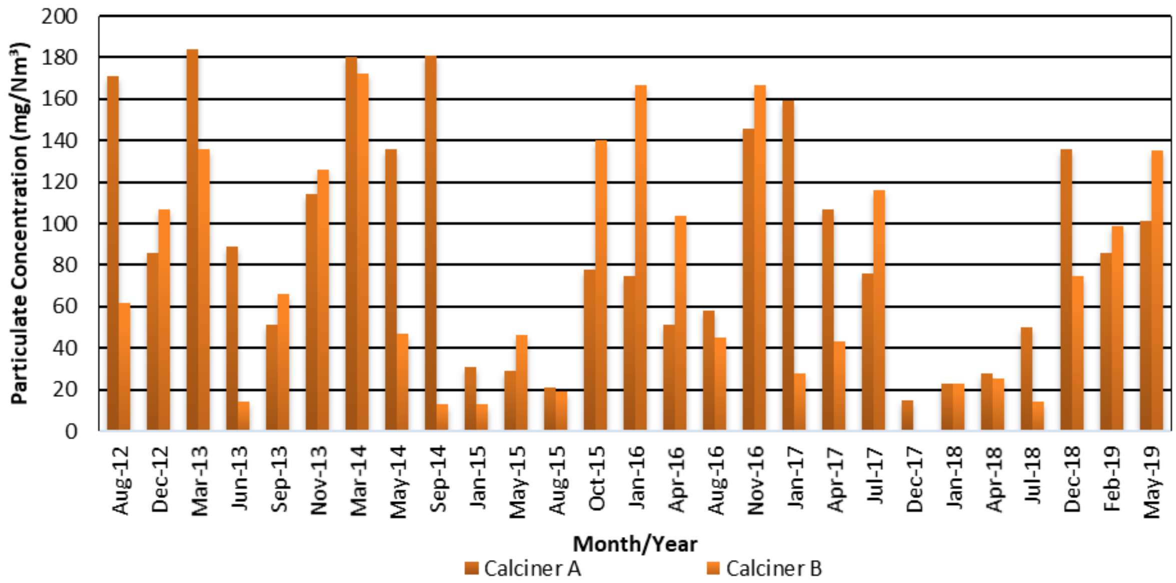


Figure 33: Historical Calciner quarterly isokinetic particulate emissions (FY19).

Records of particulate and hydrogen sulphide emissions from the Slimes Treatment Plant to assess against the pollutant levels in the Environment Protection (Air Quality) Policy 2016 (see Table 2.1 of the Monitoring Program – Airborne Emissions) (AE 2.3).

Particulate and hydrogen sulphide emissions from the Slimes Treatment Plant are measured on a biannual and annual basis respectively by isokinetic sampling. Any measurement above 100 mg/Nm³ for particulates from the roaster scrubber (Saunders Furnace) or above 5 mg/Nm³ of hydrogen sulphide from the NOx Scrubber was reported to EPA Regulation and Compliance and investigated. These values were not exceeded during FY19 as shown in Table 13.

Table 13: Measured particulates and Hydrogen Sulphide concentrations (mg/Nm³)

	Saunders Furnace Particulates (mg/Nm³)	NOx Scrubber Hydrogen Sulphide (mg/Nm³)
December 2018	51	<0.03
April 2019	50	<0.03

Records of real-time monitoring of particulates to ensure that concentrations at Roxby Downs remain within the compliance criteria. (AE 2.6)

The real-time dust monitoring system records ground level dust concentration data at 10 minute intervals at sensitive receptor sites. The calculation of the operational component of these levels is

determined by subtracting dust concentrations measured at the Northern background site from measurements recorded at sensitive receptors during attributable wind direction periods. The real time operational dust concentration results for Roxby Downs and Olympic Village are shown in Figure 34 and Figure 35.

The highest PM_{10} recorded for each of the sensitive receiver's (operational contribution) PM_{10} dust 24hour average was 80.67µg/m^3 at Roxby Downs and 38.37µg/m^3 at Olympic Village (refer to section 3.1.7).

Real time average background PM_{10} concentration is shown in Figure 36.

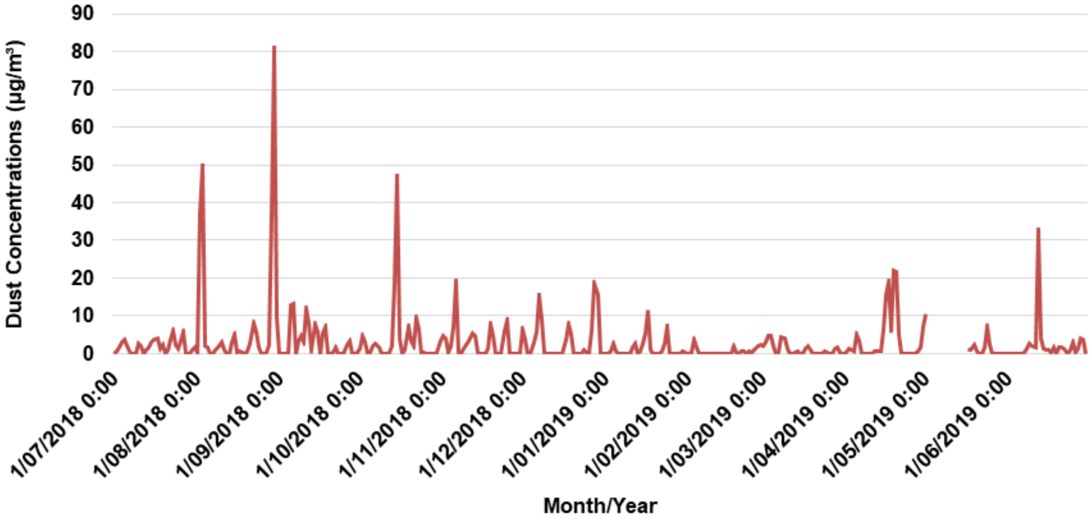


Figure 34: Real time PM_{10} 24-hour 'operational contribution' dust concentrations at Roxby Downs (FY19)

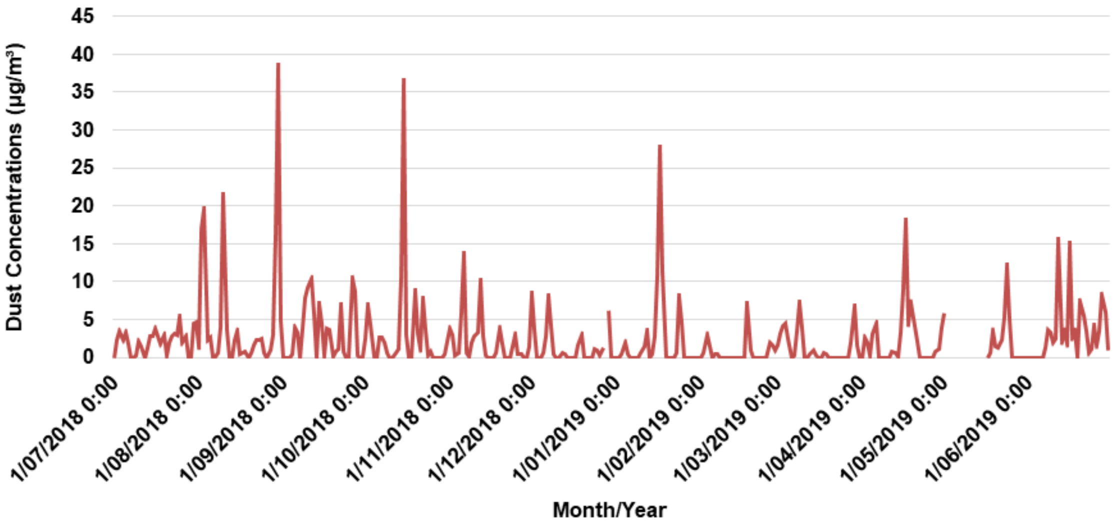


Figure 35: Real time PM_{10} 24-hour 'operational contribution' dust concentrations at Olympic Village (FY19).

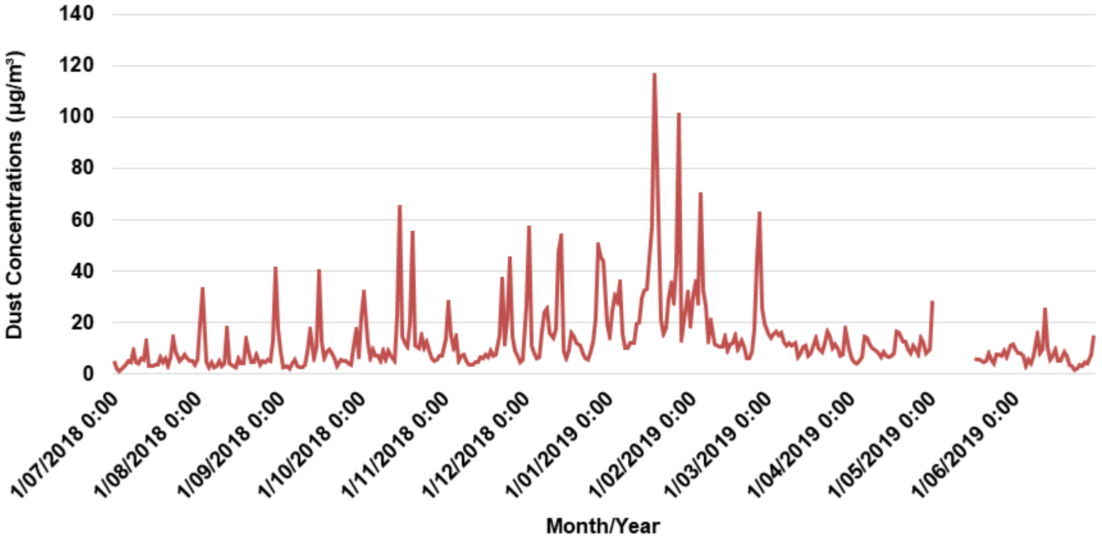


Figure 36: Real time dust concentrations at Northern Background Station (FY19)

Provision of real-time particulate information to inform the management of dust producing activities at the operation. (AE 2.6)

The real time dust monitoring stations are recording information at 10 minute intervals with all information stored and managed on the Airodis air management data base. A daily report is distributed to stakeholders which shows background and operationally contributed PM_{10} dust levels. If high winds and storms are anticipated a site wide weather warning is circulated to all operational areas, with site ceasing outdoor operations during storm events.

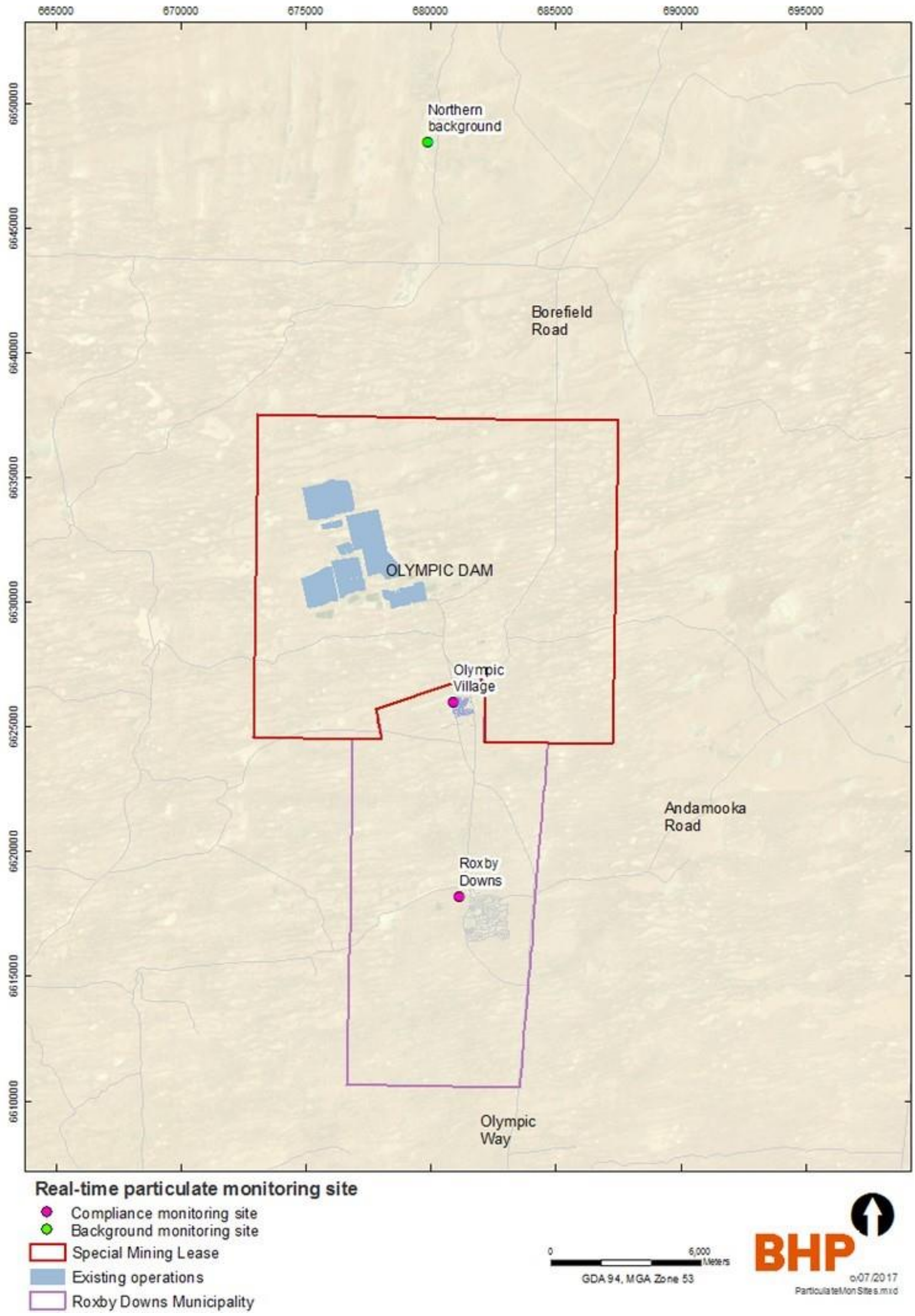


Figure 37: Location of real time dust monitoring sites.

3.1.5 Deliverables (FL 2.1)

A report on the annual changes in perennial communities within and surrounding the SML.

Provide a comparative assessment on perennial species existing at different distances from the Main Smelter Stack.

In FY19, 65 permanent quadrats (i.e., sites) were monitored for perennial vegetation (Figure 38). *Acacia ligulata* had the greatest relative abundance overall from 2011 to 2018, followed by *Dodonea viscosa*.

Similar to FY18, a linear regression analysis of Treatment and Control sites found that *Acacia ligulata* significantly decreased over time (Table 14) and *Dodonea viscosa* significantly increased over time (Table 14). In FY19, *Callitris glaucophylla* was also found to significantly decrease at both Treatment and Control sites (Table 14). In addition, *Acacia ramulosa* had significantly decreased at Treatment sites, while *Acacia aneura* had significantly increased at Control sites (Table 14). Prior to FY19 monitoring, *Acacia ramulosa* was recorded at a slightly higher mean relative abundance. This was due to a misidentification of juvenile plants. An increase in *Acacia aneura* was largely observed after a change in field surveyor after this work was taken in-house. Therefore, differences observed may also be cause by the misidentification of plants. Work to improve the data collection method will be undertaken in the coming years.

Excluding relationships found in *Acacia ramulosa* and *Acacia aneura*, similar changes at both Treatment and Control sites indicates that changes in species composition are not due to impacts from the mine.

In addition, Simpson's index values averaged over a maximum of 12 years showed that plant diversity could not be linked to proximity of the mine. A regression analysis determined that plant species diversity averaged over 2006 to 2018 did not significantly change with distance from the operation (up to 27 km from the main smelter stack; $F_{1,65} = 0.081$, $p = 0.777$; $R^2 = 0.001$ 0.001; Figure 39). Therefore, the operation does not appear to be having a significant impact on the species diversity of surrounding perennial flora communities.

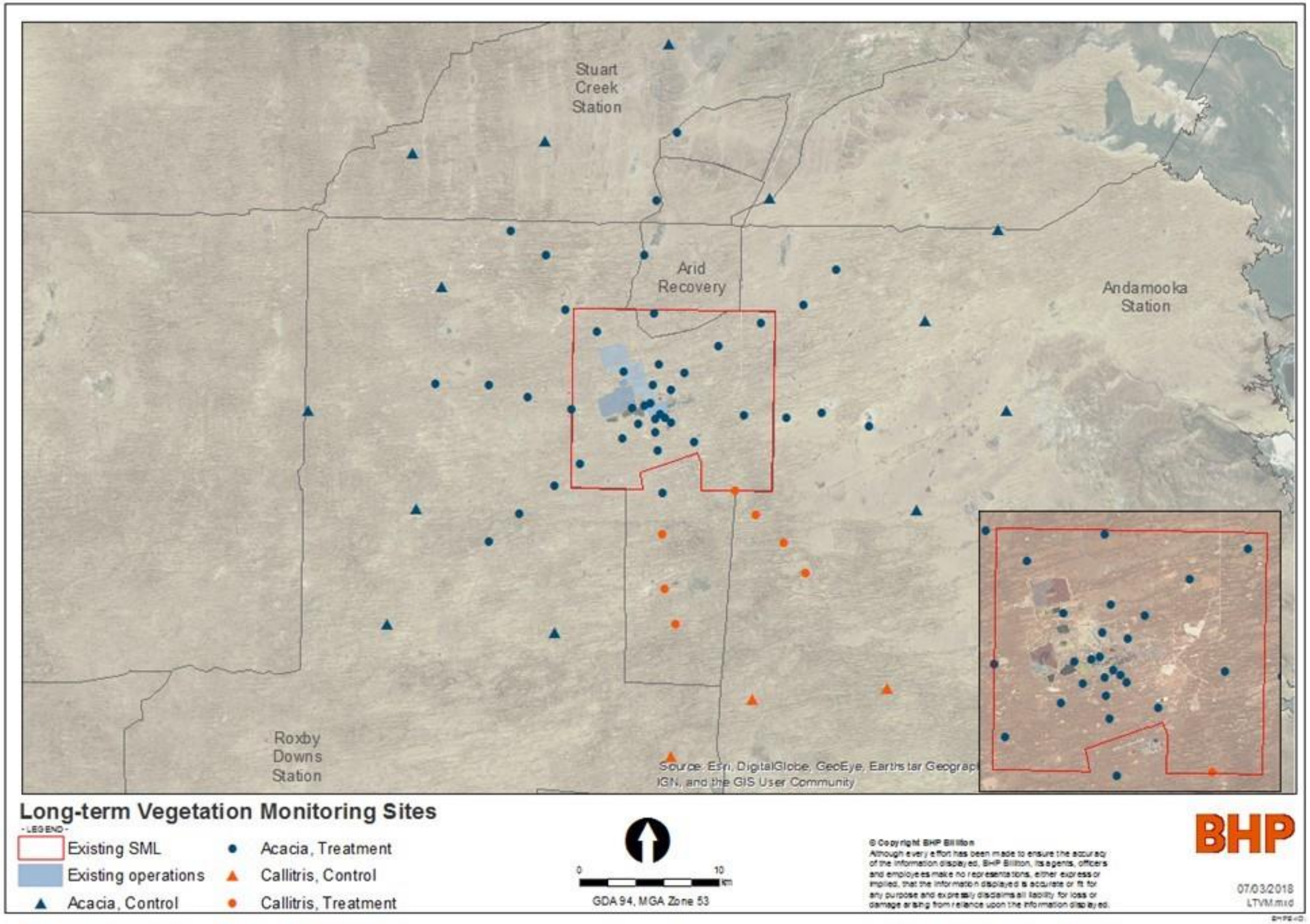


Figure 38: Location of radial sample sites monitored in FY19.

Table 14. Linear regression analysis results for all species in Treatment and Control sites from FY12 to FY19.

Species code	Treatment		Control	
ACAN	$F_{1,6} = 0.007$, $p = 0.935$	$R^2 = 0.001$	**$F_{1,6} = 8.995$, $p = 0.024$**	**$R^2 = 0.600$**
ACLI	**$F_{1,6} = 44.198$, $p < 0.001$**	**$R^2 = 0.880$**	**$F_{1,6} = 34.986$, $p = 0.001$**	**$R^2 = 0.854$**
ACOS	$F_{1,5} = 0.278$, $p = 0.620$	$R^2 = 0.053$	-	-
ACRA	**$F_{1,6} = 34.897$, $p = 0.001$**	**$R^2 = 0.853$**	$F_{1,6} = 10.037$, $p = 0.019$	$R^2 = 0.626$
ALOL	$F_{1,6} = 3.233$, $p = 0.122$	$R^2 = 0.350$	$F_{1,6} = 0.153$, $p = 0.709$	$R^2 = 0.025$
CAGL	**$F_{1,6} = 19.983$, $p = 0.004$**	**$R^2 = 0.769$**	**$F_{1,6} = 42.154$, $p < 0.001$**	**$R^2 = 0.875$**
DOVI	**$F_{1,6} = 116.583$, $p < 0.001$**	**$R^2 = 0.956$**	**$F_{1,6} = 67.623$, $p < 0.001$**	**$R^2 = 0.919$**
ERGL	-	-	-	-
ERLO	$F_{1,6} = 0.026$, $p = 0.877$	$R^2 = 0.004$	-	-
ERMA	$F_{1,1} = 8.301$, $p = 0.213$	$R^2 = 0.892$	-	-
GUQU	$F_{1,6} = 1.262$, $p = 0.304$	$R^2 = 0.174$	-	-
HALE	$F_{1,4} = 0.174$, $p = 0.698$	$R^2 = 0.042$	-	-
LYAU	$F_{1,6} = 2.365$, $p = 0.201$	$R^2 = 0.256$	-	-
PIMI	$F_{1,4} = 1.860$, $p = 0.244$	$R^2 = 0.317$	-	-
PIAN	$F_{1,6} = 0.004$, $p = 0.958$	$R^2 = 0.001$	-	-
SAAC	$F_{1,3} = 3.015$, $p = 0.181$	$R^2 = 0.501$	-	-
SALA	$F_{1,6} = 0.104$, $p = 0.757$	$R^2 = 0.017$	-	-
SASP	-	-	-	-
SEPE	$F_{1,6} = 3.310$, $p = 0.119$	$R^2 = 0.356$	$F_{1,6} = 0.073$, $p = 0.796$	$R^2 = 0.012$

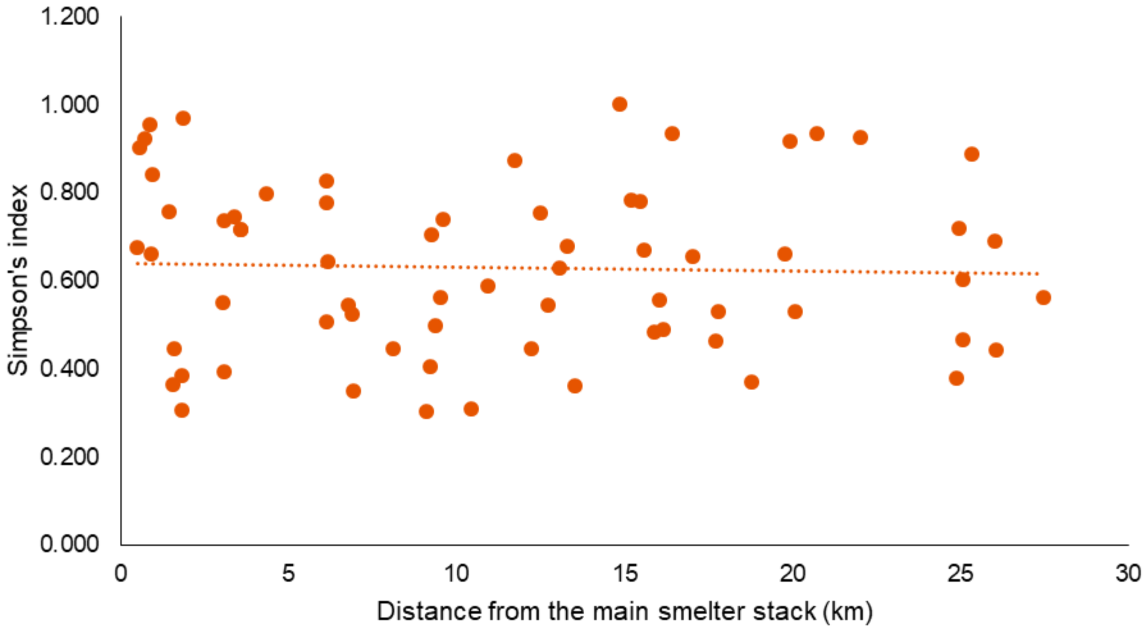


Figure 39: Simpson's index averaged over 2006 to 2018 for each site and plotted against the distance of the site from the main smelter stack.

3.1.6 Target FY19

- None applicable

3.1.7 Actions FY19

Implement an Environmental Improvement Plan should any significant increase of operationally contributed PM_{10} 24 hour average of $50_{\mu g}/m^3$ occur over the year.

No significant increase of operationally contributed PM_{10} 24 hour average of $50_{\mu g}/m^3$ occurred over the year. No improvement plan is required at this present time.

