Bat activity at Granny Smith Gold Mine: 2024 Annual Report

Report to:

Granny Smith Gold Mine

February 2025

Disclaimer

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Executive summary

Granny Smith Gold Mine (GS) was initially certified as compliant with the International Cyanide Management Code (Code) in April 2011, recertified in March 2014, April 2017, October 2019 and most recently in May 2022. In part, ongoing full compliance was subject to the fulfilment of recommendations made in the report titled *Influences of hypersaline tailings on wildlife cyanide toxicosis: Granny Smith Gold Mine, December 2010* (Smith 2010) and referred to here as the Causational Report. These recommendations were subsequently amended in July 2014 in the report titled *Re-evaluation of Recommendations associated with the International Cyanide Management Code Standard of Practice 4.4* (Overdevest and Donato 2014) and referred to here as the Re-evaluation Report.

Recommendation 4 of the Re-evaluation Report required GS to maintain a systematic and comprehensive wildlife monitoring regime to assess the risk (if any) to wildlife associated with the higher cyanide discharge concentrations. As part of the wildlife monitoring regime, GS must conduct seasonal insectivorous bat monitoring to understand patterns of use and associated risks afforded by the tailings system.

This report demonstrates and fulfils the requirements of Recommendation 4 of the Re-evaluation Report.

The influence of hypersalinity on insectivorous bats is not well understood. However, bat activity has been found to diminish around hypersaline water bodies (relative to freshwater bodies) by two orders of magnitude (Adams, Donato et al. 2008, Smith 2010). Monitoring of bat activity has been undertaken at the GS tailings facility since 2007, with data from previous reports indicating that bats are the most common mammal on the GS tailings systems (Smith and Gursansky 2011 , Madden-Hallett, Gursansky et al. 2013). A greater understanding of bats' seasonal usage of tailings dams will further enable GS to adopt a proactive approach to managing any risk to bats and maintaining compliance with the Code.

Insectivorous bats were monitored using Anabat™ SD2 detectors at the tailings storage facility (TSF) on four occasions: Summer, Autumn, Winter, and Spring. Anabat™ devices were placed near the supernatant at the active TSF cell, and concurrent monitoring using the same methodology was also used to survey bats at a non-saline control site. From July 2021 to October 2024, the control site monitoring was located at the Phoenix pit. Each Anabat™ recorded for a continuous period of four hours from dusk. Bat activity is measured as calls per hour (CPH).

For completeness, historical bat monitoring data collected from 2007 to 2023 at GS is provided and analysed in the context of the data from the current monitoring period. This report is provided to further understand bat ecology and risks at the tailings system in the context of the Code. A Cyanide Code auditor may request this report.

Bat monitoring was conducted for 108 hours over 27 nights at the TSF and 96 hours over 24 nights at the control site for the current reporting period. At the TSF, 106 echolocation calls (1.0 CPH) were recorded from four taxa, of which four (4%) were buzz calls (feeding calls). At the control site, 1 665 echolocation calls (17.3 CPH) were recorded from seven taxa, of which 40 (2%) were buzz calls.

Historically, the relationship between bat activity at the TSF and the control site suggests that if the region experiences a dry summer, bats leave the region and migrate to wetter or more favourable habitats. If the region experiences a wet summer, bats either stay in the area or return to the region from drier habitats. This corresponds with bats taking advantage of increased freshwater bodies that attract food (insects) to the region. Bat activity appears to be less influenced by winter rainfall at the TSF and control sites. This is expected, as the six months are represented by cold nights, low abundance of flying insects, and is also the period when most bats are in torpor or have left the region.

In 2019 and 2020, predominantly at the TSF, this trend did not continue. Bat activity increased to 11.4 and 9.4 calls per hour, respectively, while summer rains declined. Summer rains in 2019 and 2020 were 10% and 63% below the long-term average, and bat activity increased by 256% and 194%, respectively. However, from 2021 to 2023, following four consecutive years of limited summer rains, bat activity at the TSF has continued to decline from 1.5 CPH to 0.6 CPH.

In 2024, summer rains increased by 374% compared to the previous four years, but bat activity has been relatively subdued. In previous years, a delay of up to 12 months between the change in climatic conditions and the response in bat activity has been documented.

Bat activity at the control site has fluctuated since monitoring commenced in 2010 at an annual average of 17.8 ± 10.4 calls per hour (n = 15 years). Annual bat activity levels have also increased and declined in response to summer rains. However, in recent years (2020 to 2024) these fluctuations may result from the haul road lakes drying out in 2017 and moving the control site in 2018 to the larger water masses at the Windich and Phoenix pits.

Previously, as salinity decreased at the TSF, bat activity and buzz calls increased at the TSF and decreased at the control site compared to the long-term averages. This was not the case in 2024 and from 2019 to 2023, with bat activity remaining low at the TSF as corresponding TDS results were also low. Historically, a decline in salinity at the TSF has resulted in increased feeding/drinking behaviour of the bats currently present at GS.

The results from the 2024 bat monitoring considered in this report are consistent with previous findings. They demonstrate that the risks to wildlife from cyanide in the TSF have not measurably changed since the Causational Report.

Introduction

Granny Smith Gold Mine (GS) was initially certified as compliant with the International Cyanide Management Code (Code) in April 2011, recertified in March 2014, April 2017, October 2019 and most recently in May 2022. In part, ongoing full compliance was subject to the fulfilment of recommendations made in the report titled *Influences of hypersaline tailings on wildlife cyanide toxicosis: Granny Smith Gold Mine, December 2010* (Smith 2010) and referred to here as the Causational Report. These recommendations were subsequently amended in July 2014 in the report titled *Re-evaluation of Recommendations associated with the International Cyanide Management Code Standard of Practice 4.4* (Overdevest and Donato 2014) and referred to here as the Re-evaluation Report.

This is the tenth annual bat monitoring report as an adjunct to the Re-evaluation Report. This replaces the six-monthly technical reports for the Granny Smith Gold Mine that were an adjunct to the Causational Report.

Recommendation 4 of the Re-evaluation Report required GS to maintain a systematic and comprehensive wildlife monitoring regime to assess the risk (if any) to wildlife associated with the higher cyanide discharge concentrations as part of its compliance requirements. As part of the wildlife monitoring regime, GS must conduct seasonal insectivorous bat monitoring to understand patterns of use and associated risks afforded by the tailings system.

GS was one of three mining operations that undertook a study in the context of the Code on the effects of hypersalinity as a protective mechanism for wildlife from an otherwise toxic solution (Adams, Donato et al. 2008). Code Standard of Practice 4.4 requires operations to implement measures to adequately protect wildlife, particularly birds and livestock, from the adverse effects of cyanide process solutions. That study was conducted under the auspices of the Minerals and Energy Research Institute of Western Australia as Project 398 (referred to here as M398). The study accepted that hypersalinity acted as a protective mechanism and led to compliance with Code Standard of Practice 4.4 for two operations.

At the time of the M398 study, the GS tailings system was determined to be a saline system rather than hypersaline and therefore, required further work. Once GS installed a hypersaline wash circuit to produce a hypersaline tailings stream and supernatant, a second study (Causational Report) (Smith 2010) commenced, building on and continuing the M398 study (Adams, Donato et al. 2008). The study developed and rigorously tested hypotheses describing the general trend of lower wildlife mortality rates due to cyanide toxicosis at high salinity levels. One hypothesis has been accepted by peer review as follows:

> *Hypothesis 7A: Hypersalinity (> 50 000 mg/L total dissolved solids (TDS)) provides a natural barrier for wildlife exposure to weak acid dissociable (WAD) cyanide contained in tailings solutions because at this salinity the solutions are outside the physiologically safe drinking range of wildlife and wildlife seeks to avoid its ingestion while foraging.*

Recommendations provided in the Causational Report were made in the context of the relevant standards of practice specified in the Code. The recommendations addressed perceived risks of wildlife cyanosis at GS and identified requirements for ongoing compliance with the Code. The recommendations addressed maintenance of the protective measures already in place (> 50 000 mg/L TDS within the tailings) and possible changes of risks to wildlife under differing environmental and seasonal conditions. Each of the recommendations developed is site-specific to GS.

This report is primarily aimed at addressing Recommendation 3 of the Causational Report, amended to Recommendation 4 of the Re-evaluation report that assessed hypersalinity as a protective mechanism at GS (Smith 2010), which is as follows:

> *Recommendation 4: Assessment of risk to wildlife on a continual basis*
>
> *This requires a continuation of the wildlife (including seasonal bat) monitoring at the TSF and an appropriate control waterbody until patterns of use and associated risks are understood. The data collected during these survey times shall be assessed for consistency with existing knowledge of the ecology of the GS TSF and associated risks*.

Donato Environmental Services Pty Ltd (DES) has conducted seasonal bat monitoring since Code compliance was achieved to address this recommendation. This annual bat report presents results from the bat monitoring conducted in 2024. Monitoring was undertaken at the GS tailings system and an associated control site (Phoenix pit).

