# IDENTIFYING OPPORTUNITIES FOR MINE PIT LAKE REUSE AFTER MINE CLOSURE

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## KEYWORDS

Mine pit lakes, water quality, reuse, mine closure

## ABSTRACT

This paper examines trends in mine pit lake water quality, based on sampling and chemical analysis from pit lakes across Western Australia. Pit lake water quality was largely controlled by groundwater quality, particularly for major ions, pH and salinity, highlighting the importance of assessing groundwater and surface water coupling to understand water quality evolution. Opportunities for reuse of pit lake water after mine closure were explored by comparing mine pit lake water quality to guidelines for potential reuse options. Major ions and total dissolved solids exceeded guideline levels more frequently than trace metals or metalloids. 'Typical' pit lake water quality for the Goldfields and Murchison was assessed to provide insight into potential post-mining uses in each region.

## INTRODUCTION

Mine pit lakes form in open pit mining voids that may extend below the natural water table after the end of mining and associated pit dewatering. Over time, groundwater, rainwater and surface runoff can accumulate in voids, often leading to the formation of permanent lakes (Castro and Moore, 2000, Doupé and Lymbery, 2005). Pit lakes are subject to physical and chemical processes that influence pit lake water quality and the potential release of water to the receiving environment (Cook *et al.*, 2021). Mine pit lake water quality evolves over many years past mine closure, which makes regulation and management of these legacy sites challenging.

Potential risks and impacts of poorly managed pit lakes include contamination of local and regional groundwater aquifers, potential impacts on groundwater dependent ecosystems and wetlands, poor vegetation health, and adverse effects on fauna that use the pit lake as a drinking water source. Alternatively, pit lakes can be managed to provide various benefits, such as serving as storage for process water for mining operations, managing waste rock, or providing new sites for recreation, irrigation, aquaculture, livestock drinking water or wildlife habitat.

A recent estimate identifies approximately 1170 mine voids in WA, including dry, partly wet, and water-filled voids (Bekele *et al.*, 2025). For many pit lakes in Western Australia, the principal sources of solutes in the lake are groundwater inflows (particularly for saline and hypersaline pit lakes) and catchment inflows from exposed pit walls, tailings, leach pads, underground mine voids and waste rock, along with rainfall (Commander et al., 1994). Many of these lakes experience high or increasing salinity due to high evaporation rates and saline, adjacent aquifers (Garnham et al., 2014).

There are knowledge gaps in the current understanding of the influences on pit lake water quality in arid environments with high net evaporation, as commonly occur in Western Australia (Johnson and Wright, 2003). The aim of this study was to investigate the water quality of contemporary mine pit lakes in Western Australia across mining commodities and regions, and to identify potential opportunities for reuse of mine pit water following mine closure.

## METHODOLOGY

Twenty-six pit lakes from 14 different mining operations across a range of mined commodities (gold n = 17, base metals n = 2, other n = 7) were sampled between 2019 and 2021. Analysis of water samples included field measurement of pH,

oxidation/reduction potential, and electrical conductivity (EC), and laboratory analysis of a wide suite of major and trace elements, nutrients, total dissolved solids (TDS), and dissolved organic carbon. This water quality analysis was complemented by comprehensive analysis of representative pit wall rock and sediment samples from each pit lake. Full details of sampling and analysis are reported in Linge *et al.* (2022).

A screening risk assessment of chemical hazards was undertaken by comparing pit lake water quality to guidelines relevant for potential exposure pathways for mine pit lakes (DMIRS, 2020), such as groundwater flow towards abstraction bore for livestock watering or potable use, or recreational use of the pit lake (Table 1). Risk quotients (RQ), where a measured concentration is ratioed to the relevent guideline value, were calculated. Concentrations below the limit of reporting were considered as half the LOR. The calculated RQ were then classified into 'high risk', when RQ ≥ 1, medium risk when 1 > RQ ≥ 0.1, and low risk when RQ < 0.1. This approach has previously been used to assess the human health risk of potable use of recycled wastewater (Linge *et al.*, 2012).

*Table 1: Water quality guidelines selected for screening risk assessment of mine pit lake water*

| **Exposure Pathway** | **Guideline** |
|---|---|
| Livestock | Livestock drinking water quality limits related to cattle (ANZECC and ARMCANZ, 2000). |
| Irrigation | Long term trigger values (up to 100 years) for irrigation of crops and pastures (ANZECC and ARMCANZ, 2000). |
| Non-potable or Recreational | Value is generally 10 times the corresponding ADWG health value, or equal to the ADWG aesthetic value. Non-potable guidelines developed by WA Department of Health to evaluate and manage chemicals in contaminated sites (DoH, 2014). Values for managing risks in recreational water from NHMRC (2008) |
| Aquaculture | Values for aquacultures and human consumption of aquatic foods (ANZECC and ARMCANZ, 2000). |
| Aquatic Ecosystem Protection | Trigger values for protection of 95% freshwater aquatic ecosystems for slightly to moderately disturbed systems (ANZG, 2018). |
| Drinking Water | Australian Drinking Water Guidelines (ADWG) (NHMRC and NRMMC, 2011). |