Although an exceedance of PM_{10} in September 2018, site investigations confirmed that was a result of a naturally occurring regional weather event and not due to site based activities.

3.2 Sulphur dioxide emissions

3.2.1 Environmental Outcome

No adverse impacts to public health as a result of sulphur dioxide emissions from ODCs operations.

National Environmental Protection Measure (NEPM) 1999, levels for ambient air quality are based on the protection of human health. Roxby Downs and Olympic Village ambient SO_2 analyser results for the reporting period showed no exceedance of the NEPM for ambient air quality SO_2 at either Olympic Village or Roxby Downs Township.

An annual review of monitoring data collected at sensitive receptors (ambient ground level concentrations) has shown there were no adverse impacts to public health as a result of sulphur dioxide (SO_2) emissions from ODC's activities during FY19.

3.2.2 Compliance criteria

Annual average SO_2 concentration of less than 0.02 ppm at sensitive receivers, Olympic Village and Roxby Downs.

The measured annual average SO_2 concentrations for the reporting period was 0.0007ppm and 0.0000ppm at Roxby Downs and Olympic Village respectively, which is less than the 0.02ppm NEPM limit.

24hour average SO_2 concentration of less than 0.08 ppm at sensitive receptors, Olympic Village and Roxby Downs

The measured maximum 24hour average SO_2 concentrations for the reporting period was 0.0037ppm and 0.0001ppm for Roxby Downs and Olympic Village respectively. This is below the 0.08ppm NEPM limit.

One hour average SO_2 concentration of less than 0.2 ppm at sensitive receptors, Olympic Village and Roxby Downs

The measured maximum hourly average SO_2 concentration for the reporting period was 0.0045ppm and 0.0027ppm for Roxby Downs and Olympic Village respectively, which is less than the 0.2ppm NEPM limit.

3.2.3 Leading Indicators

- None applicable

3.2.4 Deliverables

Calibration records for SO_2 analysers on the Main Smelter Stack and Acid Plant Tails Gas Stack (AE 2.1).

The Acid Plant Tails Gas Stack (APTS) and Main Smelter Stack (MSS) SO_2 analysers were maintained in accordance with site procedures and manufacturer's recommendations throughout the reporting period. Calibration maintenance plans (CMPs) are scheduled through 1SAP and are automatically generated. These CMPs are part of Olympic Dams' pollution control register and monitored for completion frequently. Currently, the in-stack real time SO_2 and particulate analysers on the MSS and the APTS are calibrated on a weekly and quarterly basis. All calibration maintenance plans were completed for FY19 and the calibration records are kept electronically.

Records of SO_2 emissions to assess compliance with the monitoring and reporting requirements of EPA Licence 1301 and the Environment Protection (Air Quality) Policy 2016 (AE 2.1).

Isokinetic sampling of the Main Smelter Stack and Acid Plant Tails Gas Stack was undertaken in July 2018, for sulphur trioxide, with sulphur dioxide testing in July 2018 and March 2019. The results indicate

continued compliance with the requirements of EPA Licence 1301 and the Environment Protection (Air Quality) Policy 2016. Table 15 and Table 16 display the results for FY19.

Table 15: Smelter 2 Main Smelter Stack sampling results FY19

Sampling Point Main Smelter Stack	Total acid gas emissions (mg/Nm^3)	Sulphur trioxide and acid mist emissions* (mg/Nm^3)	Sulphur dioxide emissions ** (mg/Nm^3)
Reporting Level	**3000**	**100**	**2400**
July 2018	24	1	23
March 2019	-	-	72

* Expressed as sulphur trioxide equivalent

** EPA Licence 1301 Licence requirement level without sulphur trioxide

Table 16: Smelter 2 Acid Plant Tails Stack sampling results FY19

Sampling Point Acid Plant Tails Gas Stack	Total acid gas emissions (mg/Nm^3)	Sulphur trioxide and acid mist emissions* (mg/Nm^3)	Sulphur dioxide emissions ** (mg/Nm^3)
Reporting Level	**3000**	**100**	**2400**
July 2018	902	<0.1	902
March 2019	-	-	598

*** Expressed as sulphur trioxide equivalent**

**** EPA Licence 1301 Licence requirement level without sulphur trioxide**

Data to confirm that approximately 99 per cent of all SO_2 generated during the smelting process is captured. (AE 2.1)

The percentage of SO_2 recovery for the reporting period FY19 was 98.85 %. This recovery result has decreased from 98.99% from FY18, however remains compliant with the required approximate of 99% SO_2 capture deliverable.

Records of ground level SO_2 concentrations at Olympic Village and Roxby Downs Township to assess compliance with the ground level SO_2 concentration requirements of the Ambient Air Quality NEPM and the values contained in schedule 2 of the Environment Protection (Air Quality) Policy 2016 (AE 2.4)

Ambient SO_2 1 hour, 24 hour, and 1 year average (mean) concentrations for FY19 at Olympic Dam Village and Roxby Downs were measured by real time continuous ambient SO_2 monitors in accordance with EPA Licence 1301 Condition (305-138).

The measured maximum average 1 hour, 24 hour, and 1 year concentrations for Roxby Downs and Olympic Village results along with the applicable NEPM values, are presented in Table 17 below. The results of the measured concentration for the FY19 reporting period show that no exceedance of the NEPM for ambient air quality limits for SO_2 occurred at Olympic Village or Roxby Downs Township (Figure 40 - Figure 45) sensitive receiver monitoring locations.

Table 17: Measured maximum average (mean) ambient SO_2 concentrations at Roxby Downs and Olympic Village.

	Annual average concentration (ppm)	Maximum 24 hour average concentration (ppm)	Maximum Hourly average concentration (ppm)
NEPM	**0.02**	**0.08**	**0.2**
Roxby Downs	0.0007	0.0037	0.0045
Olympic Village	0.0000	0.0016	0.0027

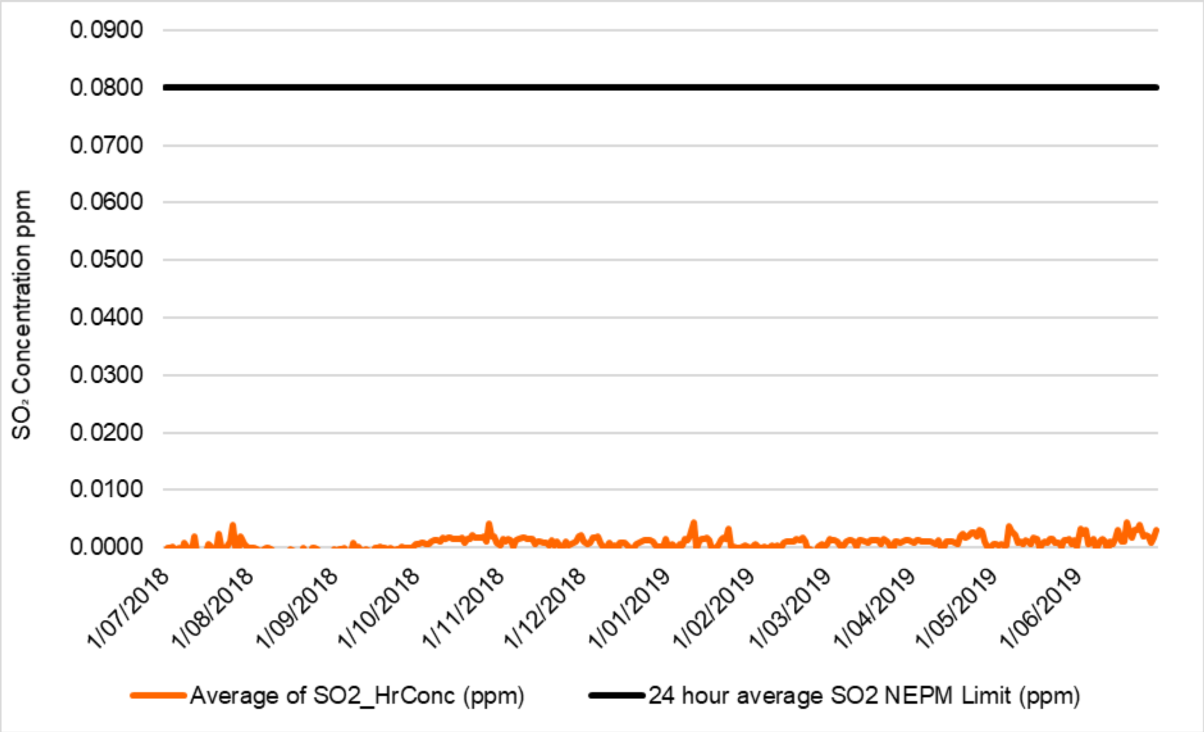


Figure 40: Measured 24hr mean SO_2 concentration at sensitive receptor, Roxby Downs.

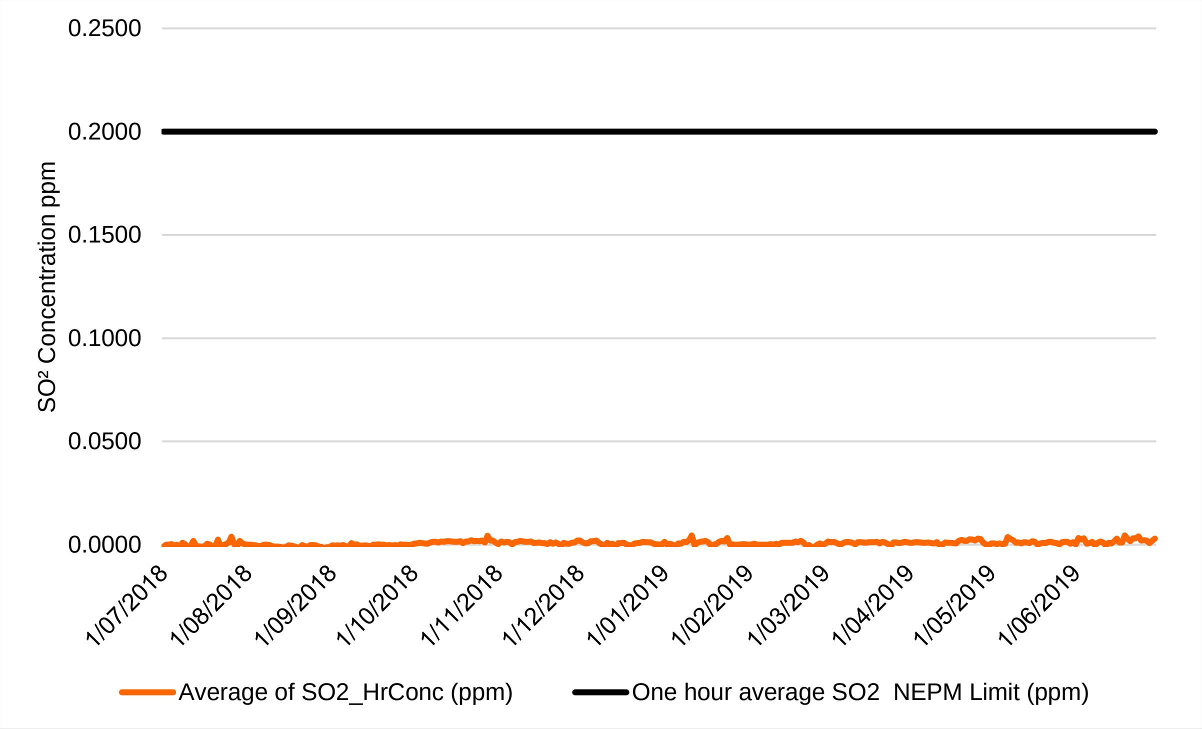


Figure 41: Measured hourly mean SO_2 concentration at sensitive receptor, Roxby Downs.

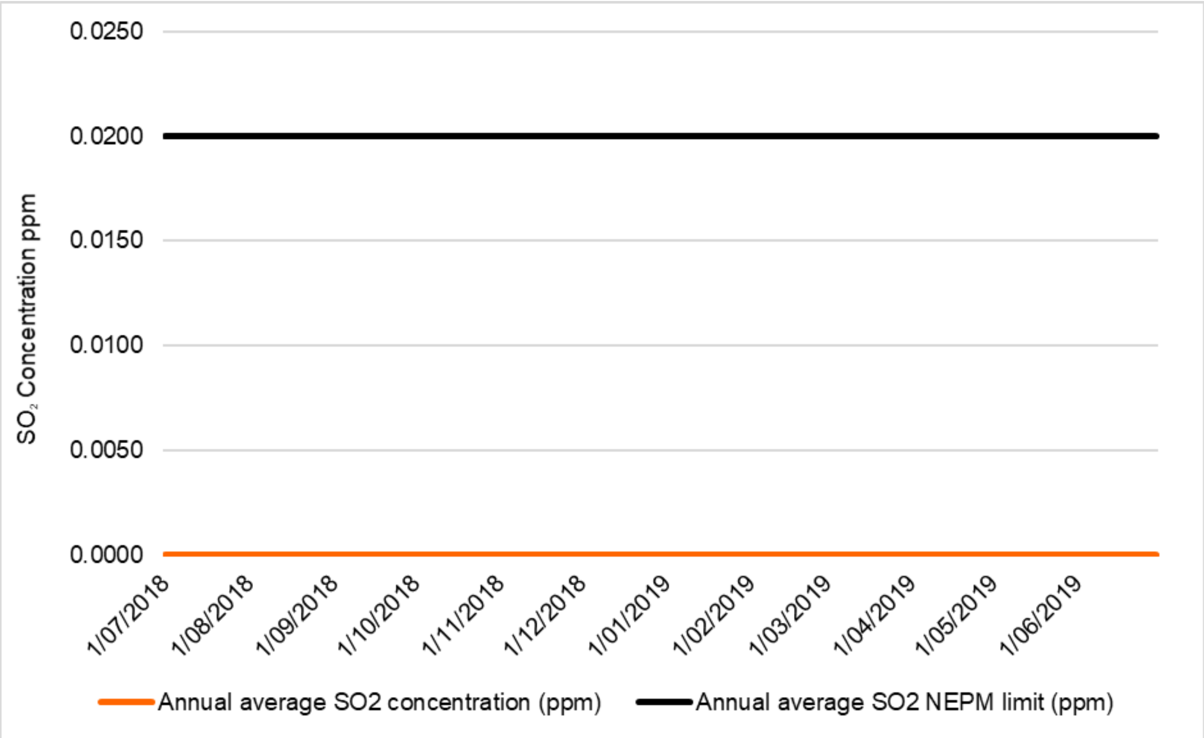


Figure 42: Measured annual mean SO_2 concentration at sensitive receptor, Roxby Downs.

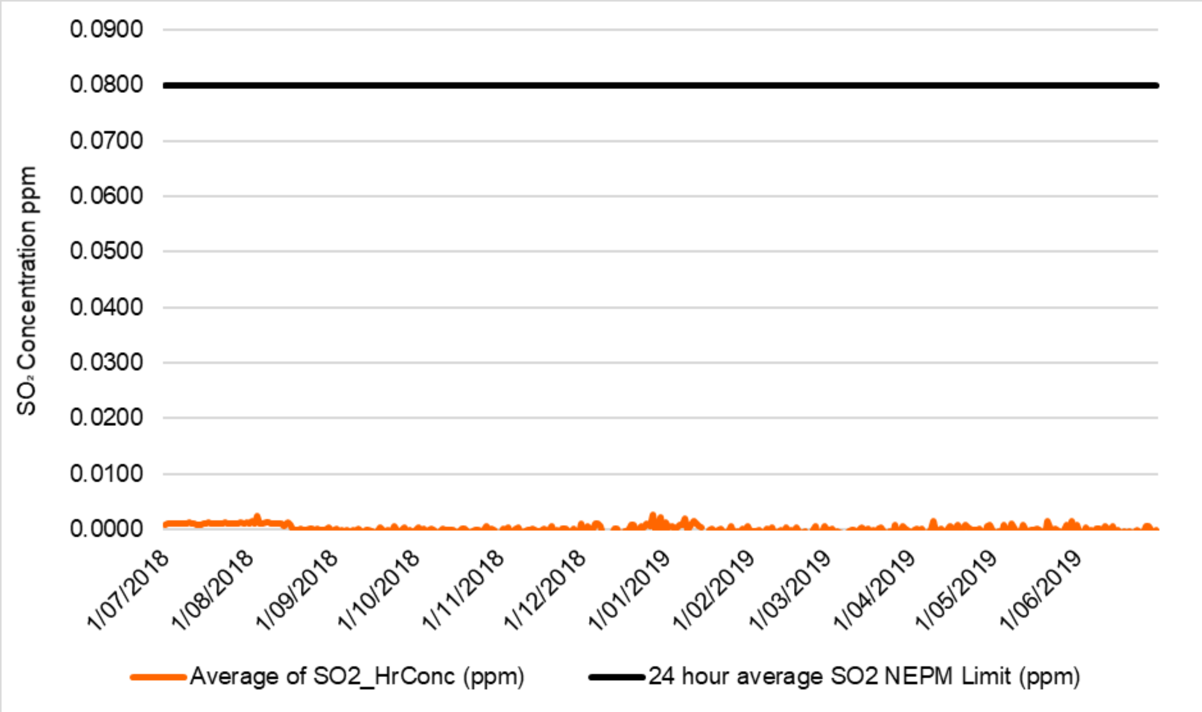


Figure 43: Measured 24hr mean SO_2 concentration at sensitive receptor, Olympic Dam.

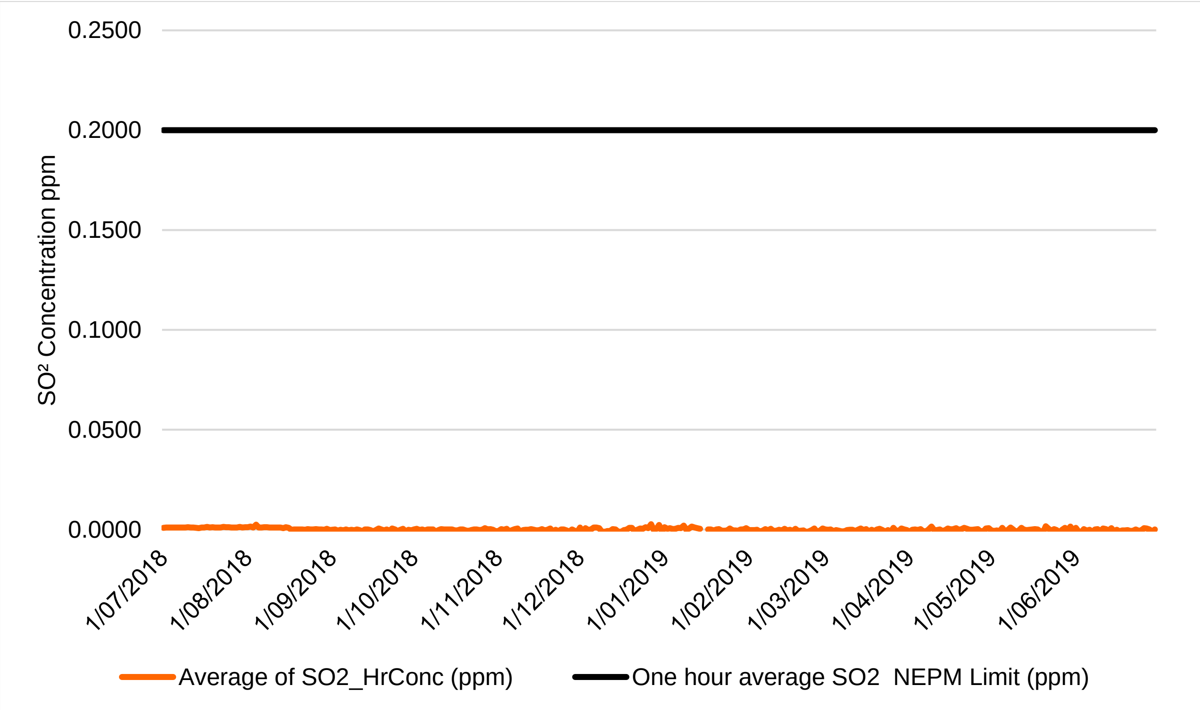


Figure 44: Measured hourly mean SO_2 concentration at sensitive receptor, Olympic Dam.

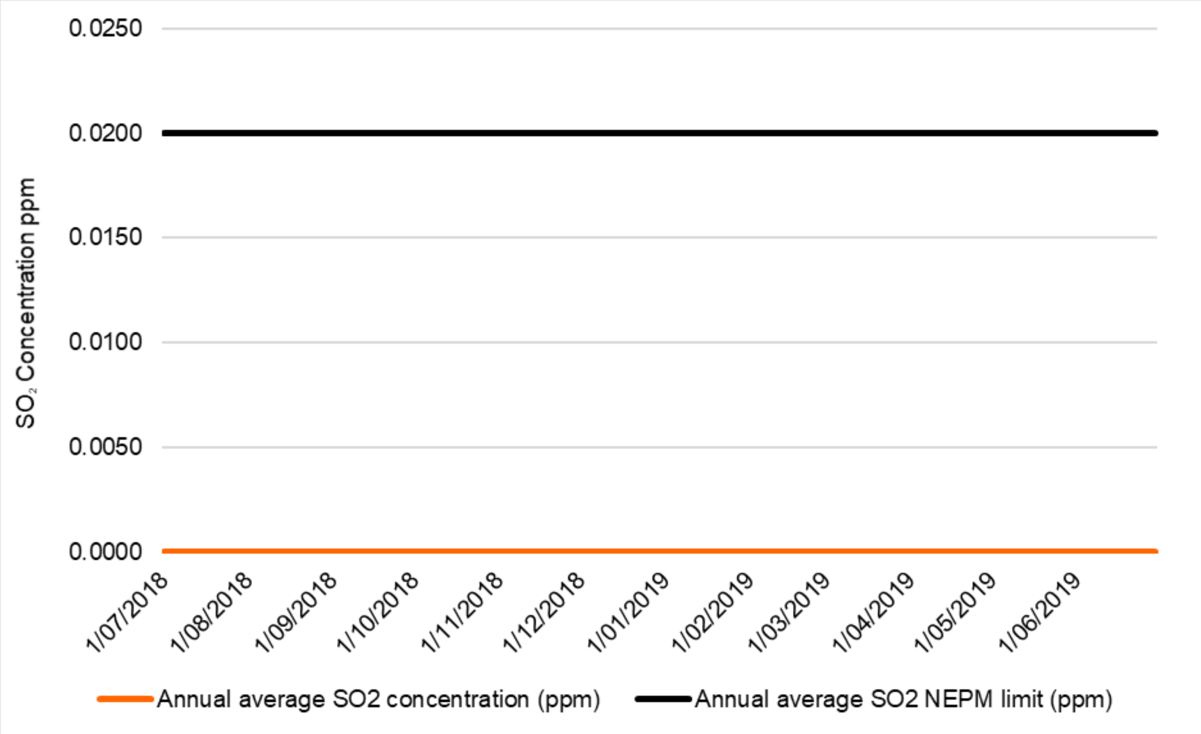


Figure 45: Measured annual mean SO_2 concentration at sensitive receptor, Olympic Dam.

3.2.5 Targets FY19

Approximately 99 percent of all SO_2 generated during the smelting process is captured.

This Target has been achieved for FY19, refer section 3.2.4 deliverables.

3.2.6 Actions FY19

- None applicable

3.2.7 Continuous Improvement

Continue a watching brief on sulphur dioxide emission reduction technology.

Olympic dam continues to maintain and operate the acid plant to recover maximum possible sulphur emissions for reuse and will continue to implement new technology and techniques as they become available.

3.3 Saline aerosol emissions

3.3.1 Environmental Outcome

No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of ODC's activities.

No significant adverse impact to populations of listed species from saline aerosol emissions was observed during FY19. Observations made during environmental inspections and supported by data collected during various flora and fauna monitoring programs, did not find any significant adverse impacts to listed species.

3.3.2 Compliance criteria

No loss of an important population of Plains Rat (*Pseudomys australis*).

There was no loss of an important population of Plains Rat during FY19 as a result of saline aerosol emissions. No loss of habitat to support an important population of Plains Rat was observed during the annual monitoring of emission impacts to vegetation, which are used to assess impacts to flora within the potential impact area. Standards for raise bore design (see section 3.3.6) ensure pollution controls are applied consistently to all new raise bores, which ensures that the majority of the salt deposited is reduced to a smaller radius surrounding the raise bore.

3.3.3 Leading Indicators

- None applicable

Deliverables (AE 2.5) Records from background salt deposition monitoring jars at the edge of the SML against the background limit of 20mg/m^2/day. (AE 2.5).

A system of salt deposition monitoring jars is located on the edge of the SML, north, south, east and west (Figure 46). During July 2018 sampling location sE reported a salt deposition result above 20mg/m^2/day, (23.64 mg/m^2/day), attributed to high winds experienced during July. All remaining monitoring results reported for the FY have been reported below the target threshold. Background salt deposition monitoring results, recorded at the edge of the SML, from the FY19 monitoring period are presented in Figure 47.