Background

Wildlife and livestock that visit and interact with gold mine tailings dams and associated water bodies are at risk of exposure to bioavailable cyanide present in waste solutions (Clark and Hothem 1991, Henny, Hallock et al. 1994, Northern Territory Bird Study Group 1998, Eisler, Clark et al. 1999). The primary exposure pathways for wildlife at hypersaline mine waste solutions are feeding or attempting to feed in cyanide-bearing supernatant and wet tailings habitats (Resource Assessment Commission 1991, Minerals Council of Australia 1996, Donato, Nichols et al. 2007). Specific exposure pathways are related to wildlife guilds and the behavioural ecology of each guild (Donato, Nichols et al. 2007, Smith and Donato 2007, Donato, Smith et al. 2008). The relative importance of the exposure pathways is likely to vary between mine sites according to the abundance of wildlife guilds in the surrounding region and the amount and type of habitats present within cyanide-bearing water bodies (Griffiths, Smith et al. 2009).

Within the gold industry, birds are the most commonly reported wildlife guild to suffer deaths due to interaction with tailings dams, however insectivorous bats, cattle, goats, frogs, lizards and marsupials have also been recorded (Donato 1999, Environment Australia 2003). Despite a range of wildlife, including many migratory bird species, being known to visit and interact with tailings dams on a seasonal basis (Clark 1991, Eisler 1991, Donato 1999, Griffiths, Smith et al. 2009), there is a lack of published information available on usage patterns of tailings dams by wildlife. Although the movement of many migratory birds is said to be predictable (Kingsford and Norman 2002), few studies exist on their interaction patterns with tailings dams. There is no literature on the seasonal movements of insectivorous bats and limited literature on their interactions with mine tailings systems (Griffiths, Smith et al. 2009, Griffiths, Donato et al. 2014a, Griffiths, Donato et al. 2014b).

All bats belong to the order Chiroptera, which consists of two main suborders: Microchiroptera (insectivorous bats) and Megachiroptera (typically fruit bats) (Van Dyck and Strahan 2008). No fruit bats are known to be present at GS; therefore, the information provided in this report is focused solely on the insectivorous bats, their behaviour and habitat preferences. Insectivorous bats are generally small, roost in crevices, hollows and, on occasion, houses and use echolocation for navigation and hunting. Their preferred diet includes moths and beetles. However, most insectivorous bats are opportunistic and will consume a broad range of insects, including mosquitoes and midges. Most Microchiroptera are aerial foragers, catching and eating insects on the wing and, therefore, can remain airborne for hours at a time (Churchill 1998). Insectivorous bats, although not blind, rely on echolocation to navigate and hunt for food.

Echolocation calls are high-frequency sound waves made when a bat forces air through its vocal cords, causing them to vibrate rapidly (many thousands of times per second) (Churchill 1998). This vibration creates a sound pulse that bounces back from surrounding objects. The echoes are detected by the bat’s sensitive ears and are converted to provide the bat with information on the size, texture, and distance of surrounding objects. These calls' tone, rate and frequency can be used to determine a bat’s behaviour. Cruise calls are those that are emitted for navigation purposes and tend to be at a consistent rate and generally faint. As a bat approaches its target, the calls are made more frequently. Feeding calls (referred to as buzz calls) are rapid, frequent calls and result in a distinctive pattern (as recorded by an echolocation recording device) and differ from a general cruise call (Churchill 1998, Adams, Donato et al. 2008). Social calls are generally associated with calls from within or outside a roost. The calls tend to be very low frequency and sometimes audible to humans.

Bat identification using echolocation devices compares recorded calls with known reference calls for a given species. These reference calls are referred to as voucher calls. Voucher calls vary for each species and can vary within a species depending on geographic location. Output data from echolocation devices (sequence files) provide call time, frequency, and call rate information. They can be interpreted to obtain a relative measure of bat activity and behaviour. Echolocation recording devices provide a cost-effective and non-invasive technique to determine the bat ecology of a region.

Methodology

Bat data collection

Insectivorous bats have been monitored using Anabat™ SD2 echolocation call detector systems at the GS tailings system (Figure 1). The detectors were programmed to operate from four to six consecutive nights quarterly (weather permitting). Each Anabat™ recorded for a continuous period of four hours from dusk. Bat activity is measured as calls per hour (CPH).

Anabat™ SD2 systems are not waterproof and would not be set on some nights due to the potential of rain.

During the 2024 calendar year, monitoring using Anabat™ SD2 detectors was conducted at the tailings storage facility (TSF) in January (Summer), April (Autumn), July (Winter), and October (Spring). Anabat™ devices were placed near the supernatant at the active TSF cell.

Concurrent monitoring using the same methodology was also used to survey bats at a non-saline control site. The haul road lakes have historically been the first choice to be used as the control site as they were used and reported in the Causational Report (Smith 2010) and in previous years (2010 to 2017) technical reports (Smith and Gursansky 2011 , Madden-Hallett, Gursansky et al. 2013). From 2018 to April 2021, the control site monitoring was located at the Windich Pit in response to the drying of the haul road lakes. From July 2021 to October 2024, the control site monitoring was located at the Phoenix pit (Figure 2) in response to salinity levels at the Windich pit increasing above 35 000 mg/L TDS.

For completeness, data collected at the TSF and the control site from 2007 to 2023 has been included in the current report (in summary) to enable a review of bat activity and behaviour over four seasons for 17 years. The complete historical dataset has been reported previously (Smith and Gursansky 2011 , Madden-Hallett, Gursansky et al. 2013 , Gursansky and Donato 2016, Gursansky and Donato 2017, Gursansky and Donato 2018, Gursansky and Donato 2019, Gursansky and Donato 2020, Gursansky and Donato 2021, Gursansky and Donato 2022).

Analyses of echolocation call data included identifying species, where possible, and the number of calls recorded for each species. Anabat™ software (Corben 2000b) was used for recording calls and AnaLook software (Corben 2000a) to view calls for bat identification. Bat calls were identified using voucher call samples documented in Pennay, Law *et. al.* (2004) (Pennay, Law et al. 2004). To maintain time-series independence, the analysis did not include calls of the same species within five seconds (Pennay, Law et al. 2004). Only search-phase calls were used for bat identification, as these are relatively regular-shaped pulses that bats emit as they navigate the landscape.

Some difficulty occurred in distinguishing between calls of Gould's Wattled Bat (*Chalinolobus gouldii*) and the Inland Broad-nosed Bat (*Scotorepens balstoni*). Difficulty in separating Gould's Wattled Bat from *Mormopterus* species also occurred. Therefore, if identification to species level for these calls could not be determined, the call was recorded as unidentified. Difficulty differentiating between various species of the genera Scotorepens occurred; therefore, all calls were collated and recorded as *Scotorepens* spp.. The free-tailed bat taxonomy is currently unresolved, so all free-tailed bat calls were grouped as *Mormopterus* spp., except for *Austronomus australis. Nyctophilus* species cannot be accurately separated and were subsequently collated at the generic taxa level.

Nomenclature

Due to the current ongoing taxonomic changes for Chiroptera species, the nomenclature for this report follows that used in previous reports with the following exceptions: Generic common names for Free-tailed Bats (mainly *Mormopterus* spp.) (Reardon, Armstrong et al. 2015) (previously recorded as Inland Free-tail Bat). White-striped Free-tailed Bat (*Austronomus australis*) (Reardon, Armstrong et al. 2015) has taxonomically changed and was previously recorded as *Tadarida australis*.

Chemistry data collection

Chemical sampling was conducted by trained technicians of the TSF discharge spigot when the mill was operational, typically for 13 to 14 consecutive days per calendar month. Tailings samples were analysed on-site for cyanides and salinity (as total dissolved solids (TDS)).

Data collected by the Anabat^{TM} SD2 detectors were compared with the monthly average salinity and cyanide concentrations. Relationships between bat activity and the chemical and physical parameters were assessed for the period January 2024 to October 2024, inclusive.

Figure 1. Anabat located at TSF 4 Supernatant Anabat inside the rainproof box: Photo April 2024.

Figure 2. Anabat control site has moved to the Phoenix Pit since July 2021. Photo July 2024.

Results

Bat monitoring was conducted for 108 hours over 27 nights at the TSF and 96 hours over 24 nights at the control site for the current reporting period (Table 1). At the TSF, 106 echolocation calls (1.0 CPH) were recorded from four taxa, of which four (4%) were buzz calls (Table 1). At the control site, 1 665 echolocation calls (17.3 CPH) were recorded from seven taxa, of which 40 (2%) were buzz calls (Table 1). As indicated in Table 1, bat activity was lower at the TSF by 179% compared with the freshwater control site at 1.0 calls per hour compared to 17.3 calls per hour, respectively.

Table 1. Total number of nights, hours and insectivorous bat cruise and buzz calls recorded using Anabat™ SD2 detectors between January 2024 and October 2024 at the TSF and the control site

Site	Nights	Hours	Cruise calls	Cruise calls per Hour (CPH)	Buzz Calls	Buzz Calls per Hour	Ratio: Cruise calls to Buzz Calls
TSF	27	108	106	1.0	4	0.04	27:1
Control	24	96	1 665	17.3	40	0.4	42:1

DES commenced bat monitoring over the TSF in 2007 and included 1 296 hours of monitoring over 323 nights from August 2007 to October 2024. For this period, 3 413 cruise calls have been recorded, of which 363 (11%) were buzz calls (Table 2).