Figure 46: Salt Jar deposition monitoring locations FY19

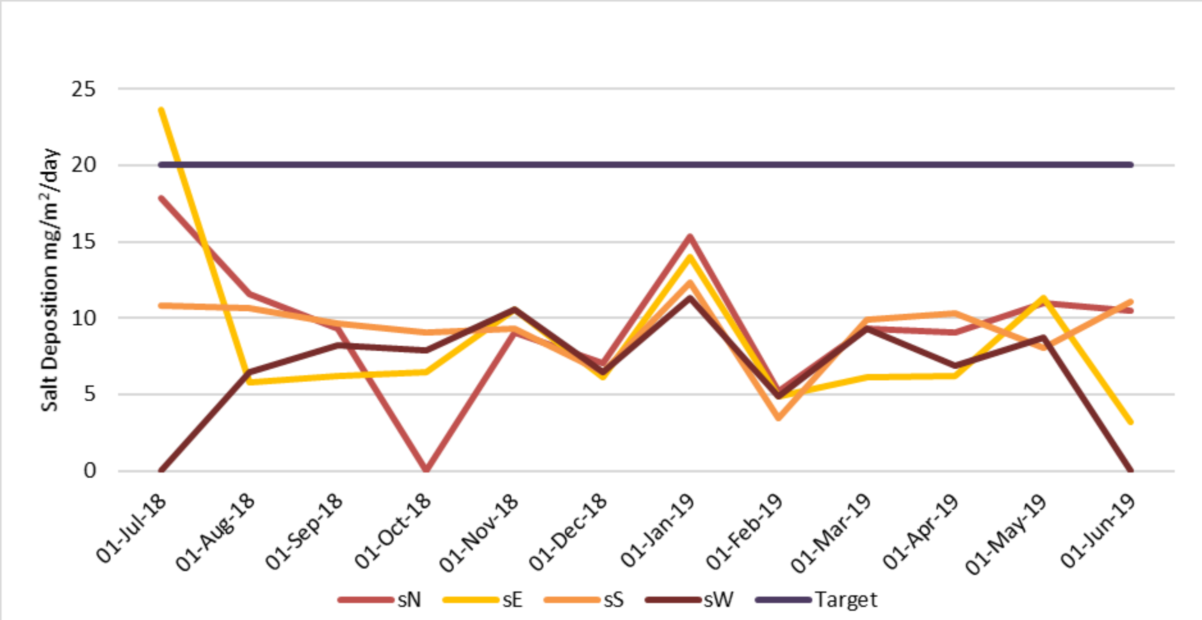


Figure 47: Salt deposition at all monitored raise bores for FY19.

A statement of impacts to the Plains Rat (AE 2.5).

Impacts to flora within the impact zone of the operation are modelled through monitoring of long term changes to perennial vegetation (see Chapter 3.1 Particulate Emissions). Results of these programs and historical fauna programs have demonstrated that the impact to flora and fauna is largely restricted to the vicinity of the operation and is rainfall dependent. No Plains Rats species were observed to be impacted directly by saline emissions in FY19.

3.3.4 Target FY19

Monitor the deposition of salt from saline aerosol emissions at the edge of the SML against background levels of 20 mg/m²/day. Salt deposition monitoring as a result of saline emissions occurs on a monthly basis. A monthly maintenance plan is scheduled through 1SAP and is automatically generated. This management plan is part of ODC's pollution control register and monitored for completion frequently. All maintenance plans were completed for FY19 and the records are kept electronically. See section 3.3.4 deliverables where the results of this monitoring have been reported.

3.3.5 Actions FY19

Install and maintain controls as per the design standard around raise bores. Standards for raise bore design ensure controls are applied consistently to all new raise bores. Raise bores are designed and constructed with 20m splash ponds with surrounding barricades/walls. The exhaust outlet is inverted over the splash pond. This ensures that the majority of the salt deposited is reduced to a smaller radius surrounding the raise bore.

3.4 Radioactive emissions

3.4.1 Environmental Outcome

No adverse impacts to public health as a result of radioactive emissions from ODCs activities.

ODC has consistently operated in a manner that limits radiation dose to members of the public, from operational activities, to less than a small fraction of the 1mSv/yr public dose limit prescribed by the International Commission on Radiological Protection (ICRP). As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at ODC.

No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive emissions from ODCs activities.

There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODCs activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota (NHB) assessment sites is used as an indicator of the potential exposure of listed species to radioactive emissions. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

3.4.2 Compliance criteria

Radiation doses to members of the public less than 1 mSv/y above natural background.

The total estimated dose (FY19) to members of the public at Roxby Downs Monitoring Site (RDMS) and Olympic Village Monitoring Site (OVMS) contributed by ODC operations was 0.033 mSv and 0.034 mSv respectively.

Deposition of project originated ^{238}U less than 25 Bq/m^2/y at non-human biota assessment sites.

The average deposition of U-238, calculated as an average of results at the four monitoring sites was determined to be 0.48 Bq/m^2/y, well below the 25 Bq/m^2/y compliance criteria.

3.4.3 Leading Indicators

Indications that a dose constraint of 0.3 mSv/y to members of the public above natural background will be exceeded.

Indications that a reference level of 10 µGy/h for impacts on non-human biota above natural background will be exceeded.

NOTE: The reference level for non-human biota is set as an interim criteria until such as an agreed national approach is determined.

No leading indicators were triggered. Doses to members of the public are below Olympic Dam’s internal dose constraint of 0.3mSv/yr. Similarly the reference level of 10uGy/h for impacts on non-human biota has not been triggered.

3.4.4 Deliverables (ER 2.2)

Data leading to calculated estimates of annual radiation doses to members of the public in the critical groups identified.

The annual dose attributable to radon decay products (RDP) and radionuclides in dust is calculated and added to calculate the total annual effective dose for members of the public

Radon Decay Products

Monthly RDP averages and the five year rolling average for RDMS and OVMS during the reporting period are shown in Figure 48.

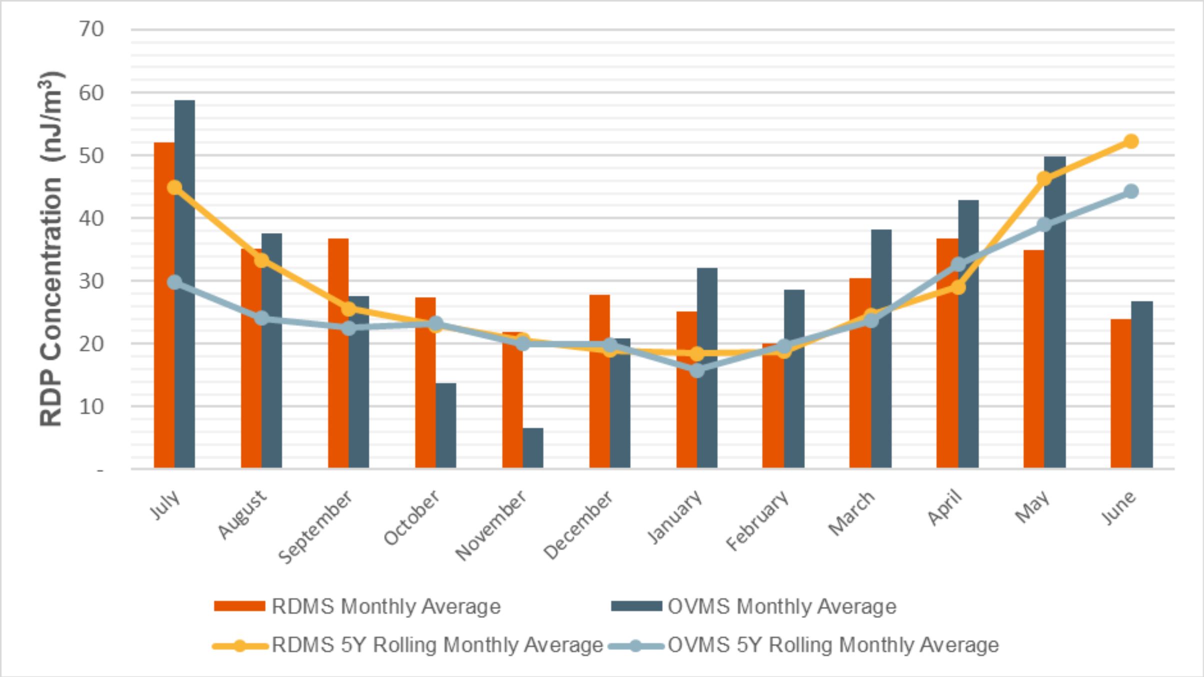


Figure 48: FY19 Radon Decay Products (RDP) monthly trends

The dose results provided in section 3.4.2 demonstrate that the dose to members of the public (as measured at RDMS and OVMS) due to RDP resulting from ODC operations is a small fraction of the applicable dose limit and indistinguishable from the limit of detection of the instrumentation used.

Analysis of historical monitoring data suggests that there is little operation related RDP concentration at these monitoring sites and the main source of RDP exposure at both OVMS and RDMS is from natural radiation background which shows significant seasonal variations as seen in Figure 48 (above).

Radionuclides in Dust Dose Assessment

Monthly concentrations of the long lived radionuclides, ^{238}U, ^{230}Th, ^{226}Ra, ^{210}Pb and ^{210}Po for the 5 year period FY15-FY19 are shown in Figure 49 to Figure 53 (includes environmental background).

The estimated FY19 radiation doses to members of the public at RDMS and OVMS due to long lived radionuclides in dust were 0.0023 mSv and 0.0020 mSv (adjusted for background) respectively. These correspond to 0.23 % and 0.20% of the public dose limit of 1 mSv respectively. These results indicate that the variation in radionuclide concentrations shown in Figure 49 to Figure 53 (inclusive) do not have a significant impact on the overall public radiation dose. It is to be noted that the dust sampling and the radionuclide analysis processes have inherent uncertainties which contribute to the fluctuations seen in the radionuclide trends.

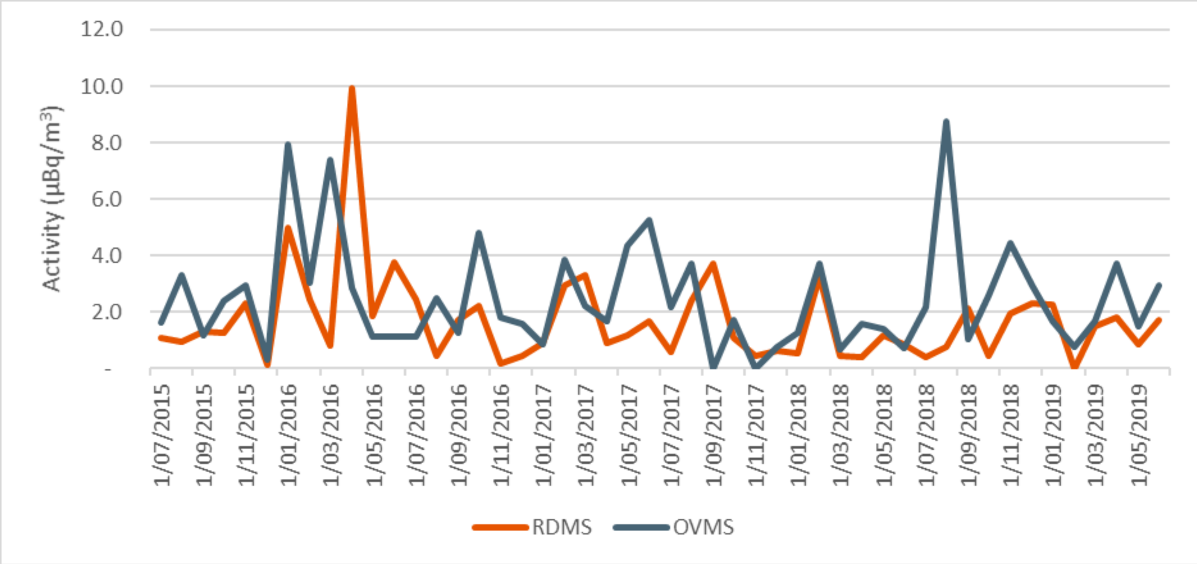


Figure 49: ^{238}U concentration for the 5 year period FY15-FY19 (PM$_{10}$)

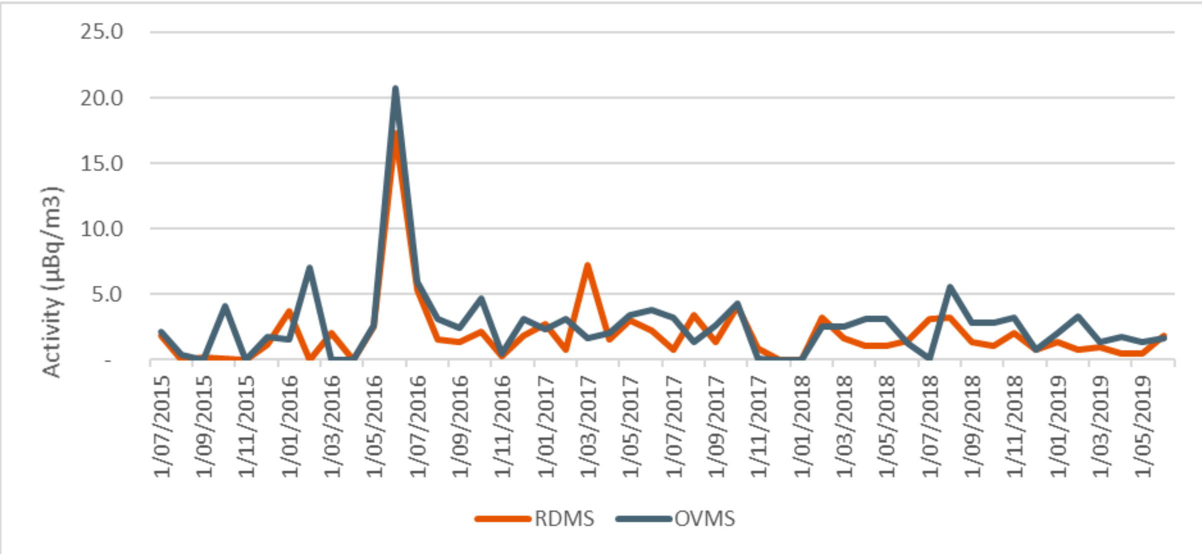


Figure 50: ^{230}Th concentration for the 5 year period FY15-FY19 **(PM$_{10}$)**

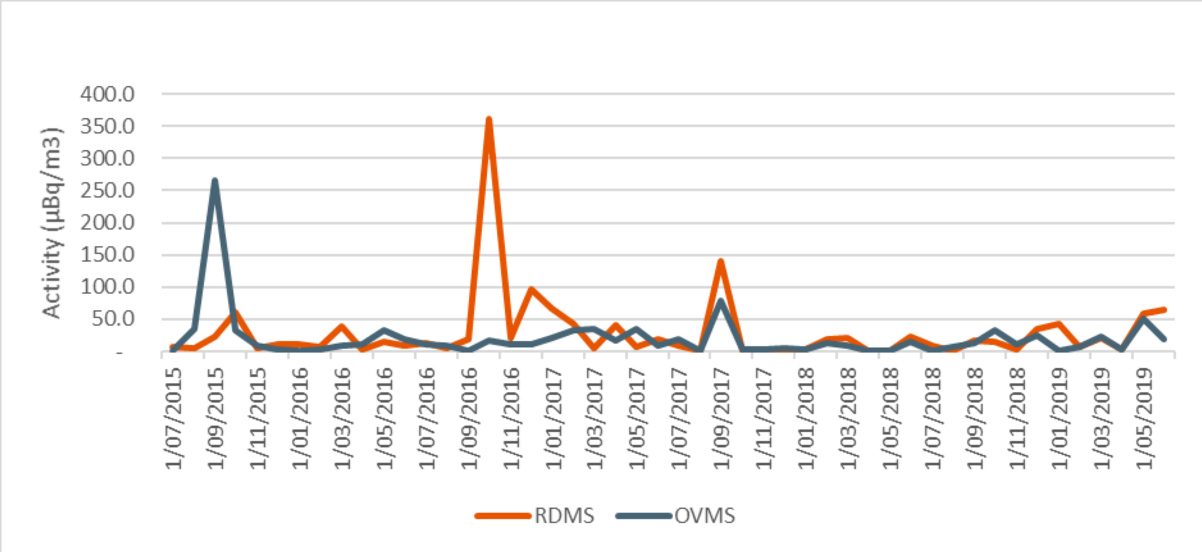


Figure 51: ^{226}Ra concentration for **the 5 year period FY15-FY19 (PM_{10})**

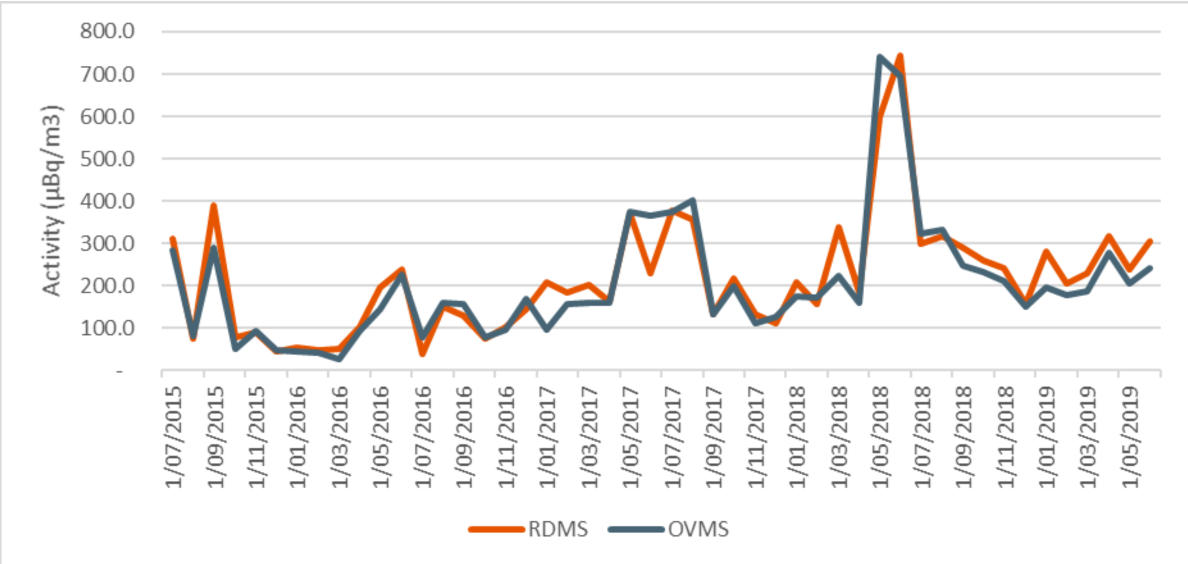


Figure 52: ^{210}Pb concentration for the 5 year period FY15-FY19 (PM_{10})

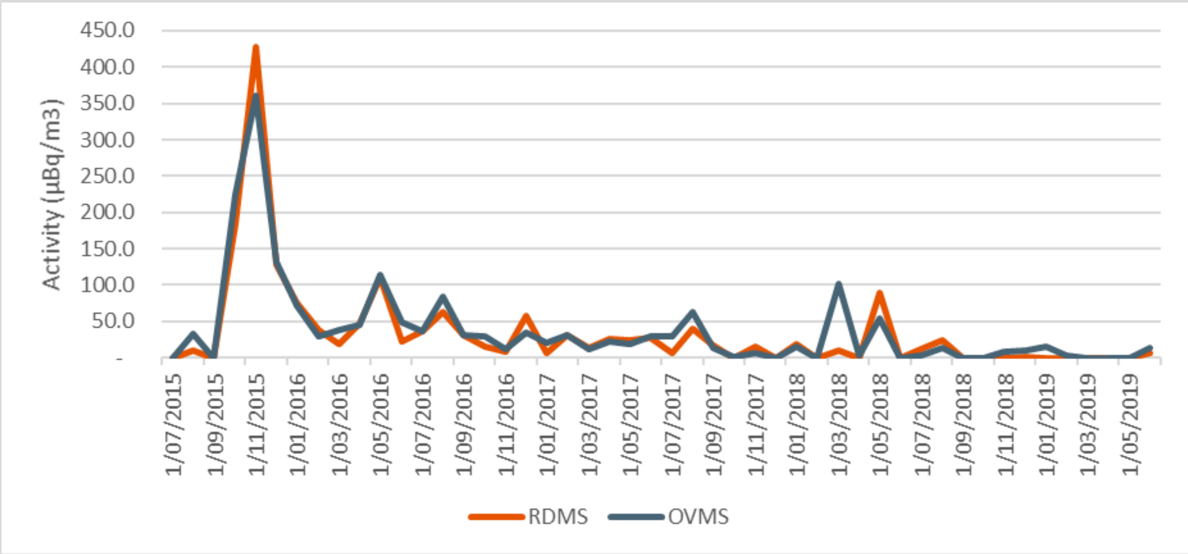


Figure 53: ^{210}Po concentration for the 5 year period FY15-FY19 (PM_{10})

Total Dose to Members of the Public

The total estimated dose (FY19) to members of the public at RDMS and OVMS contributed by ODC operations was 0.033 mSv and 0.034 mSv respectively, well below the 1 mSv/yr public dose limit and Olympic Dam's internal dose constraint of 0.3mSv/yr. Figure 54 shows the annual trend of public doses at RDMS and OVMS.

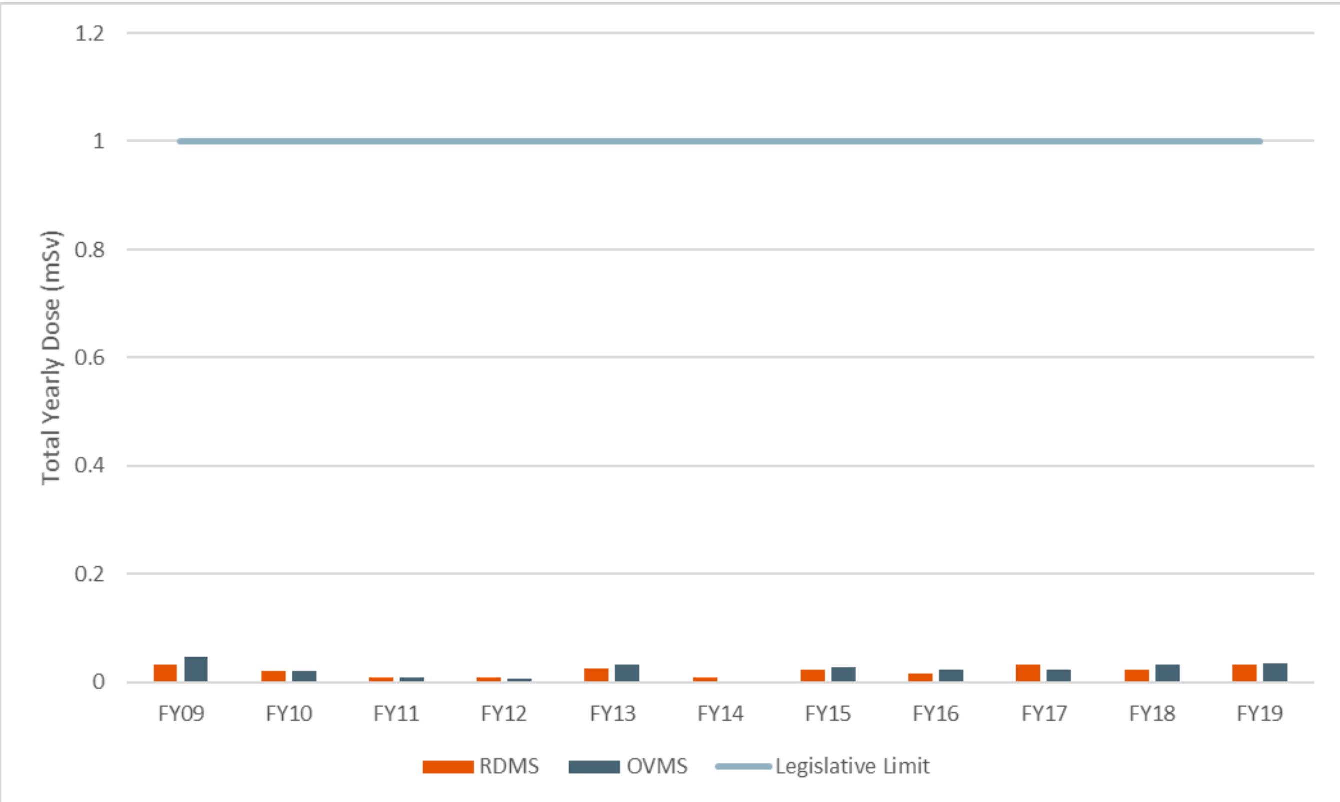


Figure 54: Yearly total effective dose trends for RDMS and OVMS

3.4.5 Deliverables (ER 2.3.3)

Records from passive dust deposition monitoring sites and comparison with the annual compliance rate of 25 Bq/m²/y at the NHB monitoring sites.

An assessment of the impacts to reference plants and animals (ARPANSA 2010) for the appropriate ERICA Tier level, including as necessary comparison of the results with the reference level of 10 µGy/h.

Dust deposition

Passive dust monitoring data for FY19 indicated an average project-originated (after background subtraction) ^{238}U deposition rate of 0.48 Bq/m²/yr. Passive dust (PD) monitoring sites PD1, PD4, PD8 and PD13 were used for this assessment (Figure 55), with site PD14 used as the background site. The results, shown in Table 18, are well below the criterion of 25 Bq/m²/yr.