In 2024, bat activity over the TSF increased by 66% from the previous year and was 62% lower than the long-term average (17 years) at 2.6 CPH. Buzz calls per hour over the TSF have increased by 67% from the previous year (0.04 to 0.01) and are also lower by 87% from the long-term average at 0.3 (Table 2).

Table 2. Total number of nights, hours and insectivorous bat cruise and buzz calls recorded using AnabatTM SD2 detectors between August 2007 and October 2024 at the TSF

Year	Survey Nights	Hours	Total Calls	Buzz Calls	Calls per Hour (CPH)	Buzz calls per Hour	Ratio: Cruise Calls to Buzz Calls
2007 Summary	2	8	8	2	1	0.3	4:1
2008 Summary	7	28	23	4	0.8	0.1	6:1
2009 Summary	0	0	0	0			
2010 Summary	20	80	53	3	0.7	0.0	18:1
2011 Summary	22	88	138	20	1.6	0.2	7:1
2012 Summary	13	52	98	25	1.9	0.5	4:1
2013 Summary	23	92	81	14	0.9	0.2	6:1
2014 Summary	12	48	74	17	1.5	0.4	4:1
2015 Summary	14	56	29	6	0.5	0.1	5:1
2016 Summary	17	68	221	28	3.3	0.4	8:1
2017 Summary	21	84	292	43	3.5	0.5	7:1
2018 Summary	34	136	161	6	1.2	0.04	27:1
2019 Summary	21	84	954	110	11.4	1.31	9:1
2020 Summary	22	88	829	68	9.4	0.8	12:1
2021 Summary	24	96	142	9	1.5	0.1	16:1
2022 Summary	26	108	161	3	1.5	0.03	50:1
2023 Summary	18	72	43	1	0.6	0.01	43:1
2024 Summary	27	108	106	4	1.0	0.04	27:1
Total All Years	323	1 296	3 413	363	2.6	0.3	9:1

DES commenced bat monitoring at a freshwater control site in 2010 and has included 1 272 hours of monitoring over 318 nights from April 2010 to October 2024. For this period, 22 620 cruise calls have been recorded, of which 1 925 (9%) were buzz calls (Table 3).

In contrast to the increase in bat activity at the TSF, control site bat activity decreased in 2024 by 38% from the previous year 28.1 to 17.3 CPH. Calls per hour at the control site were only 3% lower than the long-term average (15 years) at 17.8 CPH (Table 3). When results from the full dataset are reviewed, it is evident that annual bat activity over a freshwater control site continues to be notably higher and more variable than the TSF.

Due to extended dry periods, the haul road lakes control site dried out in 2017. From 2018 to 2024, the control site has been either the Windich or Phoenix pit and, in 2022 and 2024, exclusively the Phoenix pit. It was expected that the enlarged water mass at the two pits would provide a greater food source (insect activity), which is shown to be correct by the rise in buzz calls since 2019 (Table 3).

Table 3. Total number of nights, hours and insectivorous bat cruise and buzz calls recorded using Anabat^{TM} SD2 detectors between April 2010 and October 2024 at the control site

Year	Survey Nights	Hours	Total Calls	Buzz Calls	Calls per Hour (CPH)	Buzz calls per Hour	Ratio: Cruise Calls to Buzz Calls
2010 Summary	17	68	395	66	5.8	1.0	6:1
2011 Summary	22	88	1 414	319	16.1	3.6	4:1
2012 Summary	9	36	428	84	11.9	2.3	5:1
2013 Summary	18	72	713	152	9.9	2.1	5:1
2014 Summary	15	60	2 587	451	43.1	7.5	6:1
2015 Summary	19	76	1 128	124	14.8	1.6	9:1
2016 Summary	23	92	785	42	8.5	0.5	19:1
2017 Summary	18	72	609	56	8.5	0.8	11:1

Year	Survey Nights	Hours	Total Calls	Buzz Calls	Calls per Hour (CPH)	Buzz calls per Hour	Ratio: Cruise Calls to Buzz Calls
2018 Summary	32	128	1 645	71	12.9	0.6	23:1
2019 Summary	19	76	2 520	104	33.2	1.4	24:1
2020 Summary	21	84	939	104	11.2	1.2	9:1
2021 Summary	24	96	2 093	103	21.8	1.1	20:1
2022 Summary	37	148	3 452	95	23.3	0.6	38:1
2023 Summary	20	80	2 247	114	28.1	1.4	20:1
2024 Summary	24	96	1 665	40	17.3	0.4	42:1
Total All Years	318	1 272	22 620	1 925	17.8	1.5	12:1

In 2024, bat activity above the TSF was evenly spread between summer and spring (1.1 CPH) and autumn (1.0 CPH) and lowest in winter (0.7 CPH), with 28%, 26% and 17% of total calls, respectively (Figure 3). This result follows from the long-term trend (17 years), where bat activity above the TSF is evenly spread between summer, spring, and autumn and lowest in winter.

Similar to the previous year, White-striped Free-tailed Bat (*Austronomus australis*) and Free-tailed Bat taxa (*Mormopterus* spp.), each with 0.5 CPH (33% of total calls) were the two most actively recorded species above the TSF (Figure 3). White-striped Free-tailed Bat was most active in autumn and winter and recorded only once in summer. Free-tailed Bat was active in all seasons with the exception of winter when they were not present.

Gould's Wattled Bat (*Chalinolobus gouldii)* was the only other taxa recorded across all seasons at 0.2 CPH (11% of calls), similar to 2021 to 2023, ranging between 6% and 16% of total calls (Figure 3).

Two taxa, Broad-nosed Bat (*Scotorepens* spp.) and Long-eared Bat (*Nyctophilus* spp.) were both recorded on one occasion at 0.01 CPH in summer and autumn respectively in 2024. Broad-nosed Bat were recorded on two occasions, similarly in summer, in 2023. Long-eared Bat was not recorded above the TSF in 2023, it was last recorded above the TSF on two occasions in autumn 2022.

Forest Bat (*Vespadelus* spp.) and Chocolate Wattled Bat (*Chalinolobus morio)* have not been recorded above the TSF in 2022, 2023 and 2024. They were both recorded in 2021 on four and one occasion, respectively. Unidentified calls represented 21% of total calls (Figure 3).

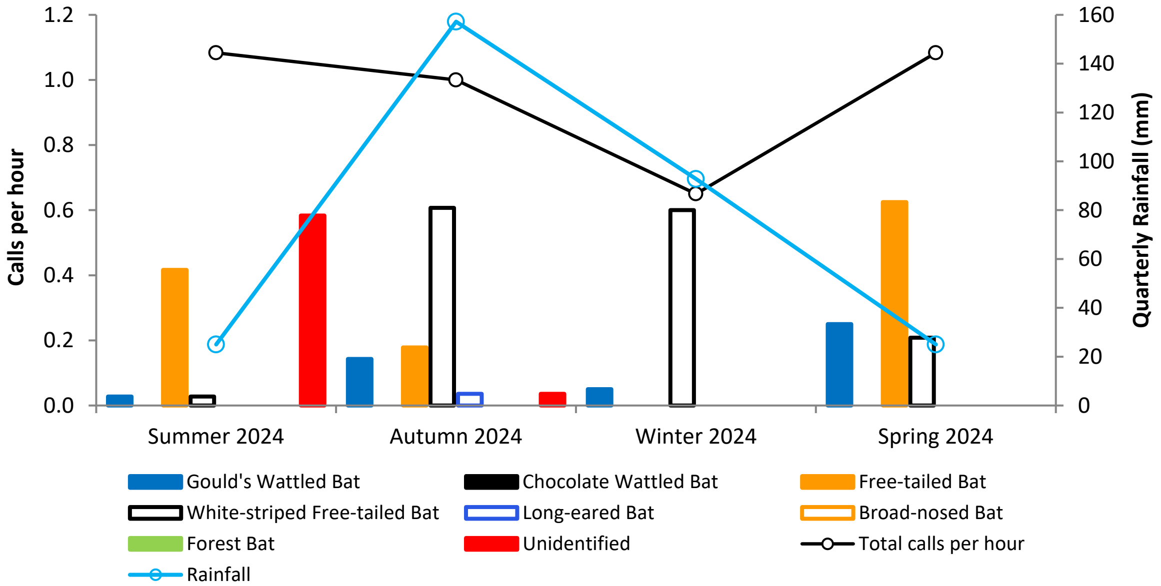

Figure 3. Seasonal bat activity (calls per hour) and quarterly rainfall at the TSF in 2024

Figure 4 illustrates bat activity per species and total calls per hour for all species combined seasonally at the TSF from August 2007 to October 2024. It shows bat activity at the TSF is lowest in winter and whilst evenly spread, gradually increases through the seasons, from autumn to summer and the spring recording the highest bat activity.

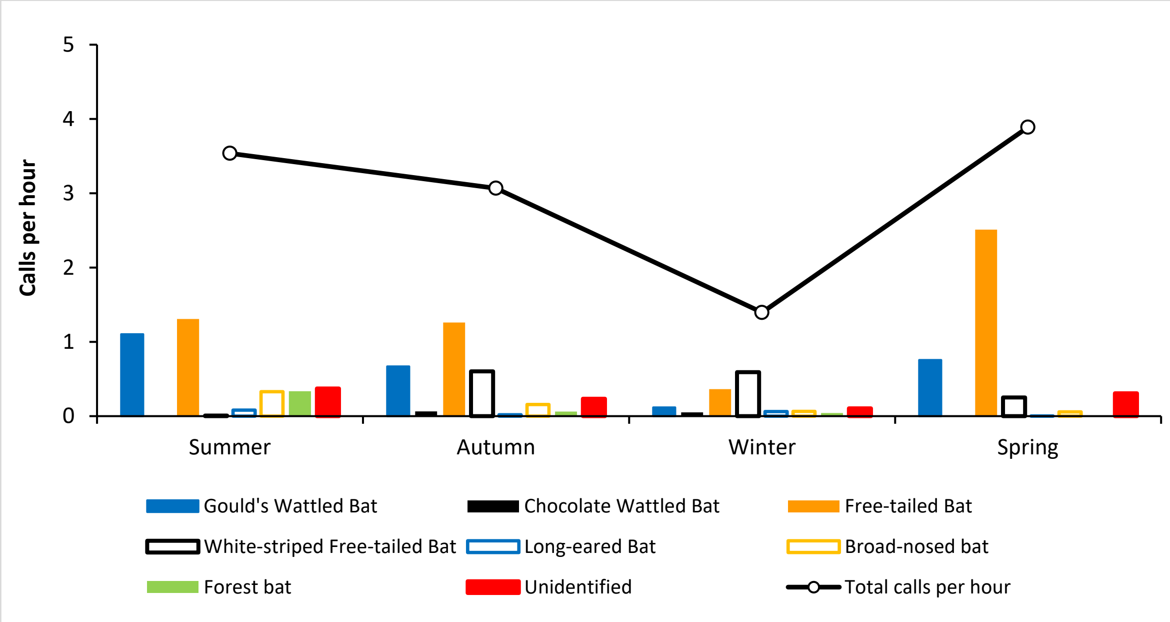

Figure 4. Seasonal bat activity above the TSF from 2007 to 2024

Bat activity at the control site in the 2024 monitoring period was highest in the summer survey, with 38.8 CPH and 54% of total calls and lowest in spring at 5.5 CPH and 8% of total calls, (Figure 5).

With a notable increase of activity in the summer, Gould's Wattled Bat at 9.5 CPH was the most active taxa recorded at the control site, with 50% of total calls. Three taxa; Free-tailed Bat (4.0 CPH), White-striped Free-tailed Bat (3.3 CPH), and Broad-nosed Bat (1.8 CPH) were each recorded in similar numbers. Free-tailed Bat were recorded across all four seasons, White-striped Free-tailed Bat was recorded in autumn and winter only and Broad-nosed Bat was not recorded in winter (Figure 5).

Two taxa; Forest Bat and Long-eared Bat each at (0.2 CPH), were active in low numbers across all four seasons (Forest Bat was not recorded in winter). Chocolate Wattled Bat was not recorded in 2024, in 2023 it was recorded at (0.03 CPH) in the summer only. Unidentified calls represented 10% of total calls at the control site and are most likely from Gould's Wattled Bat, Free-tailed Bat and Broad-nosed Bat (Figure 5).

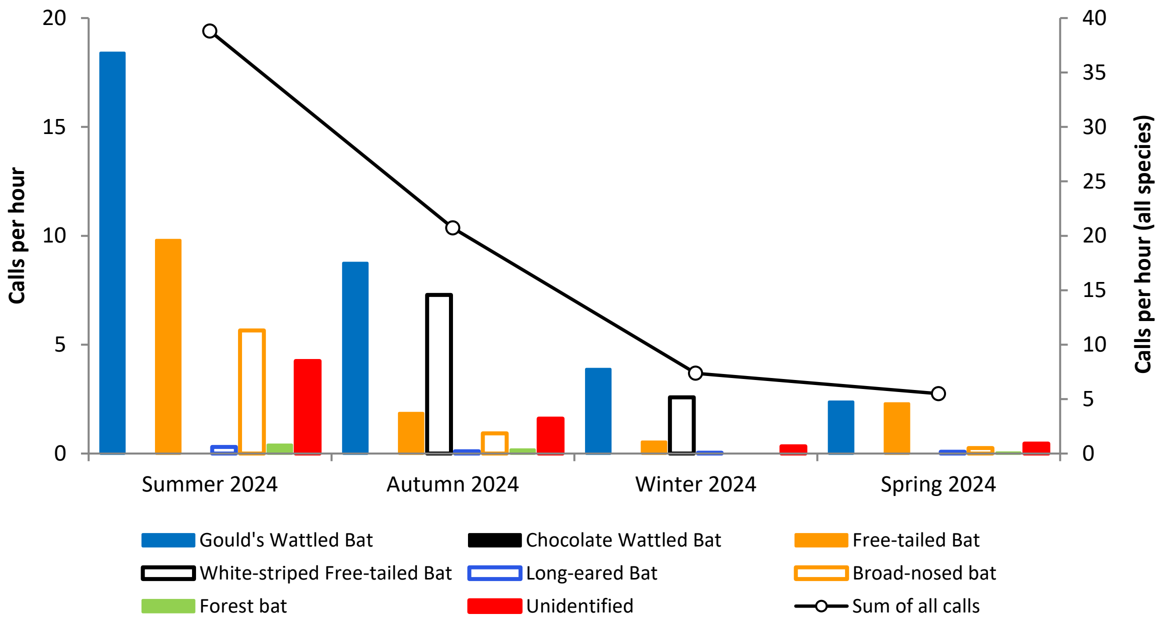

Figure 5. Seasonal Bat Activity (calls per hour) at the control in 2024. The primary y-axis displays calls per hour for each species per survey period, and the secondary y-axis displays total calls per hour for all species combined for the same period

Figure 6 illustrates bat activity per species and total calls per hour for all species combined seasonally at the control site from April 2010 to October 2024. It shows that bat activity per season at the control site is also lowest in winter, similar in the autumn and spring and notably higher in the summer. It would be reasonable to expect greater activity during summer and spring with greater flying insect activity compared to the cooler periods of June and July (Churchill 1998).

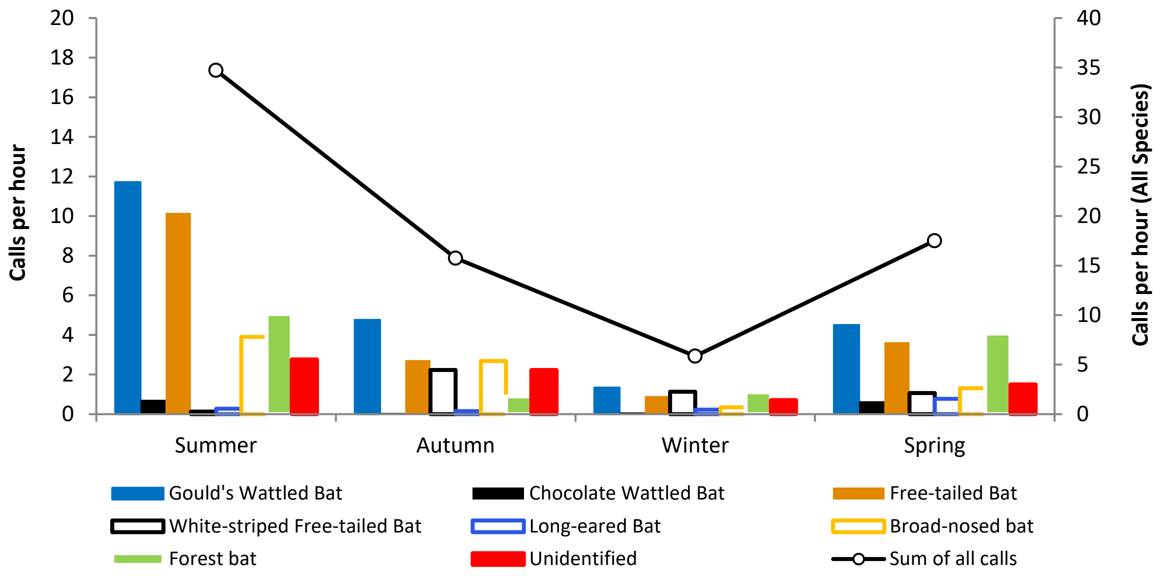

Figure 6. Seasonal bat activity at the control site from April 2010 to October 2024. The primary y-axis displays calls per hour for each species per season, and the secondary y-axis displays total calls per hour, all species combined for the same period.

A summary of the 2024 chemistry results from on-site analysis of WAD cyanide and salinity (total dissolved solids (TDS)) at the TSF spigot is provided in Figure 7. WAD cyanide concentration was stable throughout the year, and the highest monthly average was in September at 38.1 mg/L ± 5.5 and the lowest in March at 29.1 mg/L ± 12.7. The average WAD cyanide concentration for the 12 months was 33.8 mg/L ± 9.1. WAD Cyanide exceeded 50 mg/L on two occasions, on 20 January and 14 October WAD Cyanide and TDS were 52.4 mg/L and 81 000 mg/L TDS and 50.4 mg/L and 38 200 mg/L TDS respectively.