Table 18: FY19 - Project originated dust and ^{238}U deposition

	Project Originated Total Dust Deposition* (g/m²/y)	Project Originated ^{238}U Deposition* (Bq/m²/y)	Compliance Criteria (Bq/m²/y)
PD1	-	2.30	25
PD4	1.01	0.03	25
PD8	-	0.57	25
PD13	-	0.21	25

* Cells left blank indicate that the results was less than background measurement

Dose rate reference level

The ERICA software tool (v1.2.1) was used to assess the significance of measured radionuclide dust deposition data, with a Tier 2 analysis conducted for all default terrestrial organisms. Table 19 shows the results of the ERICA analysis. It can be seen that dose rates for all organisms are less than 1 % of the reference dose level of 10 µGy/h.

The risk quotient is a unit-less measure that compares the calculated NHB dose rate with the reference dose level.

Table 19: FY19 Erica screening dose level and risk quotients

Organism	Total Dose Rate (µGy/h)	Reference Level (µGy/h)	Risk Quotient
Bird	3.842E-04	10	3.842E-04
Grasses & Herbs	3.081E-03	10	3.081E-03
Mammal - small-burrowing	8.567E-04	10	8.567E-04
Mammal - large	8.276E-04	10	8.276E-04
Reptile	1.049E-03	10	1.049E-03
Shrub	4.439E-03	10	4.439E-03
Tree	4.932E-04	10	4.932E-04
Lichen & Bryophytes	2.021E-02	10	2.021E-02

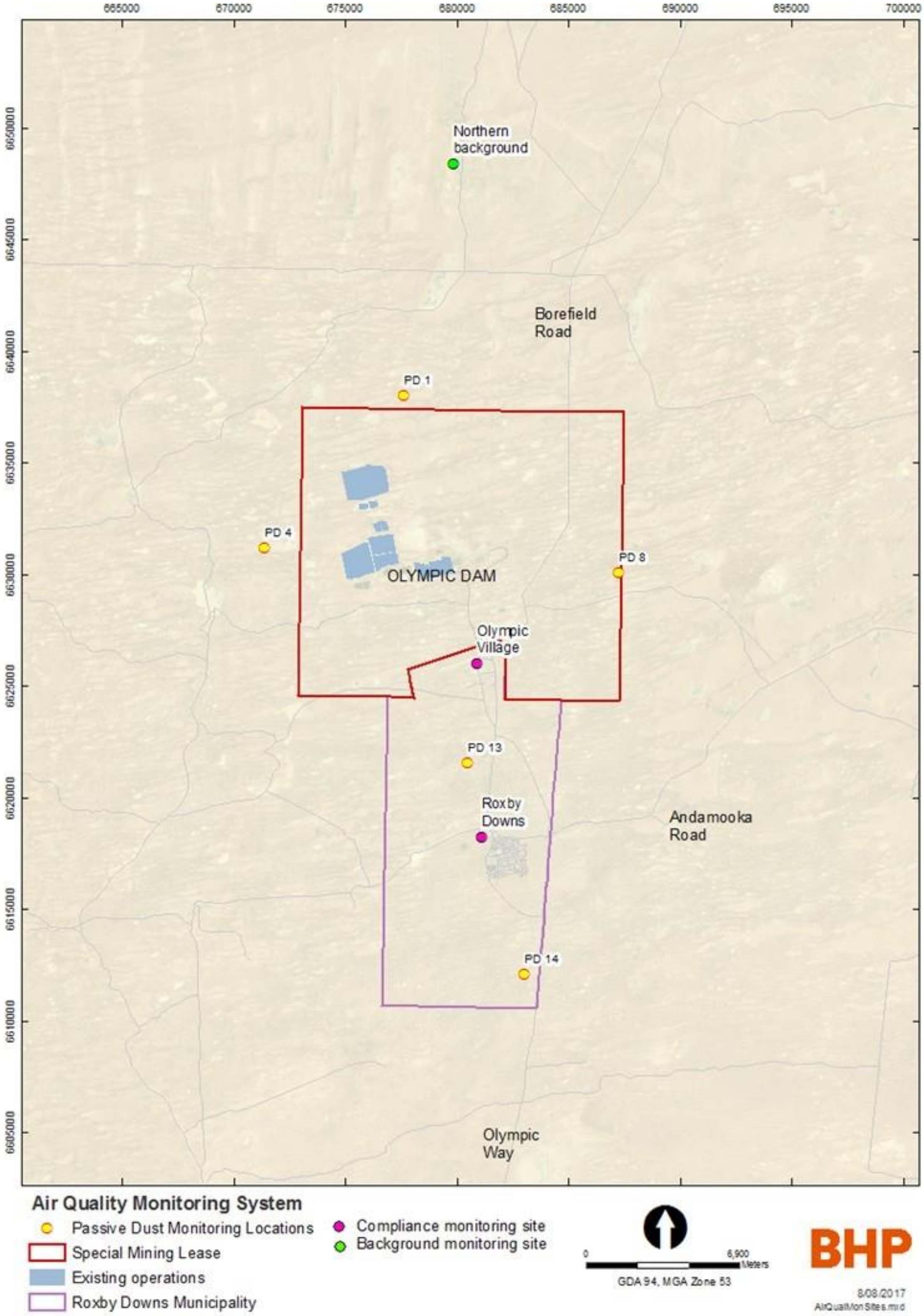


Figure 55: Location of dust deposition monitoring sites

3.4.6 Deliverables (ER 2.4)

A database of radionuclide concentrations in the environment over the long-term.

A database of radionuclide concentrations in has been maintained since 2005. Figure 49 to Figure 53 show the monthly trends of radionuclide concentration at RDMS and OVMS.

3.4.7 Targets FY19

Maintain radiation doses as low as reasonably achievable, social and economic factors taken into account, as assessed through the annual Radiation Management Plan review.

The results of the monitoring program have shown operational contributions to radiation dose for members of public to be extremely low being less than 5% of the public dose limit of 1mSv/yr.

3.4.8 Actions FY19

None applicable.

3.5 Greenhouse gas emissions

3.5.1 Environmental Outcome

Contribute to stabilising global atmospheric greenhouse gas concentrations to minimise environmental impacts associated with climate change.

BHP's climate change strategy focuses on reducing our operational greenhouse gas (GHG) emissions, investing in low emissions technologies, promoting product stewardship, managing climate-related risk and opportunity and working with others to enhance the global policy and market response. As a BHP group asset, ODC operates under the BHP group strategy.

3.5.2 Compliance criteria

Progress on OD GHG reduction and abatement opportunities that contribute to BHP strategy and response to climate change, reported annually.

As a major energy consumer, managing energy use, ensuring energy security and reducing GHG emissions at operations are key components of BHP's climate change strategy.

In FY2018, BHP began working towards a new five-year GHG emissions reduction target. Our new target, which took effect from 1 July 2017, is to maintain our total operational emissions in FY2022 at or below FY2017 levels while we continue to grow our business. Our new target builds on our success in achieving our previous five-year target which was to maintain GHG emissions at or below our 2006 adjusted baseline.

In addition to our five-year target, we have set the longer-term goal of achieving net-zero operational GHG emissions in the latter half of this century, consistent with the Paris Agreement.

See section 3.5.4 for a discussion of emission reduction opportunities and achievements.

3.5.3 Deliverables (EG 2.1)

Calculation of the site-wide GHG emission intensities, expressed as carbon equivalent intensity (kg CO_{2-e}/t milled).

GHG emissions were calculated using the National Greenhouse and Energy Reporting guidelines and emissions intensity was calculated and reported internally within BHP in line with monthly corporate reporting requirements. The calculated GHG emission intensity in FY19 was 84.4 kg CO_{2-e}/t ore milled, compared to 83 kg CO_{2-e}/t ore milled in FY18. The higher intensity primarily reflects reduced efficiencies due to the major acid plant outage in the first quarter of the financial year. Upon return to production Q2-Q4 performance was greatly improved, averaging 77.6 kg CO_{2-e}/t ore milled for the nine months.

Table 20: FY19 GHG emissions and intensity

Total emissions (kt CO_{2-e})	Scope 1 (kt CO_{2-e})	Scope 2 (kt CO_{2-e})	GHG intensity (kg CO_{2-e}/t ore milled)
672.3	202.8	469.5	84.4

3.5.4 Deliverables (EG 2.2)

•An annual report on progress on OD GHG reduction and abatement opportunities that contribute to BHP strategy and response to climate change.

BHP has announced a five-year, US$400m Climate Investment Program to develop technologies to reduce emissions from its own operations as well as those generated from the use of its resources.

This Program is aligned with BHPs strategy to develop emerging and deploy existing technologies that make step-change reductions in GHG emissions, as well as our GHG emissions targets and goals. BHP will also establish a new medium-term, science-based target for scope one and two emissions in line with the Paris Agreement. This is in addition to BHP's short-term goal to cap 2022 emissions at 2017 levels, and long-term goal of net-zero emissions by mid-century. The medium-term target will be consistent with the pathway to net-zero emissions for BHPs long-life assets. This requires planning for the long term and a deep understanding of the development pathway for low emissions technologies.

BHP has a suite of initiatives currently underway aimed at achieving reductions across its major operational emissions sources:

- Zero-carbon electricity supply: emissions from electricity use make up 42 per cent of BHPs operational emissions[1]. This includes both the power we generate ourselves and the power we buy from grids around the world. BHPs strategy seeks to accelerate the transition to lower carbon sources of electricity while balancing cost, reliability and emissions reductions.

- Zero-carbon material movement: emissions from fuel and distillate make up 42 per cent of BHPs operational emissions, primarily from the consumption of diesel in the course of material movement (for example haul trucks). BHPs strategy is to accelerate and de-risk technologies and innovations that can transition operations over time to alternate fuels and greater electrification of mining equipment and mining methods.

- Fugitive emissions: fugitive methane emissions from BHPs petroleum and coal assets make up 15 per cent of our operational emissions. BHPs strategy is to pursue innovation in mitigation technologies for these emissions, which are among the most technically and economically challenging to reduce.

In evaluating low emissions technology investment opportunities, we:

- consider technologies with the potential to deliver results across a range of time horizons;

- emphasise investments that can deliver material GHG savings;

- consider the ability of projects and technologies to leverage our global Operating Model (replicability, scale and market breadth);

- evaluate the potential for building capacity, capability and internal awareness across our business.

As well as helping us to reduce our own emissions, lessons from our low emissions technologies projects will be shared with others in our sector and more broadly. For example, we are participating in the Lakeland Solar and Storage Project, a three-year knowledge sharing partnership to demonstrate connecting large-scale battery storage to a fringe-of-the-grid solar project in regional Queensland, Australia. Outcomes of an extensive test program at Lakeland will provide insight for BHP and the resource sector with respect to security of energy supply. We are also working in collaboration with Australia's national research agency, CSIRO, to scope a project designed to determine the viability of measuring fugitive methane emissions in near real time from open-cut coal mining environments.

Olympic Dam relies on diesel equipment for development, production, ore handling and mine services. A trial is underway to deploy light electric vehicles (LEVs) powered by lithium ion batteries in Olympic Dam's underground fleet.

Data will be collected on the performance, power supply, maintenance support requirements, vehicle utilisation (charging time) and corrosion resistance of the vehicles during the 12-month trial period.

As well as reducing GHG emissions, LEVs can also lower operating costs and reduce worker exposure to diesel particulate matter (DPM). The trial is part of a broader initiative aimed at reducing DPM exposure to the lowest level technically feasible, in accordance with our occupational exposure limit.

A decision will ultimately be made on the full roll-out of LEVs to Olympic Dam's underground fleet. Knowledge gathered during the trial will also be shared within BHP to identify opportunities to accelerate the deployment of LEVs to reduce GHG emissions, DPM exposure and costs across our business.

A community of practice has been established to facilitate effective knowledge sharing. Additional studies are underway to assess the feasibility of electrifying other types of vehicles and mobile equipment, including at the Broadmeadow underground coal mine in Queensland, the Jansen Potash Project in Canada and at Western Australia Iron Ore.

For Olympic Dam over 65% of total emissions are from electricity, resulting in actual emissions being heavily influenced by the South Australian Electricity Emissions Factor that is used to calculate emissions. Similarly, actual emissions will be influenced by the strategy adopted for pursuit of group wide emissions targets.

3.5.5 Leading Indicators

- None applicable

3.5.6 Targets FY19

- None applicable

3.5.7 Actions FY19

- None applicable.

4 Generation of industrial wastes

4.1 Embankment stability of TSF

4.1.1 Environmental Outcome

No significant TSF embankment failure.

During FY19 the Tailings Storage Facilities (TSFs) were managed in accordance with the TRS Operations, Maintenance and Surveillance Manual (BHP Olympic Dam 2018d) and the Tailings Management Plan (BHP Olympic Dam 2018e) and no embankment failures of any magnitude occurred.

4.1.2 Compliance Criteria

No significant radioactive contamination arising from uncontrolled loss of radioactive material as a result of an embankment failure to the natural environment.
NOTE: Any embankment failure that leads to a reportable spill under the Bachmann Criteria will be considered significant. Significant is defined as requiring assessment and remedial action in accordance with the NEPM or EPP and the Mining Code. Measurement and monitoring is carried out in response to a specific event.

No uncontrolled loss of radioactive material to the natural environment as a result of an embankment failure occurred during FY19. To manage the risk of embankment failure, the rate of rise was maintained below 2 m per annum and the supernatant pond area was maintained below the 71 ha target set for this purpose.

4.1.3 Leading Indicators

Rate of rise of tailings at an average of 2 m per annum or less.

The rate of rise of tailings has been limited to 2 m per annum or less for all cells to ensure consolidation of tailings material. During the reporting period, tailings were distributed to TSF Cells 4 and 5 with an average rate of rise of the perimeter tailings beach of 0.92 m per annum with TSF4 and TSF5 at 0.91 m and 0.93 m per annum respectively.

The rate of rise of pore pressures within or adjacent to the TSF embankment is less than or equal to the rate of rise of tailings.

Assessing pore pressure against rate of rise provides an indication if excess pore pressures are developing in the embankment. The rise in phreatic level at VWP locations over the past year is less than or equal to the average rate of rise in tailings. Note is made this excludes VWPs that received loading from the buttress construction. A response equivalent to the buttress loading was noted in these VWPs.

The maximum supernatant pond area of individual TSF cells does not exceed 15ha for TSF1, 23ha for TSF2/3, 90ha for TSF4 and 135ha for TSF5.
Note: Each TSF has been assigned a maximum supernatant pond size which is calculated using critical operating parameters, surface contours and an allowance for significant rainfall events. Operating beyond these ponds sizes may not result in embankment failure but are considered an appropriate leading indicator in which operational processes should be reviewed.

The supernatant ponds are visually checked against marker poles daily, estimated monthly and confirmed by satellite quarterly. Over the period the recorded pond sizes have been below the leading indicator sizes.

4.1.4 Deliverables (WA 2.1)

The tailings stored at the TSF have a concentration over the 10 Bq/g exemption limit and also a total activity over the 10,000 Bq exemption limit for Radium, which defines it as a radioactive material under ARPANSA guidelines.

Monitoring of the TSF, including rate of rise of tailings, supernatant pond area, and pore pressure all contribute to management of the TSF to ensure no uncontrolled loss of radioactive material to the natural environment or significant embankment failure.

Monitoring data showing the size and location of the supernatant liquor ponds in each TSF cell on a monthly basis (EPA 31543.500-433).

Large supernatant liquor ponds have the potential to impact upon embankment stability by increasing the phreatic surface within the tailings and embankments, which in turn can lower the strength of the tailings and embankment materials. The TSF pond areas during FY19 are shown in Figure 56. The ponds have been consistent in size, reflecting the low rainfall over this period (<50% of average).

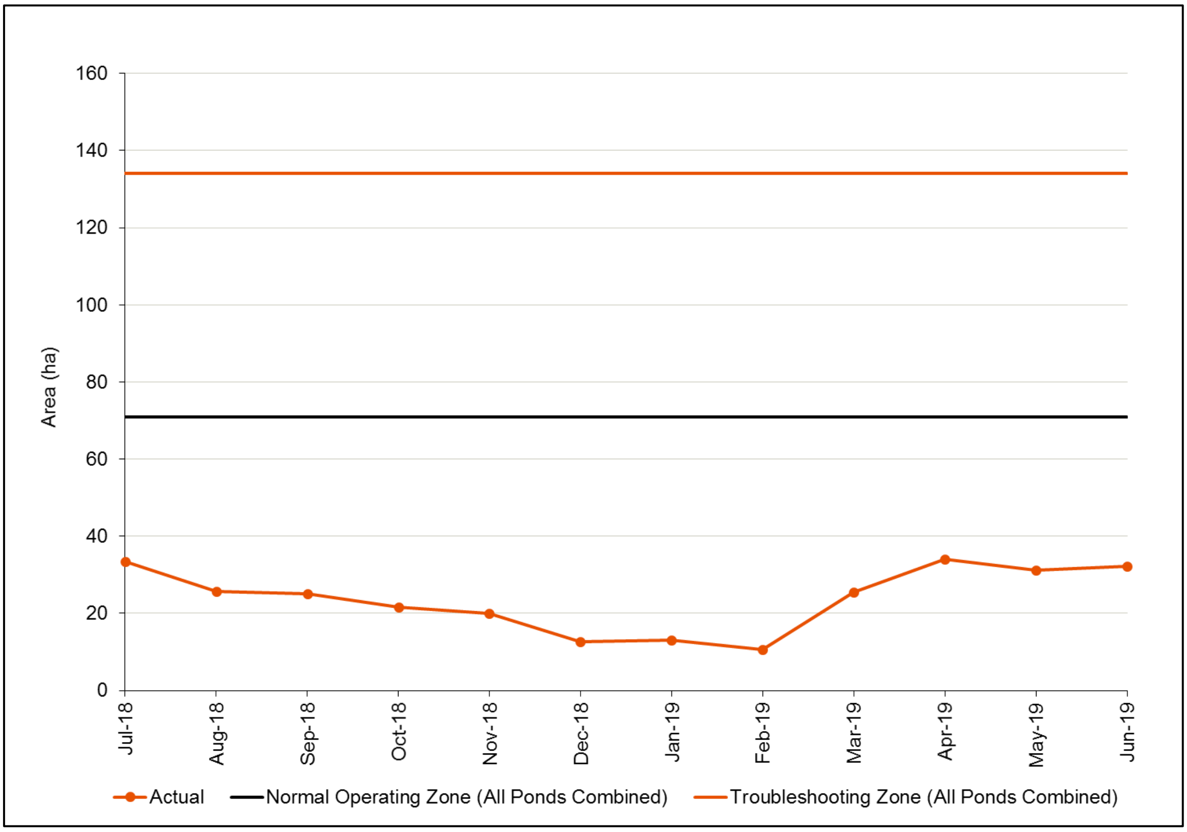


Figure 56: TSF Pond areas (ha) for FY19.

Monitoring data showing the rate of rise of tailings in each TSF cell.

At current processing rates, approximately 8 - 9 Mtpa of tailings, containing low levels of radioactivity are disposed of in the TSFs annually.

The rate of rise of tailings has been limited to 2 m per annum or less for all cells to ensure consolidation of tailings material. During the reporting period, tailings were distributed to TSF Cells 4 and 5 with an average rate of rise of the perimeter tailings beach of 0.92 m per annum. This is a reduction on previous years, in part due to the reduction in production resulting from the acid plant outage.

Tailings delivery to TSF Cell 4 prior to 2003 was biased towards the internal east wall as the availability of this wall for tailings deposition was largely unaffected by wall-raising activities, resulting in a higher beach level when compared to the external wall. A plan was initiated in 2003 to address this issue and bias the tailings delivery to TSF Cell 4 external walls. For FY19, the rate of rise along Cell 4 east wall decreased to 0.69 m from 0.92 m. This is in part related to the timing of the raises, with a wall raise occurring after the acid plant outage, meaning that the wall received less tailings than other walls.

No significant impacts have resulted from the difference in height between the internal east wall and external walls of TSF Cell 4. This issue will continue to be addressed by the program of reduced deposition to the east wall, gradually bringing it in line with other walls.

The elevation of tailings in the cells illustrated in Figure 57 gives an indication of the rate of rise of the perimeter tailings beaches.

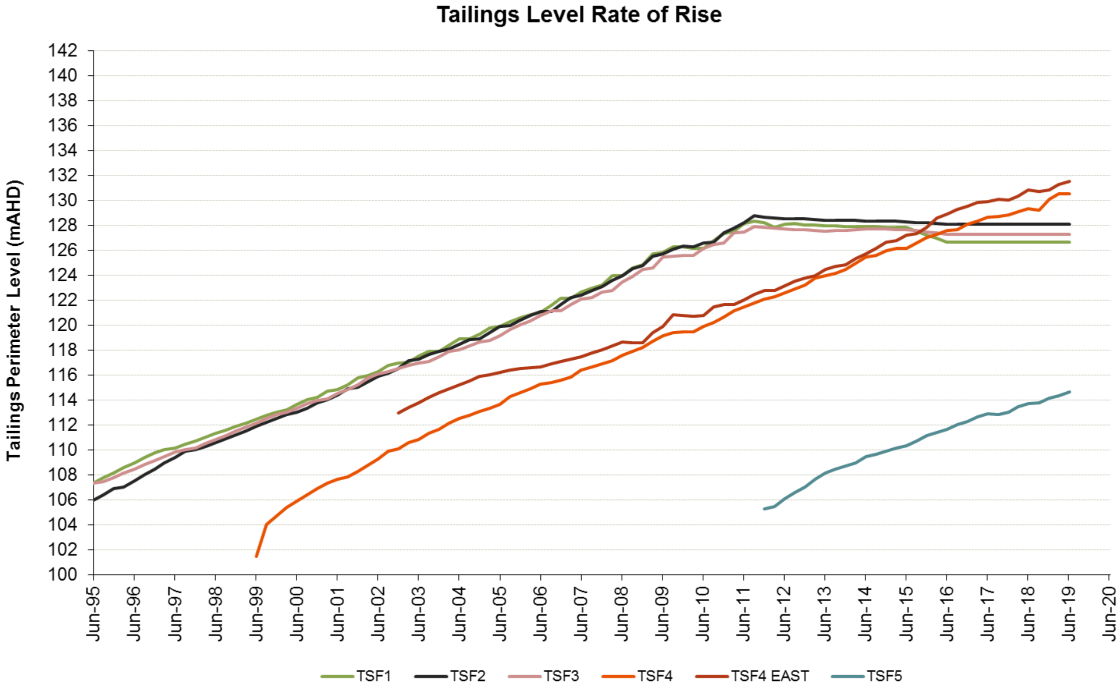


Figure 57: TSF rate of tailings rise.

Monitoring data showing the pore pressures within tailings adjacent to the external walls of the TSF.

Piezometers are monitored to assess the pore pressures within the tailings adjacent to the embankments of the TSFs. Piezometers installed at critical cross sections are monitored 3-weekly, whilst all other piezometers are monitored on a 9-weekly basis. Piezometers used include standpipe and vibrating wire piezometers.

ANCOLD provides minimum Factors of Safety (FoS) for different loading conditions. Results of the stability analysis undertaken in FY19 (SRK, 2018) indicated that the FoS for current geometries of Cell 1-3 and Cell 5 (cell 4 was reported separately) meet or exceed the minimum levels recommended by ANCOLD. As TSF5 embankment increases in height, the FoS drops, and additional stability measures (as have been applied to TSF4) may be required. The timing of these additional measures is currently being investigated.

In 2016, a routine stability assessment indicated the FoS for Cell 4 was lower than the minimum values, and prompted the TSF4 buttress programme. The initial stage provided for embankment stability to RL 131 m; this stage was completed in October 2017. The next stage provided for the next 5 raises (to RL 136m) and was completed in October 2018. This included areas that had previously been left exposed due to infrastructure constraints.

Table 21: Stability Analysis Results (SRK, 2018)

Wall Section	Static Loading FoS (min – 1.5)	Post-Seismic FoS (min – 1.0)
Cell 2/3 East Wall	RL 130.5 m: 1.58	1.22
Cell 4 North Wall	RL 136* m: 1.85	1.3
Cell 4 West Wall	RL 136* m: 1.77	1.2

Cell 4 South Wall	RL 136* m: 1.78	1.2
Cell 5 North Wall	RL 115 m: 1.52	1.41
Cell 5 East Wall	RL 115 m: 1.69	1.58
Cell 5 South Wall	RL 115 m: 1.78	1.66
Cell 5 West Wall	RL 115 m: 1.71	1.47

* TSF4 assessment used finite element modelling and considered final heights.