Salinity at the spigot fluctuated throughout the year, ranging from a monthly average high of 61 693 mg/L TDS ± 15 215 in January to a low of 8 425 mg/L TDS ± 966 in April. The average salinity at the spigot for the year was 20 328 mg/L TDS ± 15 054 and was less than 50 000 mg/L TDS on 93% of occasions. The minimum salinity was 6 400 mg/L TDS on 12 April; the corresponding WAD Cyanide at the TSF spigot was 33.2. mg/L.

The monthly average salinity in the supernatant was 21 165 mg/L TDS ± 22 833 and was below 20 000 mg/L TDS for seven consecutive months between February and August, with the minimum monthly in March at 7 393 mg/L TDS. The monthly average WAD cyanide in the Supernatant was 17.8 mg/L ± 10.4.

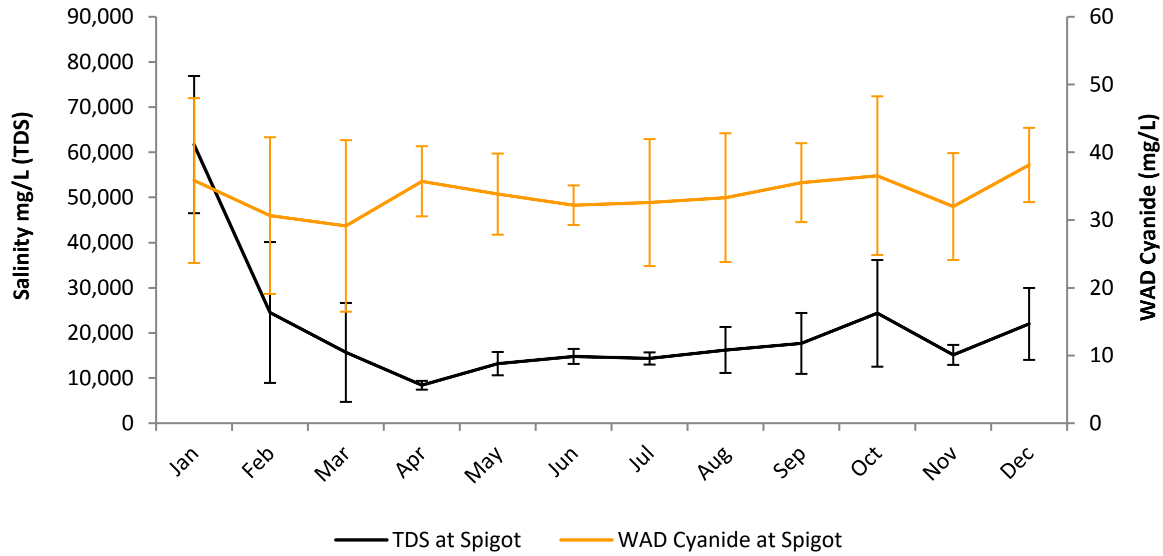

Figure 7. Monthly average (± SD) of WAD cyanide concentrations and salinity (TDS) taken from 13 to 14 samples per month at the TSF spigot in 2024

Discussion

Collation of bat calls can be used to preliminarily assess the presence and relative activity (not actual abundance) of bats within an area. The activity of insectivorous bats over water bodies is linked to access to surface water for drinking (Clark and Hothem 1991, Sanderson and Kirkley 1998) and acquiring food resources such as invertebrates above a water body. Compared to historical data, monitoring data obtained from February to October 2024 has shown that bat activity at the TSF has increased by 66% from 2023, however is lower than all previous years since 2015 and represents a long-term decline following a spike in 2019 and 2020 (see Table 2). The spike in bat activity throughout the summer of 2019 and late spring of 2020 influenced these results.

In contrast, bat activity at the control site in 2024 has decreased by 26% from 2023, however is within 3% of the long-term average (n = 15 years at 17.8 CPH). Since the control site was moved to the Phoenix Pit in mid-2021, recorded bat activity has been marginally higher than the long-term average (15 years) (see Table 3).

Bats drinking the cyanide-bearing supernatant at 14 000 mg/L TDS has not been recorded in literature but cannot be dismissed. In October 2016, when the haul road lakes became dry and salinity at the TSF decreased to 14 600 TDS, bat activity and buzz calls were higher at the TSF than at the control site. However, in 2019, 2020 and in the current monitoring period 2024, when average salinity at the TSF was also well below 15 000 TDS, bat activity and buzz calls remained higher at the control site than at the TSF.

Bat activity has been higher at the control site than at the TSF every year since concurrent monitoring commenced in 2010. This high activity level is likely due to the availability of resources (macroinvertebrates) or nearby roost sites. Bats may not differentiate between the TSF and alternate fresh water sources when they are not hypersaline. Also, the likelihood of drinking the TSF supernatant is enhanced when alternative freshwater sites have become dry. This is consistent with the findings of M398 (Adams, Donato et al. 2008) where a drop in salinity usually increases bat activity and buzz call ratio.

Seasonality and environmental conditions

DES has monitored bat activity at GS from August 2007 to October 2024. Rainfall for the 18 years is an average of 264 mm per year (22.0 ± 30.8 mm per month). The six-month period from October to March (summer) is the wet period (71% of total annual rainfall) at an average of 31.5 ± 38.9 mm per month. The six-month period from April to September (winter) is the dry period (29% of total annual rainfall) at an average of 12.6 ± 14.5 mm per month. Historically, summer rain from October to March has strongly influenced bat activity at the TSF (Figure 8) and, to a lesser extent, bat activity at the control site (Figure 9).

Bat activity at the TSF has remained relatively constant since monitoring commenced in 2007 at an annual average of 2.5 ± 3.1 calls per hour (n = 17 years). Between 2007 and 2015, bat activity at the TSF peaked in 2011 and 2012 at 1.6 and 1.9 calls per hour, respectively (see Table 2). Interestingly, other mine sites in the region (DES unpublished data (Gursanksy and Donato 2017)) also experienced notable increases in bat activity at the TSF in 2012. This followed consecutive years of higher-than-average summer rains in 2011 and 2012.

In 2013, bat activity was reduced to 0.9 calls per hour with declining summer rains, and in 2014, bat activity increased to 1.5 calls per hour in response to an increase in summer rainfall. In 2015, summer rain reduced, and bat activity at the TSF was also reduced to 0.5 calls per hour.

In 2016 and 2017, bat activity on the TSF increased to ten-year highs of 3.3 and 3.5 calls per hour, respectively. This increase corresponds to the region receiving higher-than-average summer rains in 2016 and 2017. In 2018, bat activity above the TSF decreased to 1.2 calls per hour, corresponding with the region receiving a decrease in summer rains. This relationship is replicated at other regional mine sites (DES unpublished data (Gursanksy and Donato 2017)).

In 2019 and 2020, predominantly at the TSF, this trend did not continue. Bat activity increased to 11.4 and 9.4 calls per hour, respectively, while summer rains declined. Summer rains in 2019 and 2020 were 10% and 63% below the long-term average, and bat activity increased by 256% and 194%, respectively. However, from 2021 to 2023, following four consecutive years of limited summer rains, bat activity at the TSF has continued to decline from 1.5 CPH to 0.6 CPH (Figure 7).

In 2024, summer rains have increased by 374% on the previous four years and however bat activity has been relatively subdued, in previous years a delay of up to 12 months between the change in climatic conditions and the response in bat activity has been documented.

Bat activity at the control site has fluctuated since monitoring commenced in 2010 at an annual average of 17.8 ± 10.4 calls per hour (n = 15 years). Annual bat activity levels have also increased and declined in response to summer rains. However, in recent years (2020 to 2024), this may have resulted from the haul road lakes drying out in 2017 and moving the control site in 2018 to the larger water masses at the Windich and Phoenix pits.

Historically, the relationship between bat activity at the TSF and the control site suggests that if the region experiences a dry summer, bats leave the region and migrate to wetter or more favourable habitats. If the region experiences a wet summer, bats tend to stay in the area or return to the region from drier habitats. This corresponds to bats taking advantage of increased freshwater bodies that attract food (insects) to the region.

The increase in bat activity in 2019 and 2020 at the TSF and control site appears as an outlier compared to all previous years' monitoring. However, the low annual rainfall in 2019 (60.2 mm), is also an outlier. The drought conditions the greater region of Western Australia experienced may have attracted bats back to the permanent water sources of Windich and Phoenix pits and the TSF, as all alternate water sources have dried up. As rainfall deficiencies continue and water resources become limited, the observed behaviour may change in response to current climatic conditions. In previous years, a delay of up to 12 months between the change in climatic conditions and the response in bat activity was occurring, particularly at the freshwater control site (see Figure 9). However, as conditions become more extreme, response times may be becoming more immediate.

Bat activity is not influenced by winter rainfall at the TSF and control site. This is expected as the six months are represented by cold nights and low insect activity and is also when most bats are in torpor or have left the region.

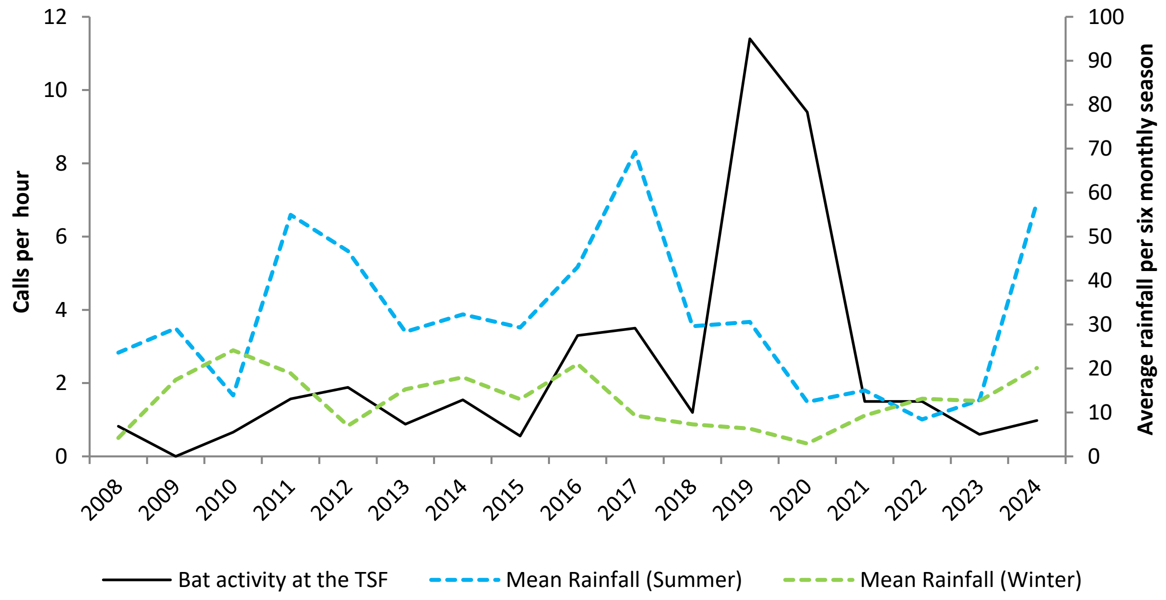

Figure 8. TSF total annual bat calls per hour for all species for summer (October to March) and winter (April to September) rain periods from 2008 to 2024 (excluding 2009 when nil bat data was collected).

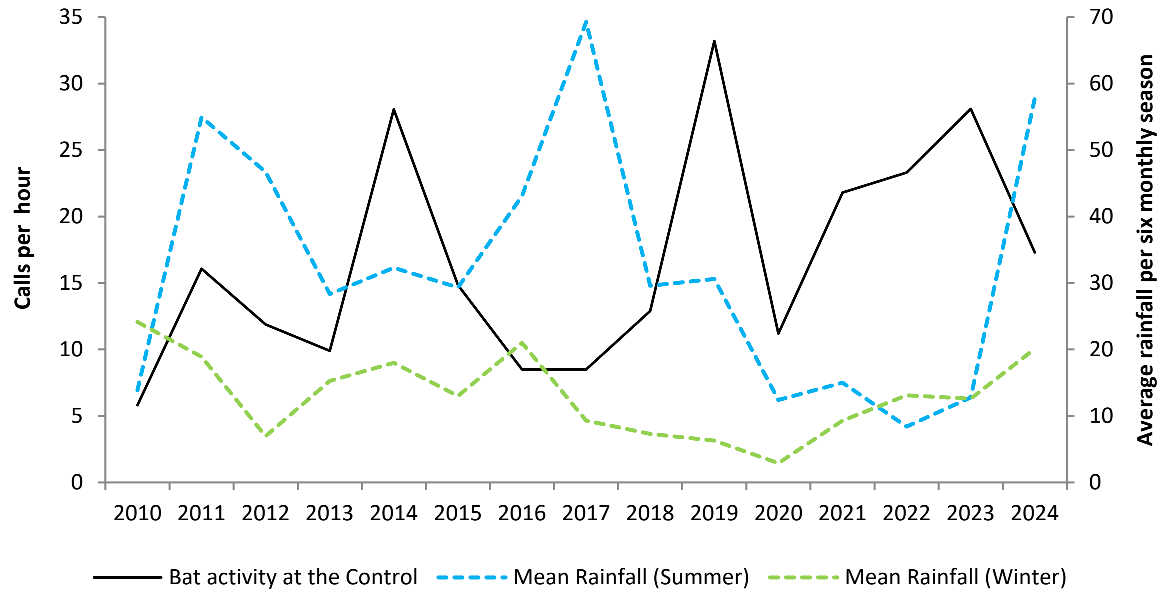

Figure 9. Control site total annual calls per hour for all species for summer (October to March) and winter (April to September) rain periods from 2010 to 2024.

Conclusion

This report demonstrates and fulfils the requirements, in part (seasonal bat monitoring), of Recommendation 4 of the Re-evaluation Report.

The results of the 2024 bat monitoring concur with the Causational Report, finding a direct relationship between the TSF supernatant salinity (or lack of it) and decreased bat activity and buzz calls. The maintenance of hypersalinity has been demonstrated to reduce bat activity, interaction, and risk to bats. Conversely, the risk profile for bats can increase due to greater presence and interaction, at least above the TSF, when it is not hypersaline. While the monthly average TDS at the spigot was below 50 000 mg/L TDS for eleven months in 2024, the WAD cyanide discharge concentrations were below 50 mg/L at a monthly average of 33.8 ± 9.1. The lowest average monthly salinity concentrations were in April, at 8 425 mg/L TDS, and the highest WAD cyanide concentration on a single day in April was 40.5 mg/L. On one day in 2024, WAD cyanide exceeded 50 mg/L, and salinity was below 50 000 mg/L TDS.

Previously, as salinity decreased at the TSF, bat activity and buzz calls increased at the TSF and decreased at the control site compared to the long-term averages. This was not the case in 2024 and previously from 2019 to 2023, bat activity remained low at the TSF, and corresponding TDS results were also low. Historically, a decline in salinity at the TSF has resulted in increased feeding/drinking behaviour of the bats currently present at GS.

The results from the 2024 bat monitoring considered in this report are consistent with previous findings. They demonstrate that the risks to wildlife from cyanide in the TSF have not measurably changed since the Causational Report.

References

Adams, M. D., D. B. Donato, R. S. Schulz and G. B. Smith (2008). Influences of Hypersaline Tailings on Wildlife Cyanide Toxicosis; MERIWA Project M398 (II) 'Cyanide Ecotoxicity at Hypersaline Gold Operations' Final Report Volume 2 - Definitive Investigation. Perth, MERIWA.

Churchill, S. (1998). Australian Bats. Melbourne, Reed New Holland.

Clark, D. R. and R. L. Hothem (1991). "Mammal mortality at Arizona, California, and Nevada gold mines using cyanide extraction." California Fish and Game 77(2): 61-69.

Clark, D. R., Jr. (1991). Bats, Cyanide and Gold mining: Where a drink of water may mean death: gold isn't the only legacy from mines. Bat Conservation International: BATS magazine. 9.

Corben, C. (2000a). Analook. Bat call analysis system.

Corben, C. A. (2000b). Anabat 6: Bat call analysis software.

Donato, D. (1999). Bird Usage Patterns on Northern Territory Mining Water Tailings and their Management to Reduce Mortalities, Public Report. Darwin, Northern Territory, Department of Mines and Energy.

Donato, D. B., O. Nichols, H. Possingham, M. Moore, P. F. Ricci and B. N. Noller (2007). "A critical review of the effects of gold cyanide-bearing tailings solutions on wildlife." Environmental International 33: 974-984.

Donato, D. B., G. B. Smith, S. R. Griffiths and C. G. Gillespie (2008). "Influences of gold mining tailings and hypersalinity on wildlife ingestion of solutions and cyanosis: a hypothesis and model." Unpublished.

Eisler, R. (1991). Cyanide Hazards to Fish Wildlife and Invertebrates a Synoptic Review. U. S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD: 1-55.

Eisler, R., D. R. Clark, S. N. Wiemeyer and C. Henny (1999). Sodium cyanide hazards to fish and other wildlife from gold mining operations. Environmental Impacts of Mining Activities: Emphasis on Mitigation and Remedial Measures. J. M. Azcue. Berlin, Springer-Verlag: 55-67.

Environment Australia (2003). Cyanide Management: A Booklet in the Series on Best Practice Environmental Management in Mining Canberra, Environment Australia. Canberra, Environment Australia.

Griffiths, S. R., D. B. Donato, G. Coulson and L. F. Lumsden (2014a). "High levels of activity of bats at gold mining water bodies: Implications for compliance with the International Cyanide Management Code." Environmental Science and Pollution Research 21(12): 7263-7275.

Griffiths, S. R., D. B. Donato, L. F. Lumsden and G. Coulson (2014b). "Hypersalinity reduces the risk of cyanide toxicosis to insectivorous bats interacting with wastewater impoundments at gold mines." Ecotoxicology and Environmental Safety 99: 28-34.

Griffiths, S. R., G. B. Smith, D. B. Donato and C. G. Gillespie (2009). "Factors influencing the risk of wildlife cyanide poisoning on a tailings storage facility in the Eastern Goldfields of Western Australia." Ecotoxicology and Environmental Safety 72: 1579-1586.