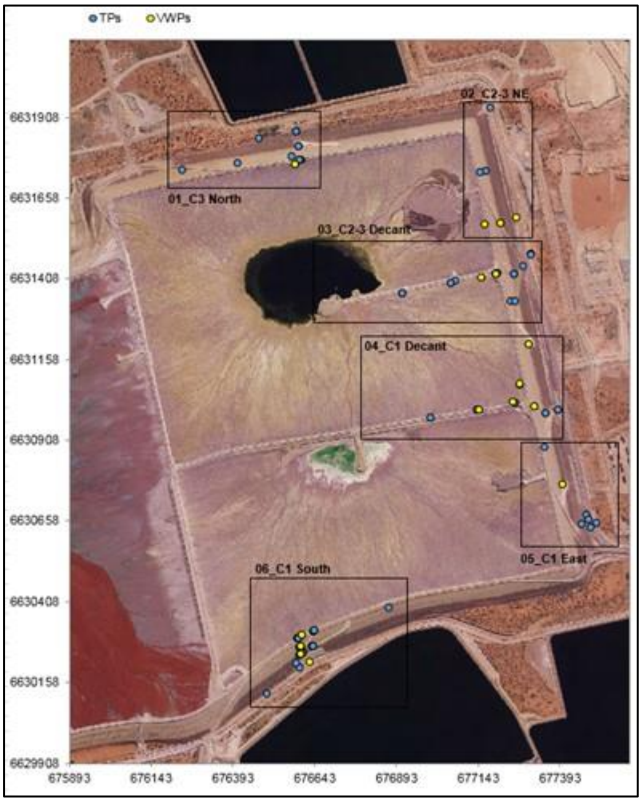


Figure 58: TSF 1-3 piezometer locations

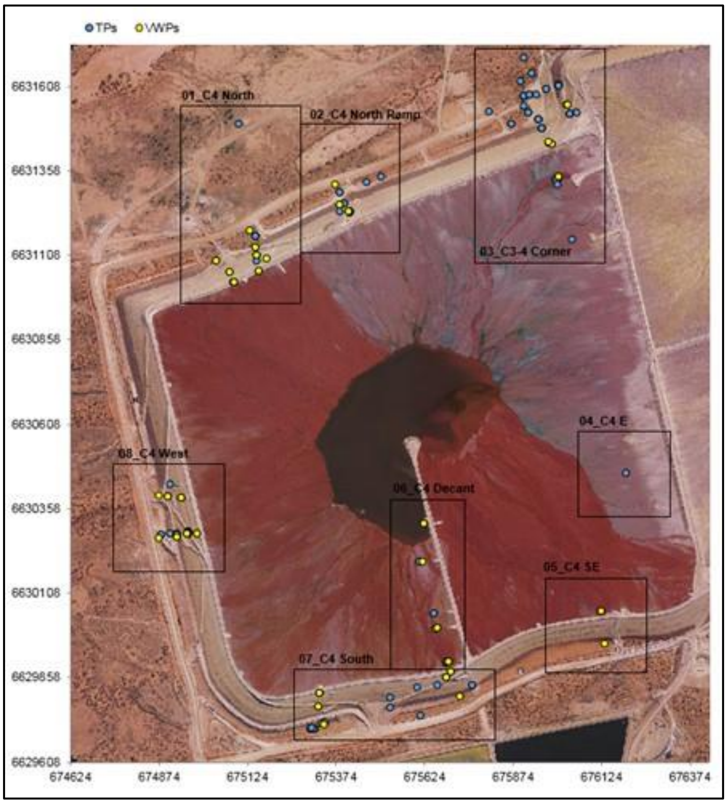


Figure 59: TSF 4 piezometer locations

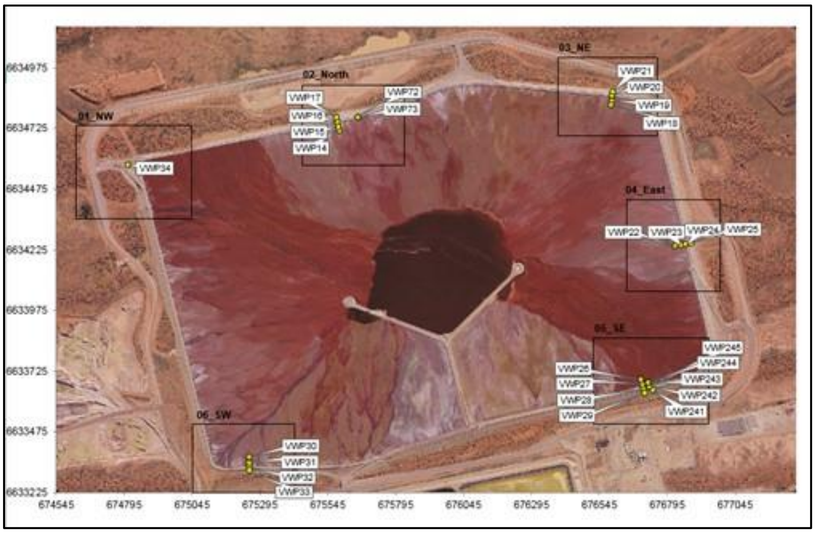


Figure 60: TSF 5 piezometer locations

Piezometers located in the East, North & South Wall of TSFs 1-3 generally show a gradual pressure drop consistent with the cessation of tailings deposition in October 2011. For example, the variation of VWP readings along East & South walls of TSF 1 are shown in Figure 61 and Figure 62. Note, negative pore pressures have been excluded.

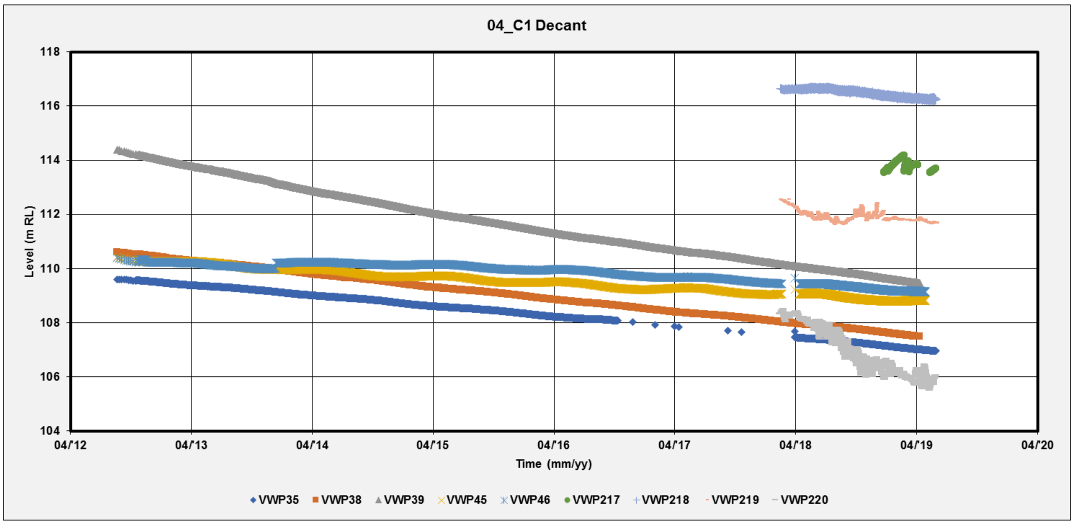


Figure 61: TSF 1 East Wall VWP readings

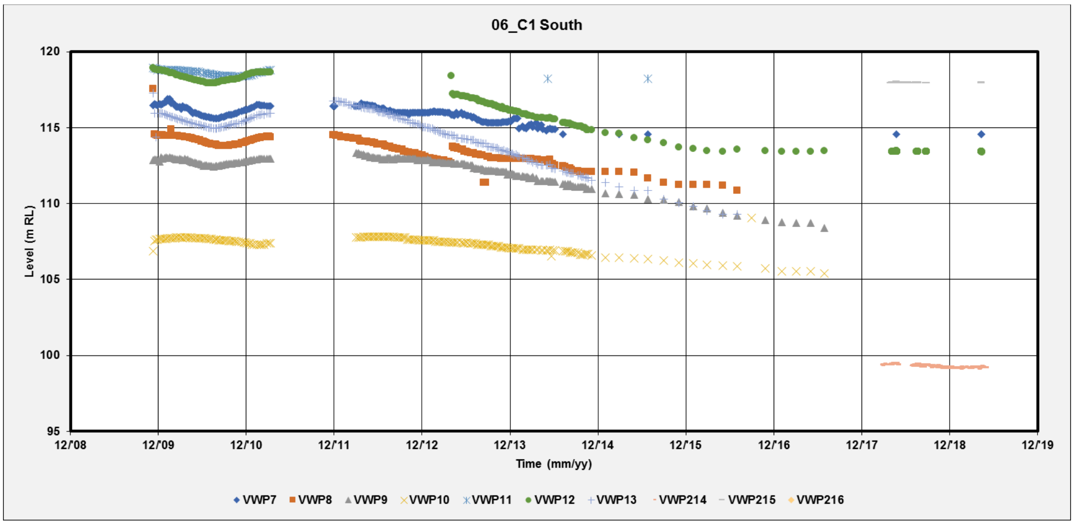


Figure 62: TSF 1 South Wall VWP readings

Piezometers installed in the tailings and upper embankment of TSF 4 show levels have been relatively constant over the period. The buttress construction resulted in increases in those piezometers that received additional loading from the buttress. The extent to which each VWP received the loading from the buttress varied. This can be seen in Figure 63 and Figure 64 below where steps in the data can be discerned within the gradual rising trend due to ongoing tailings deposition.

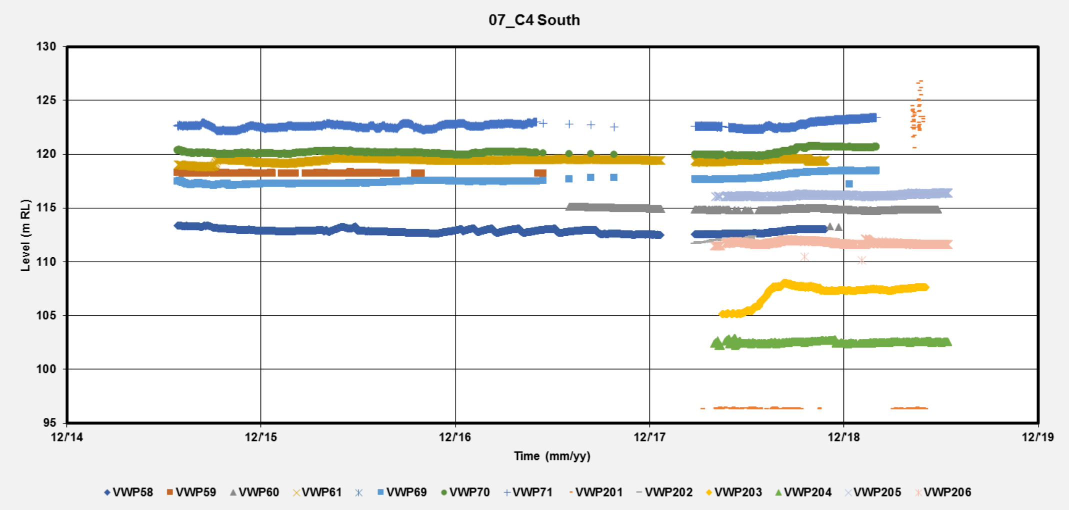


Figure 63: TSF 4 South Wall VWP readings

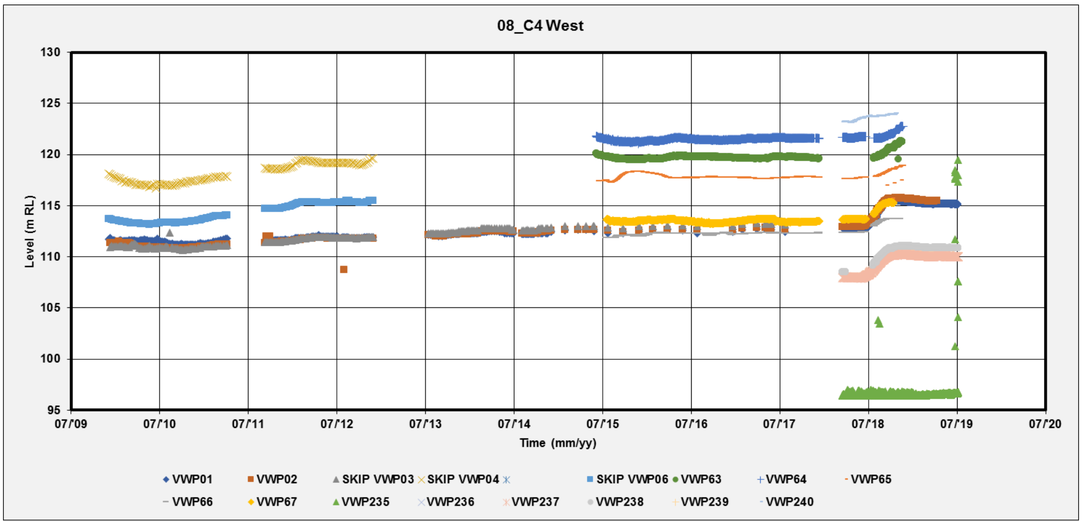


Figure 64: TSF 4 West Wall VWP readings

Piezometers installed in the tailings and upper embankment of TSF5 show levels have been relatively constant over the period, with minor fluctuations. A very gradual increase can be discerned, which is as expected as tailings continue to be added in this TSF. For example, the variation of VWP readings along TSF 5 South-East & North-East walls are shown in Figure 65 and Figure 66.

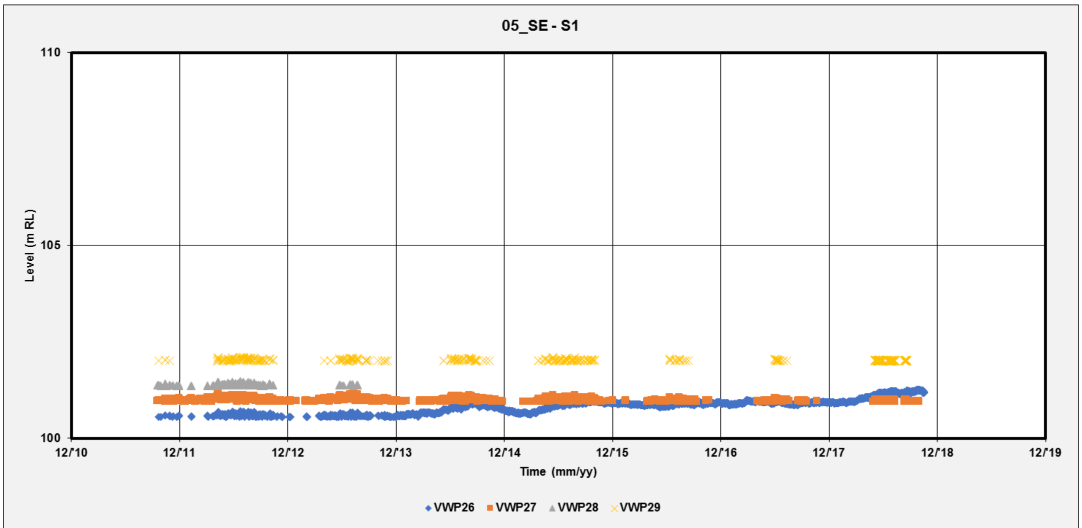


Figure 65: TSF 5 South East side VWP readings

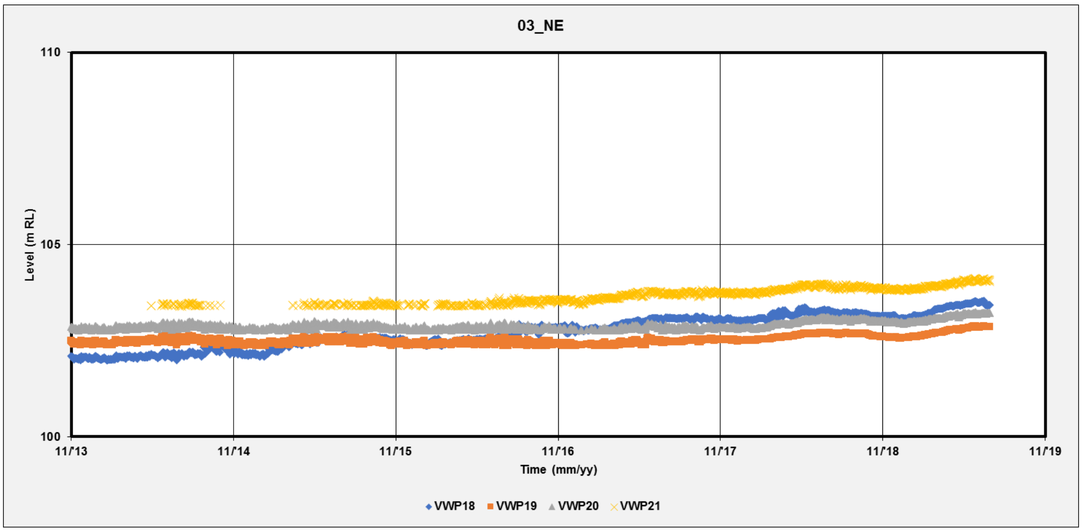


Figure 66: TSF 5 North East side VWP readings

During FY19 the TRS was reviewed by SRK, with two 6-monthly operational reviews of the TRS and one annual comprehensive review covering the period July 2017 - June 2018.

The reviews were carried out in accordance with BHP TSF Management Guidelines and ANCOLD Guidelines. All reviews confirmed that the Tailings Retention System, including the Tailings Storage Facilities and Evaporation Ponds, are in good condition and are well managed.

A review of the water balance on an annual basis (EPA 31543.500-435).

See section 4.2 Tailings seepage.

4.1.5 Targets FY19

None applicable.

4.1.6 Actions FY19

Undertake periodic (2-3 year) CPTu testing of tailings to confirm strength parameters used in stability analysis.

CPTu testing of all the TSFs was undertaken in August 2018. The results were used by SRK to assess the stability (reported above).

4.2 Tailings seepage

4.2.1 Environmental Outcome

No significant adverse impact on vegetation as a result of seepage from the TSF.

No significant adverse impact to vegetation as a result of seepage from the TSF has occurred. Eighty metres AHD (20 m below ground level) is considered as the level below which groundwater cannot interact with the root zone of plants in the Olympic Dam region. Groundwater levels in the vicinity of the TSF remain below 80 mAHD.

No compromise of current and future land uses on the Special Mining Lease (SML) or adjoining areas as a result of seepage from the TSF.

No compromise of current and future land uses on the SML or adjoining areas has occurred. Groundwater levels in the vicinity of the TSF remain below 80 mAHD and sampling indicates that seepage is being attenuated.

No compromise of the environmental values of groundwater outside the SML as a result of seepage from the TSF.

No compromise of the environmental values of groundwater outside the SML has occurred. Sampling indicates that seepage is being attenuated within the SML, and groundwater levels of bores along the SML are consistent with other regional bores. Seepage modelling has been updated to demonstrate that there are no expected future offsite impacts.

4.2.2 Compliance criteria

Maintain groundwater level (attributable to seepage from the TSF) outside the external perimeter road of TSF Cells 1 to 5 to not higher than 80 mAHD (20 m below ground level).

Groundwater monitoring results indicate that the groundwater level has not reached a level higher than 80 mAHD beneath TSF Cells (refer Figure 7 in section 1.2 – Aquifer Level Drawdown). The maximum groundwater level recorded below the TSF for the current reporting period was 67.47 mAHD at LT67.

All TSF seepage attenuated within the SML, as demonstrated by a numerical geochemical model confirmed by monitoring.

Geochemical modelling was carried out for the Expansion EIS (BHP Billiton Olympic Dam 2009) and demonstrated that all TSF seepage would be attenuated within the SML. This modelling was updated in 2015 (SRK 2015) to account for the current mine configuration (underground only) following the suspension of the Olympic Dam Expansion. Within the timeframe assessed (10,000 years), the modelling results indicate that no impacts on baseline groundwater quality at the mine lease boundary (SML) would be expected as travel times are predicted to be well beyond this timeframe and there is expected to be significant attenuation of pollutants within the SML.

Laboratory analysis of on-site and regional groundwater monitoring bores confirms the attenuation of TSF seepage within the SML. Samples from regional monitoring bores contained analytical concentrations either below limits of reporting, or within concentrations previously reported (see Chapter 1.3 - Aquifer Level Drawdown).

Groundwater levels of bores on the SML boundary are consistent with other regional bores. This seepage attenuation is demonstrated in Figure 17 in section 1.2 - Aquifer Level Drawdown, which shows water levels (AHD) from the perimeter of the TRS decreasing with distance from the TRS towards the SML boundary, to the same level as other regional bores.

4.2.3 Leading Indicators

A measurement of groundwater level outside the external perimeter road of the TSF that exceeds 70 mAHD (30 m below ground level) as a result of seepage.

The leading indicator value was not reached. The maximum groundwater level recorded below the TSF for the current reporting period was 67.47 mAHD at LT67.

A numerical geochemical model trend that indicates that all TSF seepage may not be attenuated within the SML should the trend continue.

No geochemical seepage trend was noted. Laboratory analysis of on-site and regional groundwater monitoring bores, when combined with groundwater level data, confirms the validity of the 2015 geochemical modelling (SRK 2015) findings that all TSF seepage would be attenuated within the SML.

4.2.4 Deliverables (WA 2.1)

A review of the water balance on an annual basis (EPA 31543.500-435).

The water balance for TSF Cells 4 and 5 indicates that evaporation to dispose of liquor is approximately 45% of the total inputs. This is slightly higher than previous years, although in line with longer term values.

Unaccounted liquor includes input liquor shown in Figure 67 (tailings liquor, rainfall, flushing liquor, and the decrease in supernatant pond inventory) minus liquor retained in tailings (moisture content assumed of 30 % by weight), liquor decanted to evaporation ponds, and estimated seepage from (supernatant liquor) ponds. Flushing liquor is liquor pumped out of the evaporation ponds to the TSF for the purpose of flushing lines and to enhance evaporation.

The total output liquor volume is equal to input liquor volume and is shown in Figure 68**.** Seepage from pond areas has been calculated based on the average supernatant pond areas for TSF Cells 1 – 5 (23.5 ha) and assumed tailings permeability ($2x10^{-8}$ m/s). Liquor retained in tailings was assumed to be 30 % of the weight of tailings solids deposited. This was based on previous testing of in-situ tailings.

The water balance shows 5 % of liquor input due to rainfall in FY19, with a continued trend of lower than average rainfall (< 50% of average rainfall).

A discussion on groundwater levels in the vicinity of the TSF in FY19 is provided in section 1.2 - Aquifer Level Drawdown.

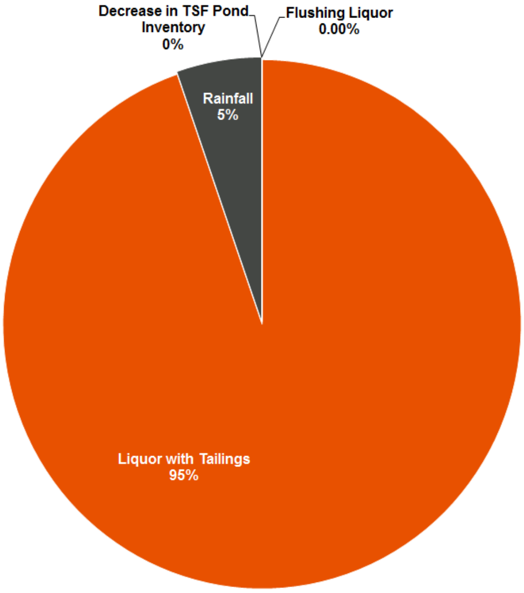


Figure 67: TSF Cells 4 & 5 Liquor Balance – Inputs FY19

Note: Liquor Inputs [Total 7,209 ML]

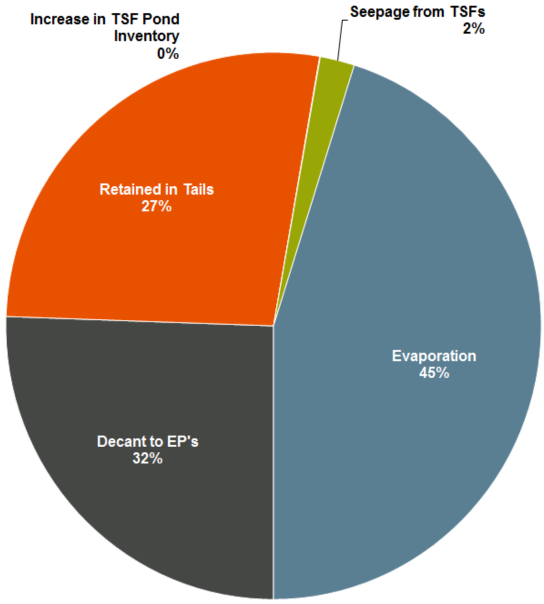


Figure 68: TSF Cells 4 & 5 Liquor Balance – Outputs, FY19

Note: Liquor Outputs [Total 7,209 ML]

4.2.5 Deliverables (WA 2.2)

Monitoring data showing the liquor level in each cell of the EPs.

Figure 69 shows the liquor levels in the evaporation ponds with respect to freeboard limits. Freeboard in the Evaporation Ponds (EPs) consists of allowances for wind, waves and rainfall runoff.

Levels in EP5B have remained low, with the pond out of service over the period. EP3 was brought back into service at the end of the period, following completion of the wall raise. EP1 is close to the limit of its capacity, and is used primarily for evaporation area. EP2 solids level is at freeboard limit, and only receives occasional seepage flow pumped from the collection systems on the east side of TSF1 and 2, and pigging flows.