Gursanksy, W. and D. B. Donato (2017). Bat activity at Sunrise Dam Gold Mine: 2016 annual report. V1 January. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2016). Bat activity at Granny Smith Gold Mine 2015 annual report, V1 April. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2017). Bat activity at Granny Smith Gold Mine: 2016 annual report, V1 January. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2018). Bat activity at Granny Smith Gold Mine 2017 annual report, V1 January. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2019). Bat activity at Granny Smith Gold Mine 2018 annual report, V1 January. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2020). Bat activity at Granny Smith Gold Mine 2019 annual report, V1 January. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2021). Bat activity at Granny Smith Gold Mine 2020 annual report, V1 January. Darwin, Donato Environmental Services.

Gursansky, W. and D. B. Donato (2022). Bat activity at Granny Smith Gold Mine, 2021 annual report, V1, February 2022. , Donato Environmental Services, Darwin.

Henny, C. J., R. J. Hallock and E. F. Hill (1994). "Cyanide and Migratory Birds at Gold-Mines in Nevada, USA." Ecotoxicology 3(1): 45-58.

Kingsford, R. T. and F. I. Norman (2002). "Australian waterbirds – products of the continent's ecology." Emu 102: 47-69.

Madden-Hallett, D. M., W. Gursansky and G. B. Smith (2013). Technical report: wildlife and cyanide monitoring, Granny Smith Gold Mine, May and August. Darwin, Donato Environmental Services.

Minerals Council of Australia (1996). Tailings storage facilities at Australian gold mines: Submission to the Senate Environment, Recreation, Communication and the Arts Reference Committee. Melbourne, Minerals Council of Australia.

Northern Territory Bird Study Group (1998). Best Practice Guidelines: Reducing Impacts of Tailings Storage Facilities on Avian Wildlife in the Northern Territory of Australia. Darwin, Northern Territory, Department of Mines & Energy

Overdevest, N. D. and D. B. Donato (2014). Re-evaluation of recommendations associated with the International Cyanide Management Code Standard of Practice 4.4, Report to Granny Smith Gold Mine, V4. Darwin, Donato Environmental Services.

Pennay, M., B. Law and K. Reinhold (2004). Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats. Hurstville, NSW Department of Environment and Conservation.

Reardon, T. B., K. N. Armstrong and S. M. Jackson (2015). A current taxonomic list of Australian Chiroptera. Version 2015-05-15 http://ausbats.org.au/taxonomic-list/4589345107, Australasian Bat Society.

Resource Assessment Commission (1991). Kakadu Conservation Zone Inquiry: Final report volume 2. Resource Assessment Commission. Canberra, Australian Government Publishing Services.

Sanderson, K. J. and D. Kirkley (1998). "Yearly activity patterns of bats at Belair National Park, in Adelaide, South Australia." Australian Mammalogy 20: 369-375.

Smith, G. B. and D. B. Donato (2007). Wildlife Cyanide Toxicosis - Monitoring of Cyanide-Bearing Tailing and Heap Leach Facilities - Compliance with the International Cyanide Management Code. World Gold, Cairns, Australia, AusIMM.

Smith, G. B., Donato, D.B., Madden-Hallett, D.M. (2010). Influences of hypersaline tailings on wildlife cyanide toxicosis, Granny Smith Gold Mine, Final Report, December. Darwin, Donato Environmental Services.

Smith, G. B. and W. Gursansky (2011). Technical report: wildlife and cyanide monitoring, targeted seasonal conditions, migratory waders and quarterly surveys. Granny Smith Gold Mine, August 2011. Darwin, Donato Environmental Services.

Van Dyck, S. and R. Strahan (2008). The Mammals of Australia. Australia, Reed New Holland.

Appendix A

Synopsis: International Cyanide Management Code SOP 4.4 site-specific recommendations

Report to:

Granny Smith Gold Mine

Gold Fields

January 2016

Disclaimer

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- any inaccuracy in the information and data on which this report is based or contained in this report; and
- any interpretations, recommendations or opinions stated in, or which may be inferred from, this report.

Citation

Donato, D. B., 2016, Synopsis: International Cyanide Management Code, SOP 4.4 site specific conditions, Granny Smith Gold Mine, Gold Fields, V1. Donato Environmental Services, Darwin.

Distribution

Receivers	Copies	Date issued	Contact name
Granny Smith Gold Mine	Version 1 (electronic)	14 Jan 2016	F. Mills, K. Critchell, A. Radford

Introduction

The Granny Smith Gold Mine (GS) received initial full recertification of its hypersaline tailings storage facility (TSF) under the International Cyanide Management Code (Code) on 16 December 2014.

A peer-reviewed Causational Report [1] was initially developed for the GS tailings system and identified limitations in applying the Code toxicity threshold of 50 mg/L to a hypersaline TSF. It also demonstrated that hypersaline protective mechanisms occur at GS TSF and that the primary protective mechanism in reducing wildlife ingestion of cyanide-bearing solutions and tailings, is wildlife avoidance of hypersalinity.

A major finding of the Causational Report [1] was that a toxicity threshold was not breached during the intensive monitoring period, and as such, an alternative toxicity threshold, specific to GS TSF, could not be provided. Instead, cyanide operating parameters (rather than toxicity thresholds), derived from empirical data, were provided [1] (as stipulated by the Code, page 36 [2]). Given the lack of a known toxicity threshold, the report found that the operating parameters (and all recommendations) "*need to be considered as an adaptive management process and should be continually reviewed with new information and on-site data collection*", page 40 [3].

As part of the Causational Report [4], eight recommendations (site-specific Code conditions) were provided and were aimed at collecting data to monitor, measure and manage the TSF system in a manner benign to wildlife. These recommendations focus on a process of continual improvement rather than taking a prescriptive approach. This process, consistent with the intent of the Code, has led to the introduction of additional monitoring tools, including seasonal insectivorous bat monitoring and carcass detection tests.

With time and improved knowledge of the TSF ecology and chemistry, these recommendations were modified and some subsequently removed leaving 4 recommendations. These operating parameters were not intended to be viewed in a simplistic prescriptive manner, but rather, as being part of the continual improvement process that is consistent with the intent of the Code in protecting wildlife through the "*safe management of cyanide*", page 1 [2].

Considering "it is the responsibility of the operation to demonstrate to the auditor that such changes are in full compliance with the Code", page 3 [5], this synopsis with each DES quarterly gap analysis of SoP 4.4, is provided for GS.

The intent of the synopsis is to provide auditors and GS staff with up-to-date information on the site-specific Code conditions (recommendations) that apply to the GS TSF system.

Additionally, a summary of the relevant reports are included, which provide a chronological update on the site-specific conditions and information relating to changes that have occurred to these conditions and how they were derived.

Associated reports

A number of reports have been developed for the GS TSF system and provide an account of the site's process of continual improvement. The reports provide a chronological account of the development and changes to the site-specific Code-compliant conditions (provided as recommendations under the Code's standard of Practice 4.4) and are cited as follows (in chronological order):

1. Smith, G.B., Donato, D.B., Madden-Hallett, D.M., Influences of hypersaline tailings on wildlife cyanide toxicosis, Granny Smith Gold Mine, Final Report, December. 2010, Donato Environmental Services: Darwin.

This is referred to as the Causational Report as it identified the hypersaline protection mechanisms and established, through peer review, the causational relationship between the protective mechanisms and the lack of risk to wildlife. This report also provided the original eight recommendations, at the time deemed appropriate, to further understand, monitor and maintain the protective mechanisms.

2. Donato, D. B., Gursansky, W., Smith, G.B. and Overdevest, N. D., 2013. *Re-evaluation of Recommendation 1: Standard of Practice 4.4, International Cyanide Management Code*. Report to Granny Smith Gold Mine, V2. Donato Environmental Services, Darwin.

This report modified Recommendation 1 as to allow GS to alternate management between hypersaline tailings with cyanides above 50 mg/L WAD cyanide concentration and non-hypersaline tailings with cyanides below 50 mg/L WAD cyanide concentration. This amendment was peer-reviewed and accepted by the ICMI (10 June 2014).

3. Overdevest, N. D. and Donato, D. B., 2014. *Re-evaluation of recommendations associated with the International Cyanide Management Code Standard of Practice 4.4*, Report to Granny Smith Gold Mine, V4 Donato Environmental Services, Darwin.

This report made substantial modifications to the existing recommendations and removed Recommendations 2, 3, 5 and 6. This amendment was peer-reviewed and accepted by the ICMI (23 December 2014).

Standard of practice 4.4 – Site-specific Code Compliant conditions (as of 31 May 2015)

Following are the site-specific Code-compliant conditions (Recommendations) for the GS tailings system as required by the Code. These recommendations need to be incorporated in the Granny Smith Gold Mine (GSM), Cyanide Management Plan, February 2014.

Recommendation 1: Operating parameters

The following recommendations apply when the tailings system discharges above 50 mg/L WAD cyanide concentration.

Table 26. Recommended target operating parameters for Granny Smith (amended 10 June 2014)

	Maximum WAD cyanide mg/L	WAD cyanide 80th percentile mg/L	TDS mg/L
Spigot	83.3	71.7	> 50 000
Supernatant	50	N/A	> 50 000

Recommendation 2: Write an articulated tailings management plan

Recommendation removed (23 December 2014).

Recommendation 3: Assessment of risk to wildlife on a continual basis

Recommendation removed (23 December 2014).

Recommendation 4: Continuation of structured on-site monitoring regimes

Cyanide and chemistry monitoring

The following chemistry parameters should be monitored at least daily within the TSF:

- total, WAD and free cyanide at the spigot and supernatant;
- salinity at the spigot and supernatant; and
- pH at the spigot and supernatant.

Weekly samples and analysis of copper concentrations at the spigot and supernatant should be conducted.

This monitoring regime will allow investigation of:

- ongoing assessment of the risk to wildlife in the TSF;
- the relationship between spigot discharge concentrations of cyanide and salinity with those in the supernatant;
- the effects of rainfall on salinity; and
- deviations from normal operating parameters.

Table 27 (Amended). Summary of recommended chemistry monitoring regime

Analytes	Location	On-site sampling and analysis	External laboratory analysis (QA and QC sampling)	Comments
TSF sampling				
WAD cyanide	Spigot	Daily	Duplicate samples taken weekly and if automated calibrated accordingly	Calibration according to industry leading practice
	Supernatant	Daily	Duplicate samples taken weekly	Samples should be taken as early in the morning as possible
Free cyanide	Spigot	Daily	Duplicate samples taken weekly or if automated then calibrated accordingly	Samples should be taken as early in the morning as possible. Calibration according to industry leading practice
TDS	Spigot	Daily	Duplicate samples taken as considered necessary	
	Supernatant	Daily	Duplicate samples taken as considered necessary	
pH	Spigot	Daily	Duplicate samples taken as considered necessary	
	Supernatant	Daily	Duplicate samples taken as considered necessary	
Copper	Spigot	Weekly	Duplicate samples taken as considered necessary	
	Supernatant	Weekly	Duplicate samples taken as considered necessary	
Carcasses detected	Spigot and supernatant	As soon as practical	Duplicate samples	

QA and QC on all chemistry sampling should be conducted and assessed. Installation of an in-line automated WAD analyser may necessitate changes to the operating parameters to reflect the different monitoring location. A relationship would need to be established between the readings from the analysers and the resulting concentrations at the spigot. Accuracy of automated analysers is dependent on regular calibration, servicing and maintenance as considered industry leading practice and it would be necessary to ensure that these occur and are documented. Continuation of QA and QC weekly duplicate sampling of the spigot may still be necessary with samples sent to an off-site laboratory for analysis.

Duplicate tailings samples to be taken from the spigot discharge point

Duplicate tailings samples should be taken according to Table 27 (amended) from the spigot discharge point for WAD cyanide, free cyanide, copper, salinity and pH. Samples should be preserved according to a procedure that is acceptable by a NATA-accredited laboratory. Samples should then be sent to a NATA-accredited laboratory for analysis. The data collected should be assessed to determine any discrepancies in chemistry analysis and used to improve laboratory practices.

Daily wildlife monitoring by trained staff

Environment or technician staff trained in environmental monitoring techniques will need to gather data on at least a daily basis. This monitoring regime is summarised in the following table and is identical to the current on-site staff wildlife monitoring regime. The monitoring regime is designed to collect data to assess the risk (if any) and record impacts (if any). It will document the presence of wildlife and carcasses but not the precise magnitude of an impact. This, coupled with the proposed cyanide and chemistry monitoring regime, will provide data and allow some level of assessment of wildlife cyanosis risk.

The wildlife monitoring regime to be conducted by environmental or suitably trained technical staff and should include the components outlined in Table 28.

Table 28. Proposed environmental and trained technical staff routine wildlife monitoring program for the TSFs and supernatant ponds

Frequency	Water body	Time	Observations	Description
Daily Note - Daily surveys are required as long as discharge concentrations are ≥50 mg/L WAD cyanide.	Active TSF cell	Within 3 hours of sunrise	Start and finish times; species ID number; habitat usage; behaviour; condition; time in contact with water body; observer's name; location, Record zero bird presence on the data sheet if applicable.	Record habitats as: S - supernatant (water body on top of tailings) B/DT - beach/dry tailings B/W - beach/walls A - aerial DT - dry tailings WT - wet tailings Record condition as alive, stressed or dead.
			Carcasses present	Concurrent with wildlife surveys. A thorough search of all habitats on the TSF by walking or driving close to the various habitats and using optics. Record any carcasses (location & species) and photograph them. If any at-risk species are present (alive), attempts should be made to haze them from the TSF.
Same day – if carcasses present	All cyanide-bearing water bodies where carcasses present.	Afternoon	Carcasses present	If carcass detected, then carcass counts to be conducted again in the afternoon on the same day to determine carcass in-situ residence time and fate.

Seasonal insectivorous bat monitoring should continue at the TSF and an appropriate control waterbody if the operation continues to use hypersalinity as a protective mechanism.

The above-mentioned wildlife monitoring protocols should be incorporated into existing environmental monitoring documentation. Blind test balloon detection trials should be conducted to test carcass detection efficiency of the designated wildlife observers. These tests should be conducted at between four to eight week intervals. The results of such tests shall be documented.

In the event of wildlife deaths on the TSF, independent experts shall be engaged to determine if operational or procedural changes are required to maintain Code compliance.

Wildlife monitoring data management

To ensure accurate recording of wildlife monitoring data, both the technicians and environmental staff should continue to record the results of their wildlife monitoring into a single electronic database or spreadsheet to which all parties have access (as currently being done). This will provide the opportunity to compare daily wildlife observations from each monitoring regime. Data from one regime can used to validate the data collected by the other. This type of data verification can be input into adaptive management procedures to improve wildlife monitoring protocols and ensure the consistency and robustness of data collected.

Ensure that sufficient data collection is undertaken to enable statistical relationships between monitoring cyanide concentrations and wildlife visitation data. This will enable a risk-based management approach to continue to avoid cyanide impacts on wildlife [6].

Wildlife monitoring training for observers

To ensure that wildlife monitoring data collected by environment and technical staff is robust and consistent, all staff involved in monitoring must be adequately trained to observe and identify wildlife guilds, particularly guilds common to the region, that are at risk from cyanosis. Environmental and technical staff are not expected to identify individual species. Guilds of species such as ducks, waders, swallows and martins are sufficient. They must be aware of the range of habitats that different guilds of at-risk species are attracted to and which of these habitats represent significant cyanosis risks. All monitoring staff should have some general knowledge of the typical range of ‘normal’ behaviour displayed by at-risk species so that they can identify signs of distress that may indicate birds suffering from cyanosis.

Appropriately qualified staff must conduct training. This may include internal staff members with sufficient avifauna monitoring experience, or external experts [6]. Refresher training should also be provided regularly to ensure that all monitoring staff are kept up to date with the necessary skills and knowledge required for wildlife monitoring.

Recommendation 5: Ongoing assessment of laboratory practices to ensure continual improvement in accuracy of analysis

Recommendation removed (23 December 2014).

Recommendation 6: Ongoing assessment of adherence to these conditions

Recommendation removed (23 December 2014).

Recommendation 7: Minimise infrastructure in the vicinity of cyanide bearing habitats

Infrastructure minimisation on the GS TSF is required to reduce wildlife diversity and exposure pathways. This includes, but is not necessarily limited to, maintaining the tailings system devoid of waste materials other than tailings.

Recommendation 8: Vegetation suppression and removal in and near cyanide-bearing water bodies

Suppress all vegetation growth and subsequent regrowth within the perimeter of the TSF cells and not the outer slopes or surrounding drains. The presence of vegetation, alive or dead, in and around a water body significantly increases wildlife abundance, diversity and interaction with cyanide-bearing solutions.

References

1. Smith, G.B., Donato, D.B., Madden-Hallett, D.M., Influences of hypersaline tailings on wildlife cyanide toxicosis, Granny Smith Gold Mine, Final Report, December. 2010, Donato Environmental Services: Darwin.
2. International Cyanide Management Institute, The International Cyanide Management Code, September 2006. 2006, International Cyanide Management Institute. p. www.cyanidecode.org.
3. Donato, D.B., C.G. Gillespie, and S.R. Griffiths, ACMER Research Project: 58. A risk assessment of the effects of goldmining cyanide-bearing tailings solutions on wildlife. Sponsor's Report Case Study C, National Research Centre for Environmental Toxicology, Editor. 2006, ACMER: Brisbane.
4. Donato, D.B., C.G. Gillespie, and S.R. Griffiths, Draft: ACMER Research Project: 58. A risk assessment of the effects of goldmining cyanide-bearing tailings solutions on wildlife. Sponsor's Report Case Study C, National Research Centre for Environmental Toxicology, Editor. 2006, ACMER: Brisbane.
5. International Cyanide Management Institute, The Code; The newsletter of the International Cyanide Management Institute. 2009. **2009 Edition** (First Quarter).
6. International Cyanide Management Institute, Implementation Guidance for the International Cyanide Management Code. 2009, International Cyanide Management Institute: Washington DC, USA