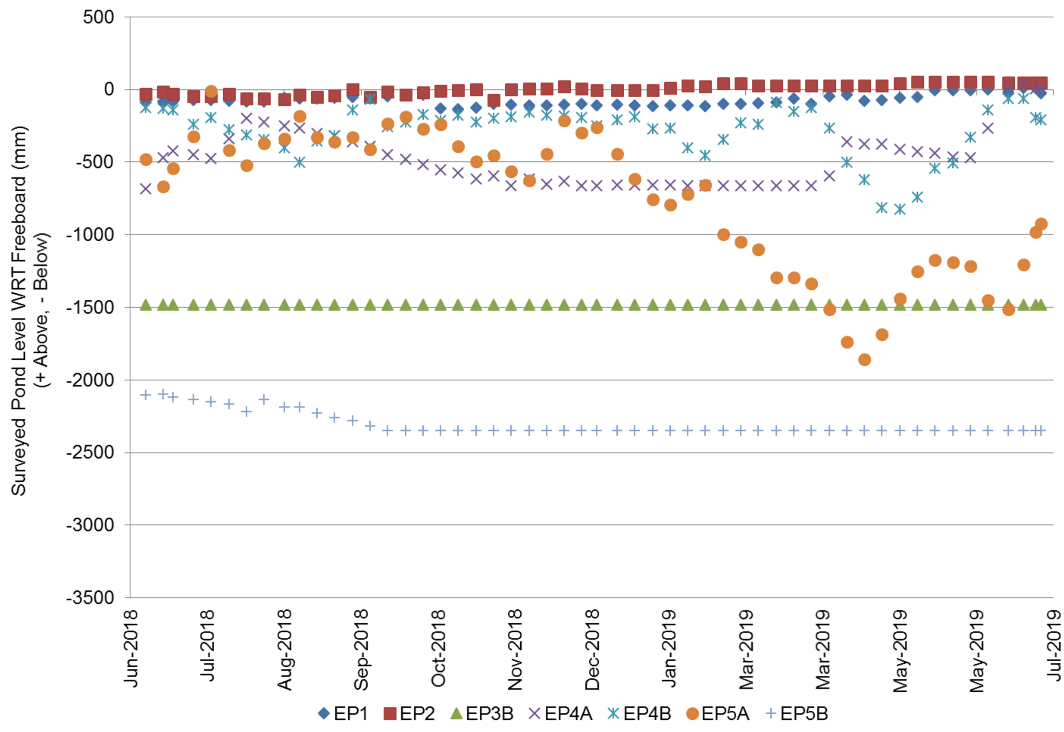


Figure 69: Evaporation Pond Liquor Levels.

Monitoring data showing the overall (solids and liquor) inventory in the EPs.

Figure 70 shows the evaporation pond capacity in relation to the normal maximum operational storage capacity. Additional pond capacity is available as a contingency to allow for large rainfall events.

Reported liquor inventory in the evaporation ponds as a proportion of storage capacity was higher than normal throughout the reporting period. This was due to a variety of factors including the removal of EP5B from its current limited service by the end of the winter period. However the completion of EP3 refurbishment and return into active service has provided additional capacity, moving the overall volume into normal operating levels.

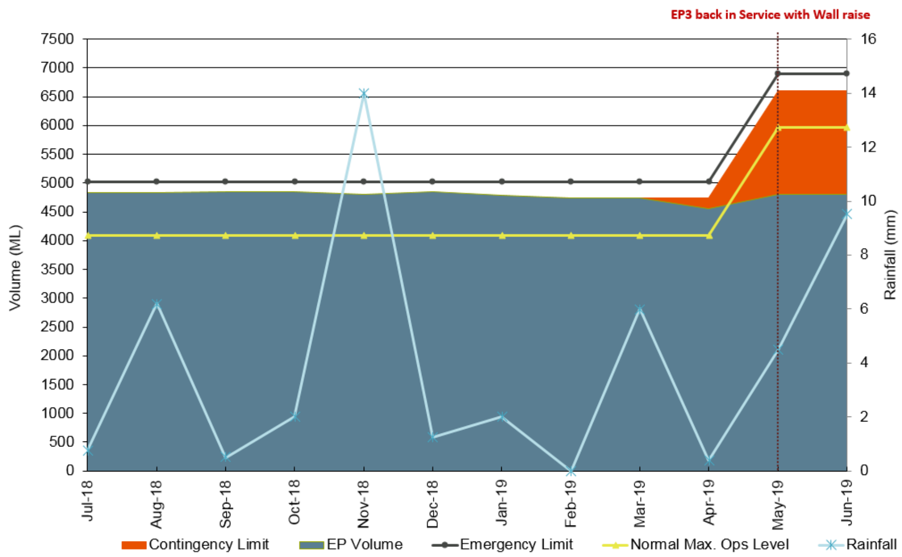


Figure 70: Evaporation pond capacity and rainfall.

Results of a liquor balance for each EP cell.

Figure 71 shows the cumulative evaporation trends for all Evaporation Ponds. A liquor balance is performed to highlight cells with potential significant leaks by comparison of the apparent evaporation from each cell of each EP. The comparison is carried out on a monthly basis. The evaporation response for each cell is broadly consistent, demonstrating that significant unexplained losses have not occurred. Variations between each pond can be attributed to usage, and the overall evaporation loss is consistent with previous years.

EP4B and 5A showed the highest evaporation rates, however this is consistent with higher usage than the other ponds, and in line with previous years. EP4A and EP1 were used sporadically over summer, and this is shown with reduced evaporation over this period.

Evaporation cells occasionally dry out when the free liquor is evaporated, exposing the surface of the precipitated solids built up in the cell. During these periods a liquor level is not able to be measured and the cumulative evaporation trends level out. Under these circumstances the water balance method is no longer effective in confirming cell integrity. However, as the cell is inactive there is minimal, if any, free liquor available and therefore very little potential for significant seepage from these cells.

EP1 and EP2 were used sporadically during the reporting period. EP3 was out of service for a majority of the period, entering service in May. Filling commenced during that period, but made little impact on evaporation levels. EP5B was in limited use during the period.

Groundwater level data collected in and around the ponds is used as an additional control to detect seepage from the Evaporation Ponds (discussed in more detail in Chapter 1.3 Aquifer level drawdown) and to support the liquor balance calculations.

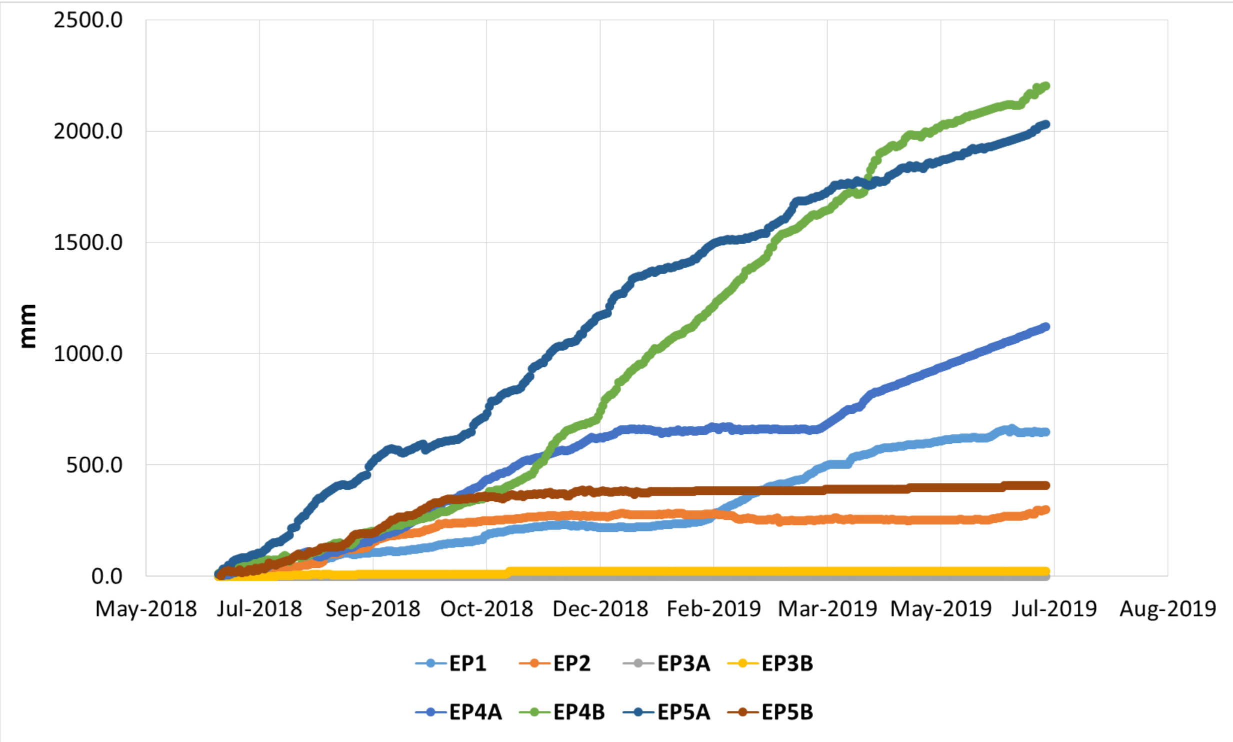


Figure 71: All EP Liquor Balance – cumulative apparent evaporation.

4.2.6 Targets FY19

- None applicable

4.2.7 Actions FY19

Identify and install additional liquor interception systems as required.

A filter blanket, drain and pumping system was installed along the eastern wall of TSF3 (Locations 23 North and South). This transfers liquor directly to EP4. This was installed at the end of the period, and commissioned in FY 20.

An interception trench was installed along the west side of TSF5 at location 21. Currently this is a temporary measure while a permanent system is being designed.

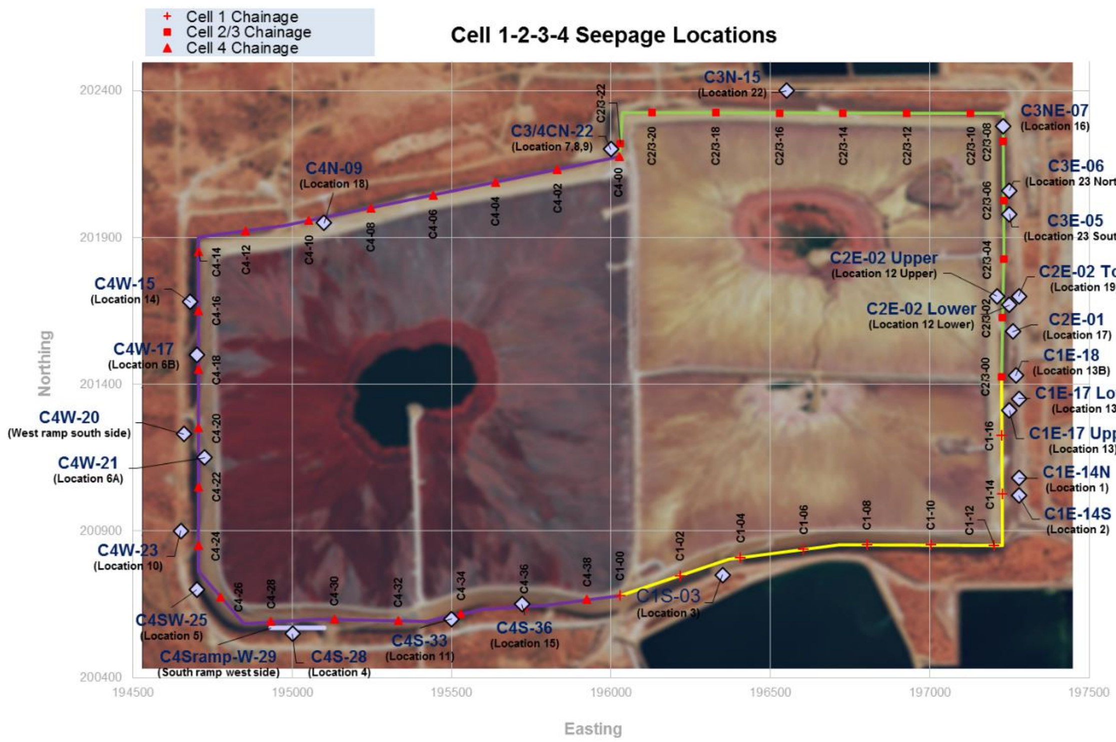
The assigning of seepage locations is being phased out, as we move to a different identifier system based on location. The installation of the buttress along TSF4 meant that a number of the historical seepages are now covered. These have been removed from the areas that are actively monitored. The buttress incorporated outlet drains that are monitored regularly.

A summary of locations of interest is shown in Table 22 with locations shown in Figure 72. Two new seepage areas were identified during the period.

Table 22: List of monitored perimeter features.

Identifier (Previous identifier)	Location	Discovery Date	Summary of Status (FY19)
Cell 1			
C1S-03 (Location 3)	South wall of TSF Cell 1 on the embankment face	Feb 2008	Filter Blanket installed over area. No change from previous reporting period.
C1E-14S (Location 2)	East wall of TSF Cell 1 at the toe and pipe corridor	2008	Interception drain, sump and pump to return seepage to EP2. Dampness extending south and east. Flow from this seepage has been erratic, with fluctuations up to 10 to 15 m3/day over the latter part of 2018. Flows returned to normal levels from beginning of 2019, but started fluctuating again in June 2019.
C1E-14N (Location 1)	East wall of TSF Cell 1 at the toe	2008	Interception drain, sump and pump to return seepage to EP2. Mostly dry, damp after rain, seepage is slowly extending north and east. There has been a further decrease in the average daily flow from 5 m^3/day to 4 m^3/day over the reporting period.
C1E-17, C1E-18 (Location 13, 13A and 13B)	Cell 1 crest of starter embankment and at toe	2009	Liquor interception trench installed at Location 13A&B. Seepage extending slightly north of 13B beyond the filter blanket. Flows have settled down after separate pumping system for location 17 and 19 was installed. A gradual decrease can be observed.
Cell 2			
C2E-01 (Location 17)	East Wall of Cell 2 at the embankment toe	February 2012	Filter blanket installed January 2016 and seepage interception trench constructed June 2017. Area is dry after construction. Flows pumped to EP2.
C2E-02 (Location 12 & 19)	Cell 2 crest of starter embankment	2009	At toe Filter blanket installed January 2016 and seepage interception trench constructed June 2017. Area is dry after construction. Flows pumped to EP2 On embankment damp strips ongoing.
Cell 3			
C3E-05 &06 (Location 23 North and 23 South)	East Wall of Cell 3 at the embankment toe	October 2016	Dampness increased to free liquor ponding. Filter blanket, drain and pump system installed.
C3NE-07 (Location 16)	Northeast corner of Cell 3	Dec 2010	Mainly dry.
C3N-13	North wall of TSF3	Sept 2018	Damp patch increasing in dampness.
C3N-15 (Location 22)	North Wall of Cell 3 at the embankment toe	August 2016	Damp patches extending.
C3/4CN -22 (Locations 7-9)	Intersection of TSF Cell 3 and TSF Cell 4 at toe	Apr 2008	Beneath Cell 3-4 buttress. Flows into sump have reduced over the period, down to almost zero. The adjacent dewatering bore is still recording flows, and the reduction in flow coincides with a refurbishment of the bore.

Cell4			
C4N-09 (Location 18)	Eastern side of the north ramp of Cell 4	November 2012	New filter blanket installed over portions as part of the buttress works. Flow directed into the same collection sump. Flow has reduced since buttress works.
C4S-28 (Location 4)	South wall TSF4 adjacent ramp	2006	Damp patches at toe
Cell 5			
C5S-12 to 14	South wall TSF5 towards eastern corner	January 2018	Damp strips in clay pan below sand dune
C5E - 28	Eastern wall towards northern corner	June 2019	Damp patches at toe of embankment
C5N - 40	North wall of TSF5	April 2017	Damp zone along service track
C5NW-54 (Location 20)	West Wall of Cell 5 at the embankment toe	June 2015	Damp areas increasing and ongoing water in collection drain chambers and sump. Pumping system installed to bypass portions of drain.
C5SW-61 (Location 21)	West Wall of Cell 5 at the embankment toe, south of Location 20	May 2016	Dampness increased to free liquor at toe. An interception trench constructed remote from the toe. Ongoing pumping from the toe drain chambers, and interception trench.



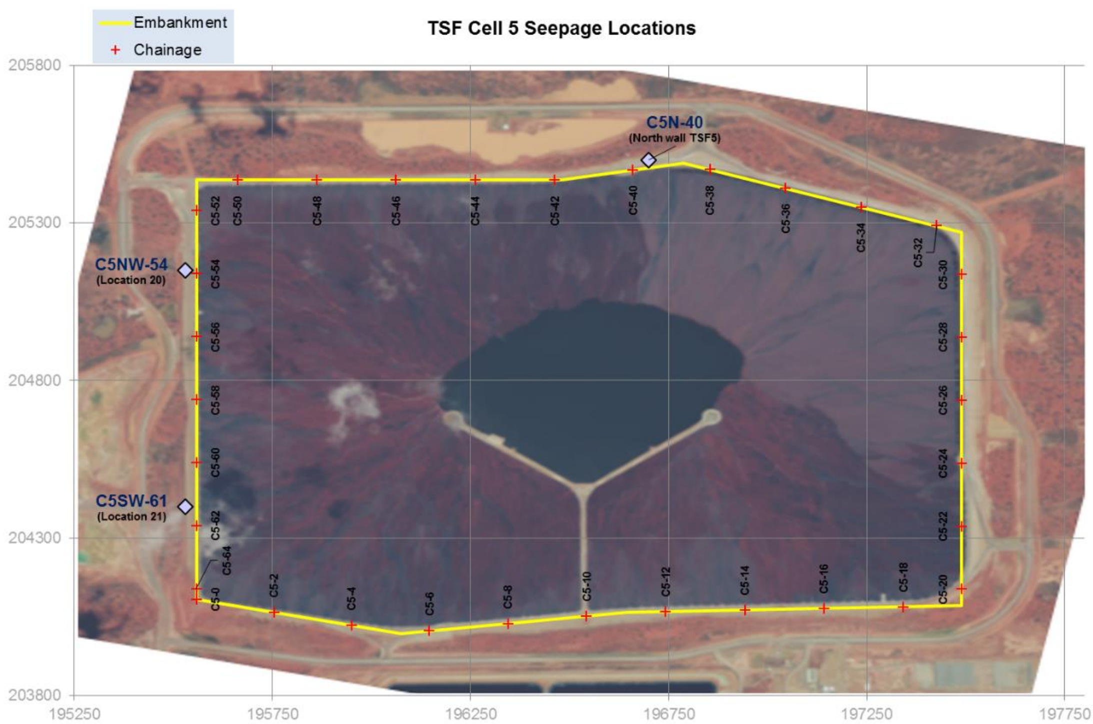


Figure 72: Location of perimeter features.

4.3 Fauna interaction with Tailings Retention System

4.3.1 Environmental Outcome

No significant adverse impacts to listed species (South Australian, Commonwealth) as a result of interactions with the Olympic Dam TRS.

No significant adverse impacts to listed species as a result of interactions with the Olympic Dam Tailings Retention System (TRS) have occurred.

The Red-necked Stint (*Calidris ruficollis*; N = 5) listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Banded Stilt (*Cladorhynchus leucocephalus*; N = 19) listed as Vulnerable under the *National Parks and Wildlife Act 1972* (NPW Act), were observed interacting with the TRS during FY19.

These numbers are extremely low in terms of overall population and therefore it is concluded that there were no significant adverse impacts to South Australian or Commonwealth listed species as a result of interactions with the TRS.

4.3.2 Compliance criteria

No significant adverse impact on the size of an important population of Banded Stilt (*Cladorhynchus leucocephalus*) as a result of interactions with the Olympic Dam TRS. *NOTE: Significant impact is as defined in the Significant Impact Guidelines and greater than predicted in the EIS* (FA 2.3).

No species listed under the NPW Act, including the Banded Stilt, were observed within the TRS during routine weekly monitoring undertaken by trained Environment personnel in FY19. However, 19 live Banded Stilts were observed opportunistically by TRS technicians during FY19. The fate of these birds is unknown, however, given the low number of observations in FY19, it is likely that there was no significant impact on the size of an important population of Banded Stilt as a result of interactions with the TRS.

4.3.3 Deliverables (FA 2.3)

An assessment of fauna activity and losses within the TRS.

An evaluation of the effectiveness of control measures and targets in reducing the number of listed migratory birds lost within the TRS.

During FY19, 33 different bird species and two other animal species were observed during the weekly monitoring of the TRS. A total of 301 live animals were observed throughout the year, with 16 showing signs of being affected by the TRS liquor, and 111 dead birds were observed. An increase in confirmed dead animals were observed after high summer rains (Figure 73). It is unclear whether all affected species die as a result of ingesting liquor. The Silver Gull was recorded in the highest numbers during FY19, with a total of 84 recorded.

Overall, there has not been a significant increase or decrease in the number of alive and dead birds observed at the TRS from FY13 to FY19 (Alive: $F_{1, 26} = 3.890$ $p = 0.059$; $R^2 = 0.130$; Dead: $F_{1, 26} = 0.190$ $p = 0.665$, $R^2 = 0.007$; Figure 74). The variability in the numbers observed is most likely due to environmental factors, such as rainfall (Figure 73).

New controls are still being evaluated prior to undertaking further trials and therefore they cannot currently be analysed for their effectiveness at reducing listed migratory species.

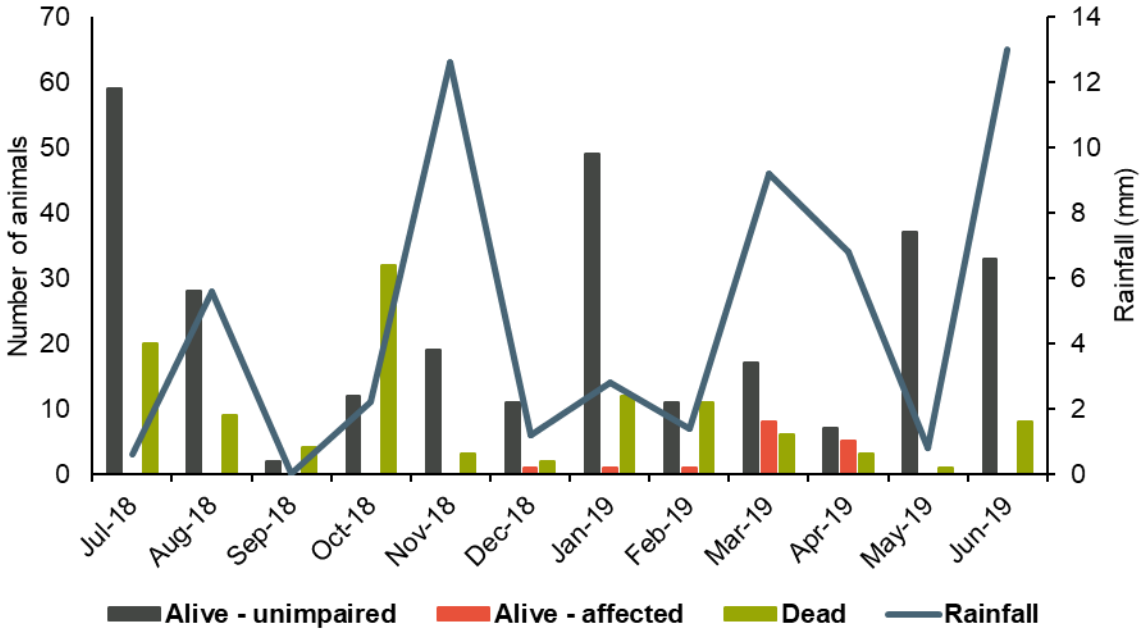


Figure 73: Monthly summary of weekly monitoring for FY19, showing total number of animals recorded as alive, yet unaffected, alive, but affected and confirmed as dead within the TRS. Rainfall data presented are collected from the Roxby Downs weather station.

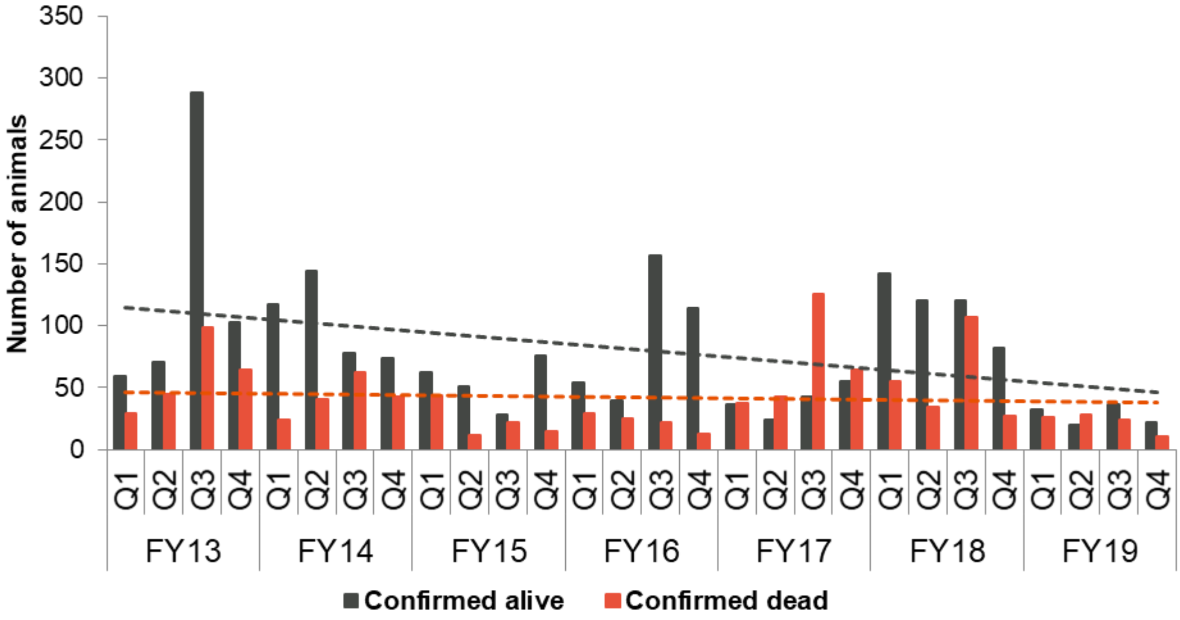


Figure 74: Quarterly summary of all weekly monitoring, showing total number of animals recorded within the TRS. Dashed lines represent linear trends.

All fauna observed opportunistically (i.e. outside formal monitoring sessions) during FY19 are summarised in Figure 75. Opportunistic observations bias towards live animals, especially large flocks, hence more live animals than dead animals are usually observed.

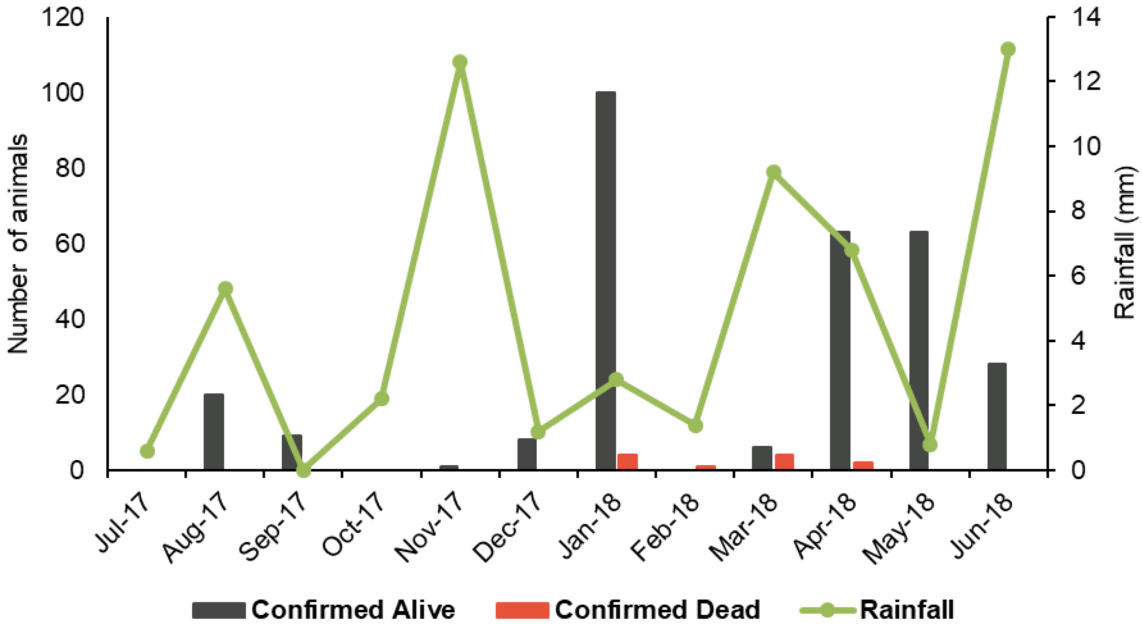


Figure 75: Monthly summary of opportunistic observations for FY19, showing total number of animals recorded within the TRS. Rainfall data presented is collected from the Roxby Downs weather station.

The data presented indicate the number of fauna counted and do not represent total numbers. They are presented as an index only. A number of factors must be considered when interpreting and refining our monitoring and data analyses:

- Birds may be seen and recorded as alive on one day and subsequently may be observed as dead. The total includes both observations, leading to a possible overestimate;
- Scavenging by birds of prey and corvids means that some carcasses may be removed from the system prior to an observation being made;
- Carcasses floating in the liquor may sink and disappear before being recorded; and,
- Some fauna species may leave the system and die elsewhere.

The number of birds recorded as dead at the TRS may represent a small proportion of those that visited. Preventing and deterring visitations by large flocks of birds, particularly Banded Stilts, remains a focus of management efforts at the TRS.

4.3.4 Leading Indicators

- None applicable

4.3.5 Targets FY19

- None applicable

4.3.6 Actions FY19

Continue investigating and trialling alternative deterrent technologies when they become available.

A summary of deterrents trialled to-date has been compiled and the process has derived a short-list of potential deterrent and offset options to be further explored based on their high feasibility, low cost and unknown effectiveness (e.g., most deterrent options only had anecdotal evidence available). As a result of this process, we have identified two plausible options to investigate further, including a sound-based deterrent and a laser deterrent. We have also started discussions with our team in Chile, as Escondida mine faces similar issues. The results of this desk-top review will be used to inform relevant stakeholders of the identified best approaches for managing avian interaction with the TRS. Research into alternative deterrent technologies will continue in FY20.

4.4 Solid waste disposal

4.4.1 Environmental Outcome

No significant adverse impacts as a result of management of solid waste.

The Resource Recovery Centre (RRC) effectively manages solid waste as per the EPA approved Landfill Environmental Management Plan 2016 (LEMP). No evidence of material environmental harm was identified through routine auditing or based on the reporting of materials disposed of to the landfill. Therefore, it can be concluded that no significant adverse impacts resulted from the management of solid waste at Olympic Dam during FY19.

During January (9th to 21st) 2019 a fire occurred at the landfill facility and was reported to the EPA in line with Licence 1301 requirements. As a result of this event a change to on ground waste management practices was implemented within the RRC to further reduce the likelihood of a similar event occurring in the future. This included the implementation of a concrete sorting pad, circulation of quick guide reference cards for waste segregation and toolbox meetings across site.

4.4.2 Compliance criteria

No site contamination leading to material environmental harm arising from the operation of the Resource Recovery Centre (WA 2.5, 2.6).

Solid wastes which cannot be reused or recycled by the RRC and are not contaminated are disposed of into the landfill facility. The RRC effectively manages solid waste as per the approved EPA Landfill Environmental Management Plan (LEMP) so that no material environmental harm is caused. Waste is minimised, stored, transported and disposed in a manner that controls the risk of adverse impacts to the environment and communities through implementation and maintenance of a LEMP. No evidence of material environmental harm was identified based on routine auditing and reporting conducted during landfill operations.

4.4.3 Deliverables (WA 2.5)

Records of quantities of general and industrial waste disposed of to landfill.

Records of all waste delivered to the Resource Recovery Centre (RRC) were maintained by the waste management contractor for the RRC during FY19. These records show a total amount of waste materials delivered to the Landfill for permanent disposal in FY19 equated to ~84,106m^3 (8,831t).

Of this waste ~59,608m^3 (6,259t) was disposed directly to the permanent landfill with ~8,274m^3 (868t) being diverted out of this waste stream and into the recyclable material stockpiles. A total of 16224m^3 (1,703t) of recyclable materials were collected from recycling points. An annual average of approximately ~29.3% of recyclable materials were recovered through implementing these two combined recovery streams during FY19. An overview of waste quantities and historical trends is displayed in Table 25 and Figure 76 as an overall percentage of total volumes.

Table 23: Waste quantities delivered to one of the delivery points within the RRC and total recyclables recovered and diverted to recycling stockpiles for off-site recycling.

	Quantity (tonnes)	Quantity (tonnes)
Total waste received at RRC	8,831	
Disposed to permanent landfill		6,259
From recycling collection areas to recycle stockpile		1,703
Diverted from Landfill (to recycle stockpile)		868
Balance		8,831

**Note: m^3 converted to Tonnes using conversion factors (mixed waste density conversion of 105m^3/t). Balance may not equal sum of numbers due to rounding.*

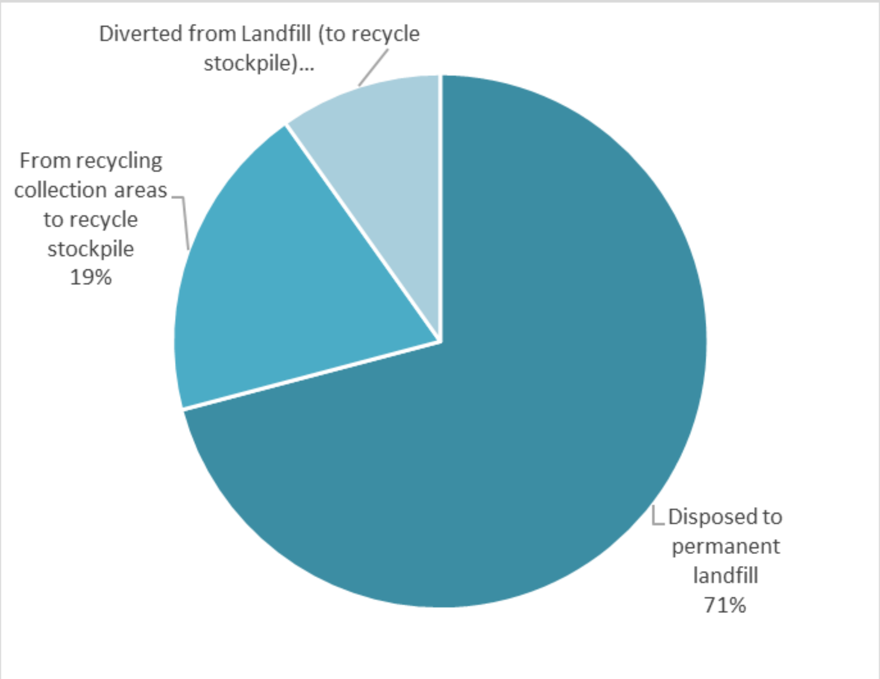


Figure 76: Overview of total waste as a percentage delivered to the RRC for FY19.

Historical waste volumes of Landfill disposal and Total Recyclable Materials sent offsite to a licenced facility for further processing between 2003 and 2019 are shown in Table 24. Figure 77 shows the estimated tonnage of waste disposed of to the landfill on an annual basis from 2003 to 2019 inclusive.

Table 24: Historical total waste received at the Resource Recovery Centre (2003-2019).

Year	Landfill Disposal *(m^3)*	Recycled Materials (Tonnes)
2003	30,622	193
2004	27,348	617
2005	14,578	510
2006	45,361	347
2007	47,964	685

Year	Landfill Disposal (m^3)	Recycled Materials (Tonnes)
2008	52,171	673
2009	40,898	936
2010	32,980	1,890
2011	37,511	1,735
2012	36,291	2,644
2013	17,739	1,248
2014	31, 433	1, 232
2015	34, 939	3, 073
2016	27, 355	2, 651
2017	30, 081	1, 957
2018	55, 254	1, 513
2019	59,608	3,145

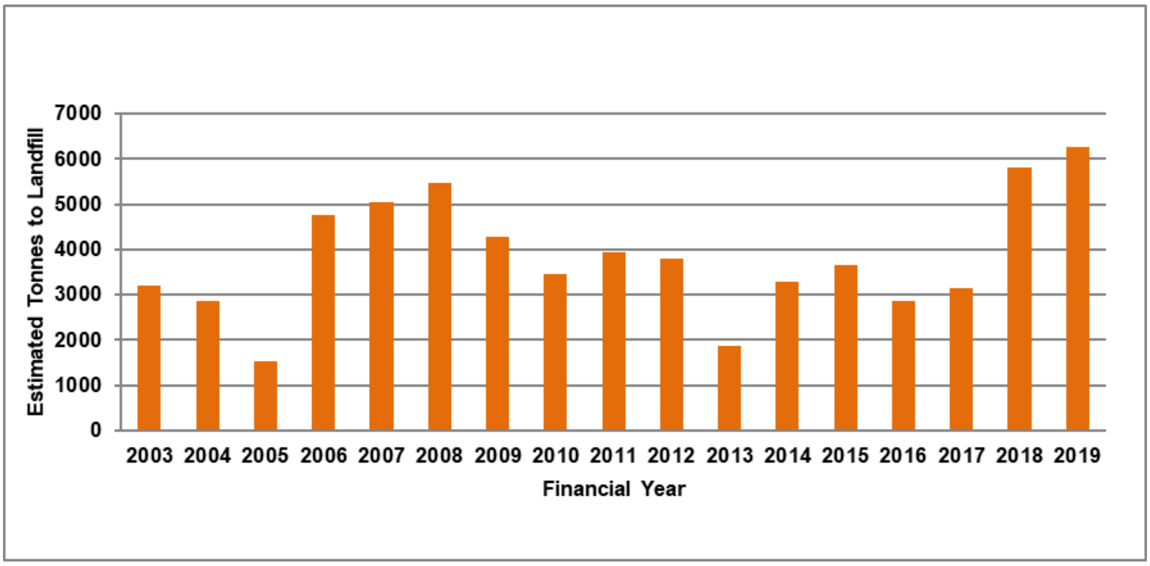


Figure 77: Historical overview of estimated general waste quantities to landfill disposal 2003-2019.

**Note estimated tonnes is based on recorded cubic meters then by applying conversion factors for density (General mixed waste of 105m^3/t).*

Records of quantities of material recovered for reuse and recycling.

All records of reclaimed and recyclable material quantities are captured and a register maintained by the RRC waste management contractor. The total amount of recyclable material sent off-site for recycling during FY19 equated to ~3,145m^3 (330t), which is an increase of ~68.98% from the previous year and a record high for Olympic Dam to date.

Table 25 provides an overview of the recyclable materials captured and the quantity of each material removed from site during FY19 to licenced facilities.

Table 25: Recyclable material transported off-site for recycling in FY19.

Recycling removed from site	Quantity (Tonnes)	Quantity (Tonnes)
Total Recycling FY19	3,145	
Hydrocarbons (Clean waste oil)		429
IBC's		23
Metal		232
Paper/Cardboard		1
Plastic		187
Timber		78
Tyres		105
Other Materials		2,090
Balance		3,145

**Note: Conversion factors in use for waste materials to ensure reporting in Tonnes (example IBC's density of 51m³/t and Tyres 200m³/t). Balance may not equal sum of numbers due to rounding.*

Figure 78 provides an overview of each recyclable category as a percentage during FY19 sent off-site and Figure 79 provides an overview of the historical recycling trends sent off-site to appropriately licenced facilities (2003-2019 inclusive).

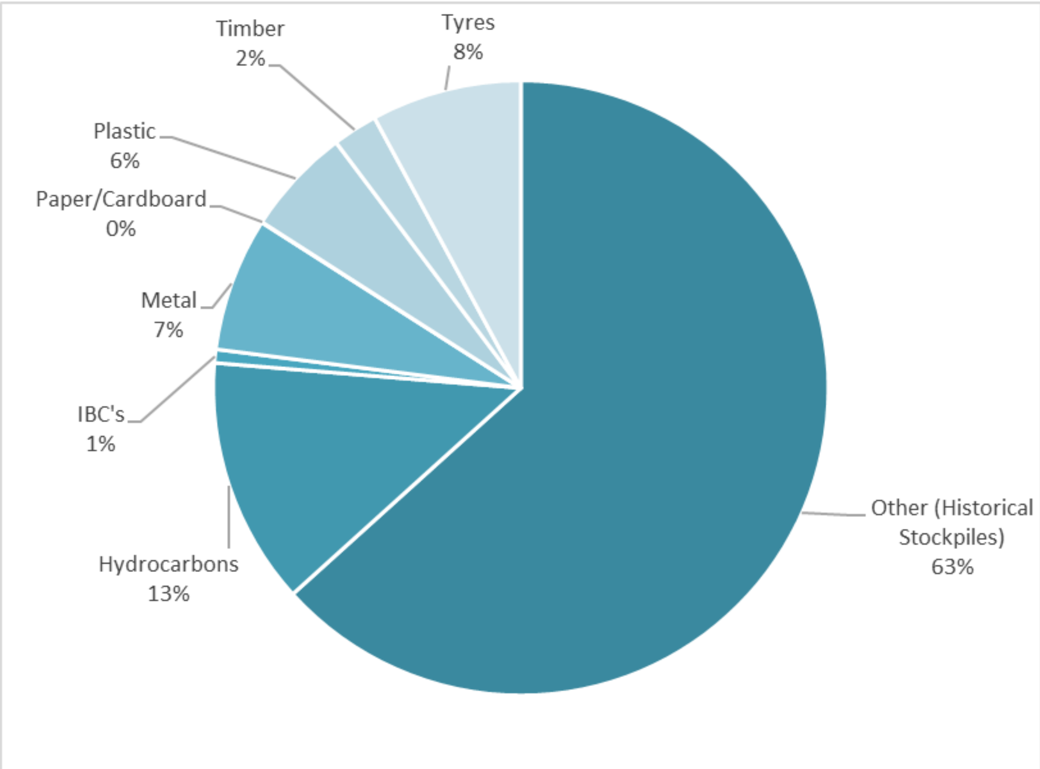


Figure 78: Category of recyclable materials transported offsite as a percentage during FY19.

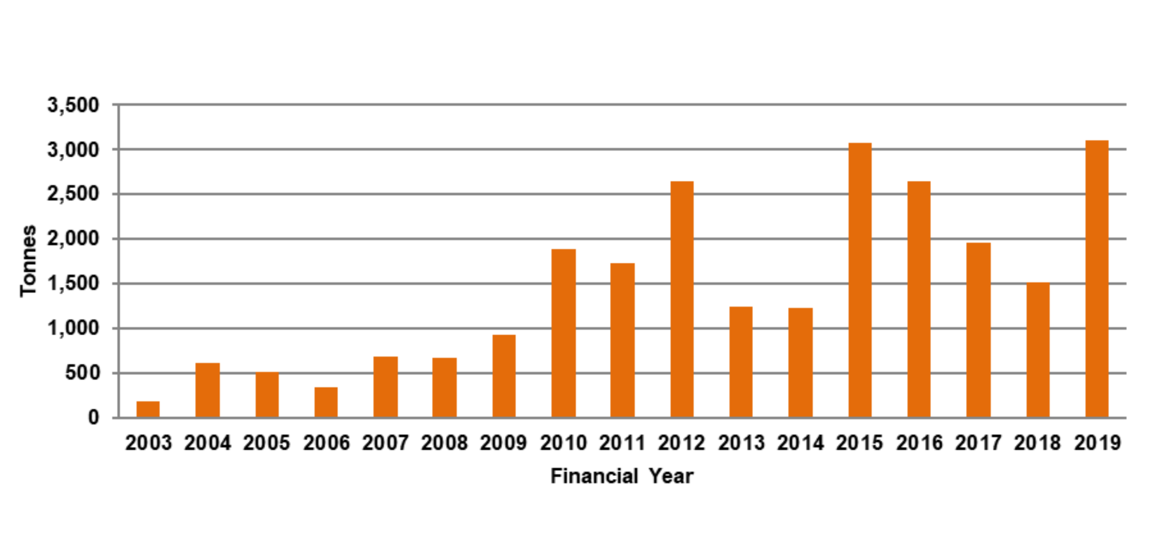


Figure 79: Recyclable materials transported offsite to suitably licenced facilities for re-processing 2003- 2019.

4.4.4 Deliverables (WA 2.6)

Records of categories, quantities and location of hazardous waste materials disposed of within the SML.

Depending on the type of hazardous or contaminated material, quantities are measured in cubic metres (m^3) or tonnes (t). Records of hazardous waste disposed of within the SML are shown in Table 26 as tonnes and Figure 80 as a percentage of overall hazardous waste disposed of by work area.

Contaminated waste disposed within the SML is discussed within the Radioactive waste section of this report (Chapter 4.5), whilst disposal of hazardous waste is to the Tailings Storage Facility (TSF). Risk assessments of materials being disposed of to the TSF ensure that TSF integrity is not compromised.

Where possible, process waste is disposed of via bunded areas and directed to tails disposal. This reduces the amount of waste disposed of at the tailings waste finger.

Records to provide evidence that listed waste is appropriately managed, specifically:

- **that listed waste is stored, contained and treated in a manner that does not cause environmental harm or nuisance or present risks to human health and safety;**
- **that all listed waste storage containers are of a suitable strength and durability, are clearly marked and contain appropriate safety warnings;**
- **that all listed wastes do not contact soils or stormwater, and that measures to prevent and recover spillages are implemented as necessary.**

The waste management contractor is responsible for maintaining all hazardous waste management records at the RRC. The location, type and quantity of hazardous waste is recorded in an electronic register, as per all relevant regulations and site procedures. The transport of hazardous waste off-site is documented through the EPA waste transport and tracking system, providing assurance that wastes are managed appropriately so as not to cause environmental harm or present a risk to human health and safety. Table 26 provides an overview of waste management streams which are approved under the Tailings Retention Storage Waste Management Plan for disposal to the TRS.

Table 26: Hazardous wastes disposed of within the SML's Tailings Retention Storage System FY19

Type of waste	Quantity of Waste (tonnes)
Process waste	1,158
Smelter	27
Acid Plant	337

Type of waste	Quantity of Waste (tonnes)
Electro Winning and Gold Room	343
Refinery	601
SX Area	516
Geometallurgy labs	0.07
Onsite laboratory	43
Miscellaneous Waste cleared for TRS	604
Balance	3,633

** Balance may not equal sum of numbers due to rounding.*

Figure 80 Shows the overall individual area contribution during FY19 of hazardous waste disposed of to the TRS.

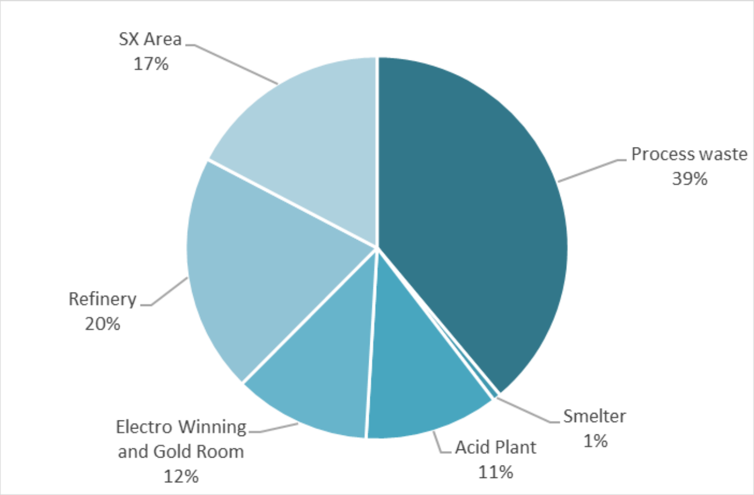


Figure 80: Hazardous wastes disposed of to the TRS during FY19 as a percentage (work area).

Other hazardous waste removed from site for disposal at licenced facilities consists of hydrocarbon waste such as oily rags, oily filters and waste acid as shown in Table 27.

ODC complies with the requirements of EPA Licence 1301 pertaining to listed and controlled waste by adhering to the approved Landfill Environmental Management Plan (LEMP), which meets government and ISO 14001 requirements. Spill kits are available at all collection and loading points for listed waste (e.g. Waste Oil Facility and Distribution Centre).

Table 27: Record of hazardous waste collected and removed off-site for further treatment during FY19.

Type of waste	Quantity of Waste	Units
Oily Filters	80	Tonnes
Oily Water	34,000	Litres
Used Acid	7,000	Litres

4.4.5 Leading Indicators

- None applicable

4.4.6 Targets FY19

Increase at source waste segregation to reduce waste to landfill

All recycling stations across site have colour coded skip bins to assist with segregation at source. This has resulted in approximately 29% diversion of recyclable material from landfill for FY19. An improvement project which includes waste management online training was rolled out across site in FY19. Additional skip bins will be provided at specific locations to facilitate further source segregation.

Reduce recycling stockpiles by 20 %

Approximately 3,145 tonnes of recyclable material was transported offsite during FY19. The recycling stockpiles will continue to be actively managed to reduce historical waste stockpiles, whilst maintaining as low as reasonably practicable level of newly received recyclables to stockpiles. An increase of ~69% in the total recycling sent off site occurred during FY19 when compared to FY18.

4.4.7 Actions FY19

Implement a plan for reducing stockpiles of recyclable material

Work continued to progress during FY19 to reduce historical stockpiles. Legacy waste stockpiles of scrap steel were specifically targeted during FY19 with ~2,389.54 tonnes of scrap steel cleared and transported off site for recycling through licenced facilities (a large majority of which was legacy material).

Implement a site wide paper/cardboard recycling programme with bailing and off site removal/recycling

Cardboard skip bins are placed at recycling stations to assist in the segregation of cardboard and paper across site. Removal of cardboard offsite as recycling remains challenging with 1 tonne being sent offsite during FY19. Paper and cardboard baling and storage is currently being investigated to assist with implementing this action.

4.5 Radioactive waste

4.5.1 Environmental Outcome

No adverse impacts to public health as a result of radioactive waste from ODCs activities.

ODC has consistently operated in a manner that limits radiation dose to members of the public from radioactive waste, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1 mSv/yr limit.

As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at Olympic Dam.

No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive waste from ODCs activities.

There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODCs activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota assessment sites is used as an indicator of the potential exposure of listed species to radioactive waste.

Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota (refer to chapter 3.4).

4.5.2 Compliance criteria

Radiation doses to members of the public less than 1mSv/y above natural background.

The total estimated dose (FY19) to members of the public at Roxby Downs Monitoring Site (RDMS) and Olympic Village Monitoring Site (OVMS) contributed by ODC operations was 0.033 mSv and 0.034 mSv respectively.

Deposition of project originated ^{238}U less than 25 Bq/m^2/y at the non-human biota assessment sites.

The average deposition of U-238, calculated as an average of results at the four monitoring sites was determined to be 0.48 Bq/m^2/y, well below the 25 Bq/m^2/y compliance criteria.

4.5.3 Deliverables (WA 2.7)

Records of the categories, quantities and location of LLRW and contaminated material disposed of within the SML.

A waste management register is maintained by site staff and the waste management contractor to track origin/s of the structural waste, waste category, quantities, radiation testing results and final disposal or storage location.

Contaminated Waste is defined as structural waste from within the operational mining and processing areas which after surface cleaning retains a radiation surface area activity of greater than 4,000Bq/m^2 and a radiation activity level below 1Bq/g. Any structural waste which returns activity readings below these thresholds can be safely recycled, any cleaned materials which remain above these thresholds must remain onsite. Table 28 shows the total tonnage of structural waste which once cleaned has remained above the safe transport thresholds and therefore been placed into a purpose built Contaminated Waste Disposal Facility (CWDF 2017-2019 inclusive).

Table 28: Permanent Contaminated Waste Disposal Facility (CWDF).

CWDF Storage Location	Type of waste	FY	Quantity of Waste (tonnes)

Cell 1 Stage 1	Contaminated structural equipment	FY17	3,304
Cell 1 Stage 1 Cell 1 Stage 2	Contaminated structural equipment	FY18	2,088
Cell 1 Stage 2	Contaminated structural equipment	FY19	2,042

The use and closure of each CWDF Cell stage is implemented through the requirements of the approved Contaminated Waste Management Plan. CWDF Cell 1 Stage 1 was approved and constructed adjacent to the Resource Recovery Centre during FY17 and was backfilled in FY18 once capacity was achieved. CWDF Cell 1 Stage 2 (Lift 1), directly above stage 1 was constructed in FY18 and currently remains in operation.

The regulatory framework for a CWDF is contained within the current licence conditions for the Olympic Dam Licence to Mine (LM1), which requires ODC to comply with the Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (ARPANSA 2005a). ODC is required to seek regulatory authorisation for various stages of the CWDF facility/cells and to have a Radioactive Waste Management Plan (RWMP) developed and maintained. Figure 81 provides and overview of the tonnages sent for storage and to which CWDF cell stage.

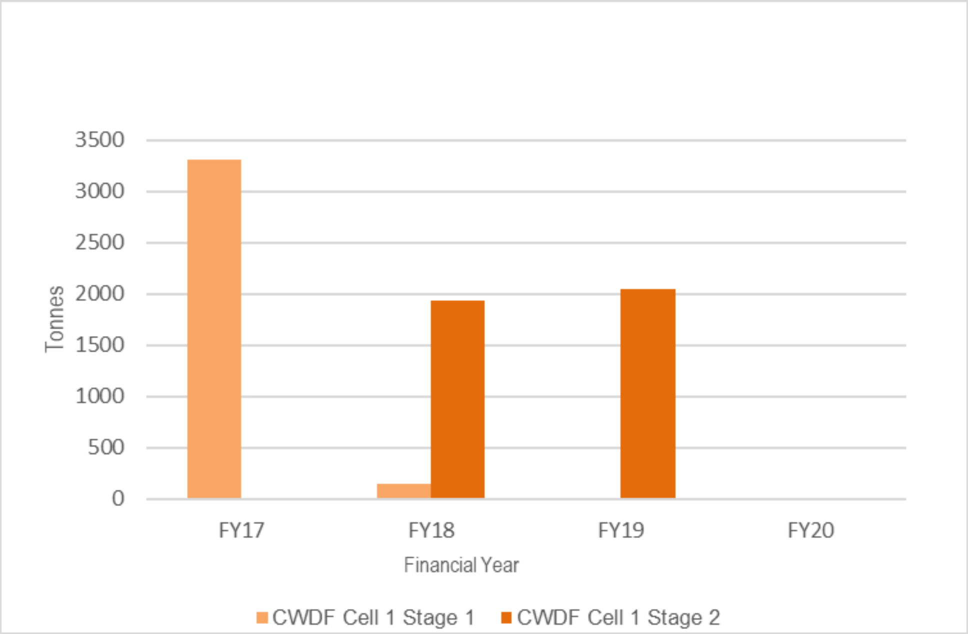


Figure 81: Overview of structural waste tonnage received at each of the CWDF cells currently utilised at OD.

Some structural waste materials return active radiation readings above >4,000Bq/m^2 and >1Bq/g after cleaning and decontamination processes have been implemented. These materials are classified as Low Level Radioactive Waste (LLRW) and are therefore segregated away from other contaminated waste materials. Table 29 summarises the quantity of LLRW which currently exceeds the contaminated waste thresholds and cannot be stored with other contaminated structural waste.

Table 29: Low Level Radioactive Waste currently in storage

Storage Location	Type of waste	FY	Quantity of waste stored (tonnes)
LLRW Area	Structural waste as LLRW	FY18	115
LLRW Area	Structural waste as LLRW	FY19	44
Total in storage end FY19			159

The cleaning of structural materials from processing and mining areas of the mine has proved to be a successful method for reducing the radiation levels, with the overall volumes of contaminated waste required to stay on site in a CDWF cell greatly reduced. The testing program has enabled OD to safely recycle a larger majority of metal waste.

4.5.4 Leading Indicators

Indications that a dose constraint of 0.3 mSv/y to members of the public above natural background will be exceeded.

Indications that a reference level of 10 µGy/h for impact on non-human biota above natural background will be exceeded.

No leading indicators were triggered. Doses to members of the public are below Olympic Dam's internal dose constraint of 0.3mSv/yr. Similarly the reference level of 10 µGy/h for impacts on non-human biota have not been triggered.

4.5.5 Targets

Maintain radiation doses as low as reasonably achievable, as assessed through the annual Radiation Management Plan review.

Quarterly ODC radiation monitoring results, radiation dose calculations and occupational hygiene results are presented to the regulatory authorities for review. In addition, an annual adequacy and effectiveness review is completed each year confirming that doses are as low as reasonably achievable.

4.5.6 Actions FY19

None applicable.

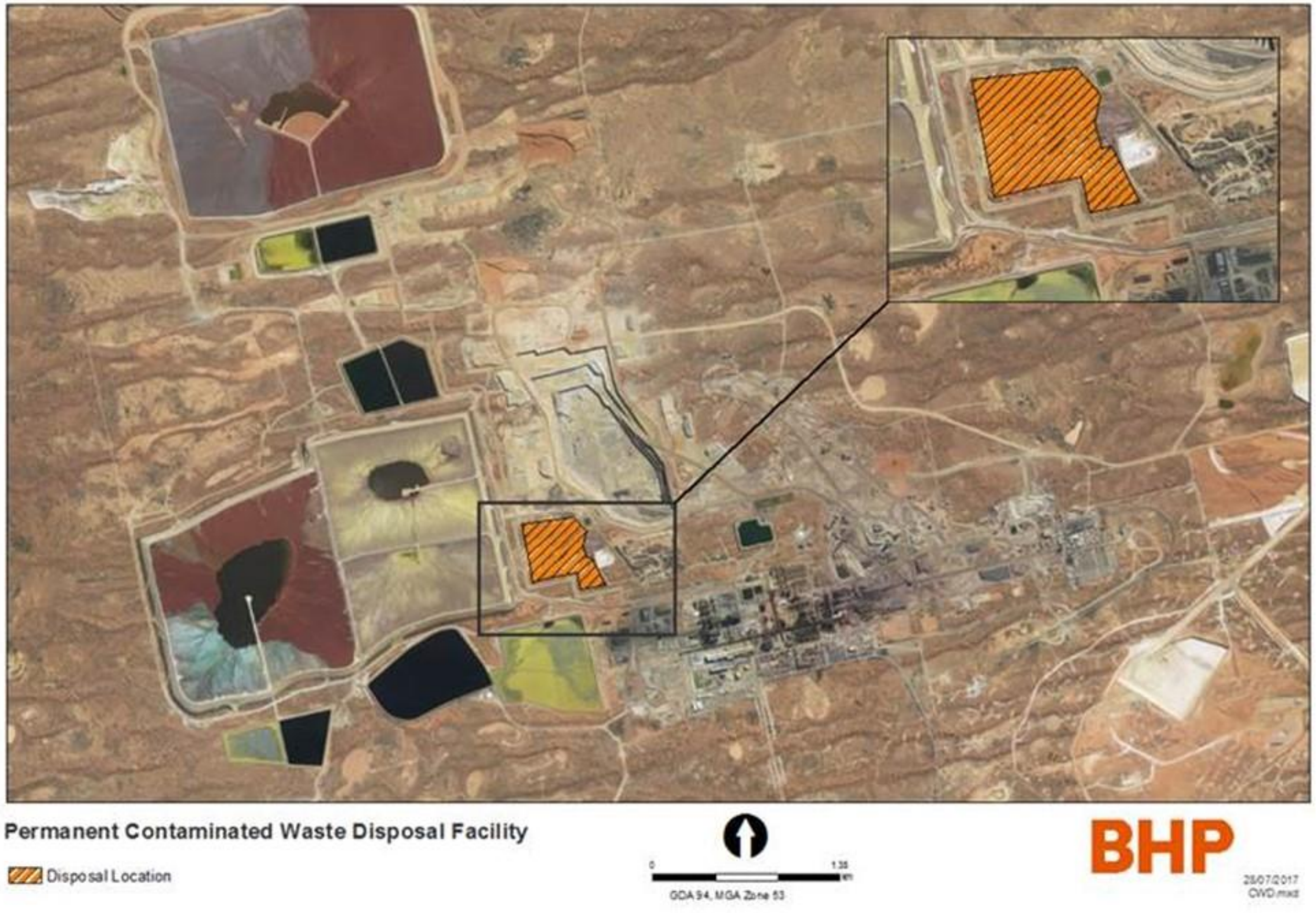


Figure 82: Approved Contaminated Waste Disposal Facility (CWDF).

Figure 83: Currently active disposal area within CWDF Cell 1 Stage 2

5 Interaction with communities

5.1 Community interaction

5.1.1 Environmental Outcome

Residents in Roxby Downs, Andamooka and Woomera have a favourable view of ODC.

Responses to the 2017 Olympic Dam Community Perception Survey indicate that ODC is a trusted organisation within its local communities. In addition to this, ODC provides employment to local and regional communities. The next Community Perception Survey is scheduled for 2020.

5.1.2 Compliance criteria

Community concerns are tracked and all reasonable complaints are addressed where reasonably practical.

ODC has a process to receive and track community enquiries, concerns, complaints and grievances through the company's complaints procedure and stakeholder engagement management plan. ODC did not receive any community complaints in FY19.

5.1.3 Deliverables (SE 2.1)

A description of the extent to which residents in Roxby Downs, Andamooka and Woomera trust ODC to act in their best interest (calculated triennially).

Responses to the 2017 Olympic Dam Community Perception Survey indicate that ODC is viewed favourably within its local communities. In addition to this, ODC provides employment to local and regional communities. The next Community Perception Survey is scheduled for 2020.

In addition, BHP has recently engaged CSIRO to run the Local Voices community perception surveying in Minerals Australia host communities, including Olympic Dam. The initial 'anchor' survey was run between March-June 2019, with 147 community members participating. Monthly perception surveying will be implemented around October–November 2019, which will provide BHP with a monthly indicator of the community's trust in BHP.

5.1.4 Deliverables (SE 2.2)

A description of residents' perceptions about quality of life services and facilities, safety and social fabric in Roxby Downs, Andamooka and Woomera (reported triennially).

ODC undertook a Community Perception Survey in 2017. Perceptions amongst survey participants raised concerns regarding availability of retail stores, cost and reliable access to power, job security and access to increased medical facilities. The next Community Perception Survey is scheduled for 2020.

Furthermore, the CSIRO Local Voices survey (as mentioned above), to be rolled out in October-November 2019, will provide additional monthly feedback on residents' perceptions about services, facilities, safety and social fabric in Roxby Downs.

5.1.5 Leading Indicators

- None applicable

5.1.6 Targets

- None applicable

5.1.7 Actions FY19

Undertake the triennial Community Perception Survey to monitor local community perceptions of ODC, and of local services and facilities.

The triennial Community Perception Survey was undertaken in 2017 to monitor local community perceptions of ODC, and of local services and facilities. The next survey is scheduled to take place in 2020.

6 References

ANZECC 2000, 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality', Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No. 4, Volumes 1-3 (Chapters 1-9).

ARPANSA 2005, Code of Practice and Safety Guide, Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing, Radiation Protection Series Publication No. 9, August 2005

BHP Billiton Olympic Dam 2009, Olympic Dam Expansion Draft Environmental Impact Statement 2009

BHP Olympic Dam 2018d, 'Tailings Retention System (TRS) Operation, Maintenance and Surveillance Manual', Olympic Dam Document No. 83204.

BHP Olympic Dam 2018e, 'Tailings Retention System Management Plan FY17-FY18', Olympic Dam Quality Document No. 80791.

BHP Olympic Dam 2019a, 'Olympic Dam Weed Management', Olympic Dam Document No. 155860.

BHP Olympic Dam 2019b, 'Olympic Dam Pest Animal Monitoring and Control'. Olympic Dam Document No. 2770

BHP Olympic Dam, 2019c. 'Great Artesian Basin Wellfields Report, 1 July 2018 – 30 June 2019', unpublished BHP Olympic Dam Report

Badman, F. J. 2004, 'Eriocaulon *and grazing pressure monitoring of the GAB springs: August 2003*.' Report for WMC (Olympic Dam Corporation) Pty Ltd. Adelaide: Badman Environmental.

Badman, F. J. 2005, '*Artesian spring flora monitoring: August 2004*.' Report for WMC (Olympic Dam Corporation) Pty Ltd. Adelaide: Badman Environmental.

Barron, P. 2018a, The Emerald Springs Native Vegetation Management Plan. Agreement between the Native Vegetation Council and BHP Billiton Olympic Dam Corporation Pty Ltd. Barron Environmental.

Barron, P. 2018b, Native Vegetation Clearance Proposal – BHP Olympic Dam Special Mining Lease Data Report. Barron Environmental.

Environment Protection (Air Quality) Policy, **2016.**

Fatchen, T. J., and Fatchen, D. H. 1993, '*Dynamics of vegetation on mound springs in the Hermit Hill region, northern South Australia*', Report for WMC (Olympic Dam Corporation) Pty Ltd. Adelaide: T. J. Fatchen and Associates.

GHD 2017, BHP Billiton Olympic Dam Annual Flora Monitoring of the Great Artesian Basin Mound Springs. Report for BHP Billiton Olympic Dam. NSW.

Golder Associates 2016, GAB Technical Memorandum 14766004-019-M-Rev2

Griffin, G. F., and Dunlop, S. R. 2014. '*Great Artesian Basin springs flora monitoring. October 2014.*' Report for BHP Billiton Olympic Dam. Pillar Valley, NSW: Datasticians.

Griffin, G. F., and Dunlop, S. R. 2016. '*At Risk Species and Grazing Pressure Monitoring of the Great Artesian Basin Mound Springs. September 2015.*' Report for BHP Billiton Olympic Dam. Pillar Valley, NSW: Datasticians.

Kinhill Engineers 1997, 'Olympic Dam Expansion Project: Environmental Impact Statement', Kinhill Engineers Pty Ltd, Adelaide.

Kinhill Stearns 1984, 'Olympic Dam Project supplementary environmental studies: Mound Springs, Roxby Management Service Pty Ltd, Adelaide.

National Parks and Wildlife Act 1972 (SA).

PPK 2002, '*Annual mound spring vegetation monitoring report 2001*', Report for WMC (Olympic Dam Corporation) Pty Ltd. Adelaide: PPK Environment and Infrastructure.

Pedler, R. D., Brandle, R., Read, J. L., Southgate, R., Bird, P. and Moseby, K. E. 2016, 'Rabbit biocontrol and landscape-scale recovery of threatened desert mammals', *Conservation Biology*. 00, 1-9.

SA Arid Lands Natural Resources Management Board 2015, Wild Dog Management Plan

SRK 2015, 'Olympic Dam Operations: Assessment of potential groundwater impacts, current operation', unpublished report to BHP, SRK Consulting (Australasia) Pty Ltd, June 2015.

SRK 2018, '2-yearly TSF Stability and Trigger Level Assessment', unpublished report to BHP, SRK Consulting (Australasia) Pty Ltd, December 2018.

7 Glossary

ADU	Ammonium diuranate, commonly referred to as Yellowcake.
AE	Monitoring Program – Airborne Emissions
AHD	Australian Height Datum, a measure of elevation referenced from approximate sea level.
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian & New Zealand Environment & Conservation Council.
Aquifer	Porous water bearing formation of permeable rock, sand, or gravel capable of yielding significant quantities of water.
APTS	Acid Plant Tails Stack
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
Bq	Becquerel, a unit of radioactive decay.
$Bq/m^2/y$	Becquerels per square meter per year
CEMP	Carbon Emissions Management Plan
Ca	Calcium.
CAF	Cemented aggregate fill.
Closure	Permanent cessation of operations at a mine or mineral processing site after completion of the decommissioning process, signified by tenement relinquishment.
CD1, CD2	Concentrate Dryer 1, Concentrate Dryer 2
CO_2-e	Carbon dioxide equivalent
Cu	Copper.
CWDF	Contaminated Waste Disposal Facility.
Domestic Water Use	Water used in the town of Roxby Downs or Olympic Dam Village.
DSD	Department of State Development
EA	Monitoring Program – Environmental Radiation
ED	Effective dose.
EG	Monitoring Program – Energy Use and Greenhouse Gas (GHG) Emissions
EDD	Effective dose attributable to radionuclides in dust
EEO	Energy Efficiency Opportunities – Federal government legislation

EDP	Environmental Disturbance Permit
EIP	Environmental Improvement Plan
EIS	Environmental Impact Statement.
EMM	Environmental Management Manual
EMS	Environmental Management System. The part of an organisation's management system used to develop and implement its environmental policy and manage its environmental aspects (Standards Australia / Standards New Zealand 2004). Note: A management system is a set of interrelated elements used to establish policy and objectives and to achieve those objectives. A management system includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources.
Environmental Aspect	An element of the organisation's activities or products or services that can interact with the environment (Standards Australia / Standards New Zealand 2004).
Environmental Impact	Any change to the environment, whether adverse or beneficial wholly or partially resulting from an organisation's environmental aspects (Standards Australia / Standards New Zealand 2004).
EPA	Environmental Protection Authority
EPBC Act	Environment Protection & Biodiversity Conservation Act 1999 (Cth).
EPMP	Environmental Protection and Management Program. Describes the environmental management and monitoring activities undertaken by BHP Olympic Dam for the purpose of quantifying any change in the extent or significance of its impacts, assessing the performance of control measures employed to limit impacts, and/or to meet legal and other obligations.
EPP 1994	Environment Protection (Air quality) Policy 1994
EPP 2015	Environment Protection (Water quality) Policy 2015
Evaporation Pond EP	A containment pond to hold liquid wastes to assist with disposal of liquor via evaporation.
FA	Monitoring Program - Fauna
FL	Monitoring Program - Flora
FoS	Factors of Safety
FY	Financial Year
GA	Monitoring Program – Great Artesian Basin
GAB	Great Artesian Basin
GIS	Geographical Information System
GHG	Greenhouse Gas

GW	Monitoring Program – Groundwater
g/m^3	Grams per cubic metre – a measure of dust concentration in air.
Gy/h	Grays per hour – a measure of absorbed radiation dose.
ha	Hectare
ICRP	International Commission on Radiological Protection.
ID	EMP chapter identification
Industrial Water use	Water used in mining or mineral processing operations and excluding domestic water use.
kg CO_2-e	Kilograms of carbon dioxide equivalence – a standard measure of greenhouse gas emissions
kg CO_2-e/t	Kilograms of carbon dioxide equivalence per tonne of material milled – a measure of greenhouse gas emission intensity of ODC.
kL/t	Kilolitres per tonne.
kt	Kilotonne
Listed Species	Those species or communities that are listed as threatened or migratory under Commonwealth and/or relevant State or Territory legislation.
LEMP	Landfill Environmental Management Plan
LNAPL	Light Non-Aqueous Phase Liquid
LLRW	Low level radioactive waste
mAHD	Elevation in metres with respect to the Australian Height Datum
mg/Nm^3	Milligrams per normal cubic metre
ML	Megalitres.
ML/d	Megalitres per day.
MP	Monitoring Program. A document which describes the environmental monitoring activities undertaken by ODC for the purpose of quantifying any change in the extent or significance of its impacts, assessing the performance of the control measures employed to limit its impacts, and/or to meet its legal and other obligations.
Mt	Million tonnes
mSv/y	Millisieverts per year – a measure of equivalent radiation dose.
MWDP	Mine water disposal pond
NaCl	Sodium chloride (salt).
NEPM 2011	National Environment Protection Measure. NEPM investigation levels (Health Investigation Level Scenario D: Industrial/Commercial land use; Schedule B1 - National Environmental Protection (2011)

NGER	National Greenhouse and Energy Reporting – Federal government reporting of greenhouse gas emissions and energy use and production
NHB	Non-human biota
Nm^3	Normal metres cubed, referring to volume at standard temperature and pressure
NO_x	Oxides of nitrogen
NPW Act	National Parks & Wildlife Act 1972 (SA)
NVMP	Native Vegetation Management Program
ODC	BHP Billiton Olympic Dam Corporation Pty. Ltd.
OV	Olympic Village, the accommodation camp located at Olympic Dam township
OVMS	Olympic Village Monitoring Site
Pb	Lead
^{210}Pb	An isotope of lead, having mass number 82 and half-life 22.3 years
pH	A measure of acidity and alkalinity
PM_{10}	Particulate matter with an effective aerodynamic diameter less than or equal to 10 µm
$PM_{2.5}$	Particulate matter with an effective aerodynamic diameter less than or equal to 2.5 µm
Po	Polonium
^{210}Po	An isotope of polonium, having mass number 84 and half-life 138.38 day
ppm	Parts per million
PRH	Practical Reference Heads
Ra	Radium.
^{226}Ra	An isotope of radium, having mass number 88 and half-life 1599 years
RDMS	Roxby Downs Monitoring Site
Rehabilitation	The reclamation or repair, as far as practicable, of a facility to an appropriate or agreed state as required by law, or company self-regulation
Rn	Radon. Chemically inert radioactive gaseous element formed from the decay of ^{226}Ra as part of the ^{238}U decay chain
^{222}Rn	An isotope of radon, having mass number of 86 and half-life 3.8235 days
RRC	Resource Recovery Centre
RSF	Rock Storage Facility
SAP	Systems Applications Products
SE	Monitoring Program – Social Effects

SEB	Significant Environmental Benefit
SEIS	Supplementary Environmental Impact Statement
Significant aspect	An environmental aspect that has or can have a significant environmental impact. Significance is determined by risk assessment.
Significant Impact Guidelines	Australian Government, 2009, 'Matters of National Environmental Significance: Significant impact guidelines 1.1, *Environment Protection and Biodiversity Conservation Act 1999*.
SML	Special Mining Lease
SO_2	Sulphur dioxide
SO_4	Sulphate
SW	Monitoring Program – Surface Water
SX	Solvent Extraction
t	Tonnes
TDS	Total dissolved solids
TP	Tapered Piezometers
TRS	Tailings Retention System. Incorporates all elements of the tailings delivery, deposition and storage system and elements associated with the collection and disposal or return of tailings liquor. The TRS includes the Tailings Storage Facility (TSF), Evaporation Ponds and Pipe Corridors including tailings delivery pipelines and liquor pipelines.
TSF	Tailings Storage Facility. Incorporates the tailings deposition and storage system, which currently comprises four storage cells.
Th	Thorium
^{230}Th	An isotope of thorium, having mass number 90 and half-life 7.54×10^4 years.
Total Industrial Water Use	Total water used including high quality (GAB) water and water recovered from other sources including abstraction of local saline water.
TSP	Total Suspended Particulates (dust)
U	Uranium.
^{238}U	The most common isotope of uranium, having mass number 238 and half-life 4.46×10^9 years.
µGy/h	Micro gray per hour
VOC	Volatile organic compound.
VWP	Vibrating Wire Piezometers
WA	Monitoring Program – Waste