# RESULTS AND DISCUSSION

### Overview of pit lake water quality

The 26 sampled pit lakes had depths from 3 to 114 m (median 20) and ages from 1.5 to 47 years (Linge *et al.*, 2022). The pit lake age was defined as the time since mining ceased. Most pit lakes had pH between 6 and 9, with four pit lakes with pH< 5. Pit lake TDS ranged from 190 mg/L to 350,000 mg/L. Based on groundwater salinity, 13 lakes were classified as having fresh/brackish groundwater (TDS <5000 mg/L), 2 had saline groundwater (5000 mg/L < TDS < 35,000 mg/L, and 11 had hypersaline groundwater (TDS >35,000 mg/L).

Table 2 summarises all analytes detected in pit lake surface water samples, including the percentage of pit lakes in which the analyte was detected, and the median, minimum and maximum values above the limit of reporting (LOR). Five analytes (Bi, In, Nb, P, Th) were never detected in any pit lake. Thirty-two analytes, including As, Au, Cr, Co, Cu, Mo, Pt, Sb, Sn, Sr, V, and Zn, had their highest concentrations in a pit lake associated with gold mining, However, 13 of these analytes were highest in a single pit lake (PL 21), which was one of the most acidic in the study (pH = 3.9). The elevated, elemental concentrations in this lake are likely due to its low pH rather than the commodity mined. Previous studies of pit lakes in the US and Europe also found concentrations of common metals (Al, Fe, Mn), and divalent base metals (Cd, Cu, Pb, Zn) were elevated when pH < 4.5 (Eary, 1999). In this study, all except Cd were highest in a pit lake with pH < 4. However, while the highest concentrations of Na, K, Br, Cl, Mg, and sulfate were also measured in gold mine pit lakes, these elevated concentrations are more likely related to the fact that these pit lakes were also hypersaline. Three elements (Ag, Cd, Ni) were present at the highest concentration in a pit lake associated with base metal mining.

Depth profiles of EC and temperature are shown in Figure 1. Electrical conductivity was constant with depth (< 5% variation) for all except four pit lakes. For two fresh pit lakes (PL 1 and PL 3), the EC was higher at the surface of the pit lake than the bottom, which may be related to evapoconcentration at the surface of the pit lake.

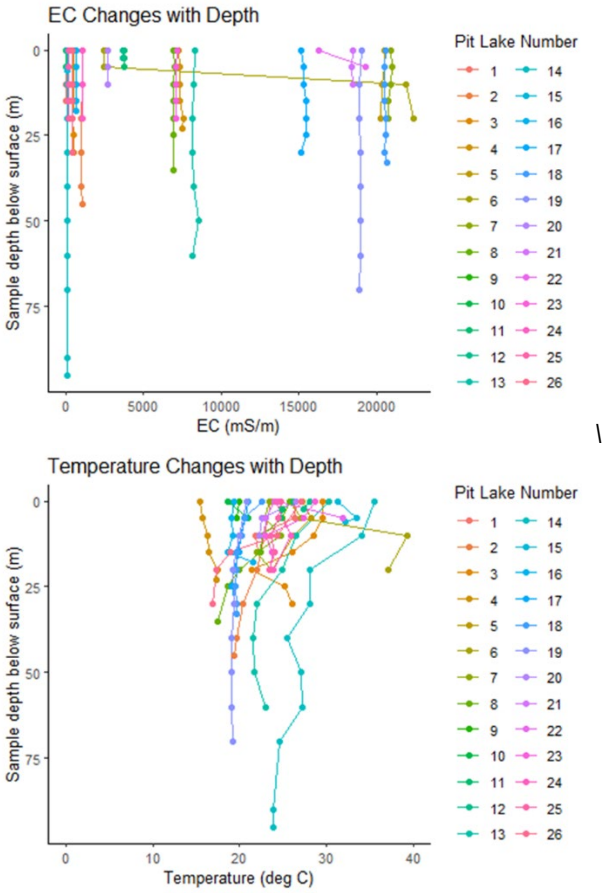


*Figure 1: Depth profiles of EC (top) and temperature (bottom) in sampled pit lakes.*

Two hypersaline pit lakes (PL 6 and PL 22) had much lower EC at their surface relative to their bottom. This is hypothesised to be the result of fresher rainwater runoff, overlying denser saline pit lake/groundwater.

Temperature generally decreased with depth, with some evidence of density stratification for pit lakes deeper than 20 m. The salinity-based stratification in PL 6 and PL 22 also influenced temperature, with the lower layer of these pit lakes being warmer than surface waters. Additionally, PL 4 showed a gradual increase in temperature with depth, likely due to sampling in winter at very low ambient temperatures.

Groundwater samples or historical groundwater data were available for thirteen pit lakes. Pit lake water quality largely reflected groundwater quality, particularly for major ions, pH and TDS. Pit lake EC strongly correlated (R = 0.85, Figure 2) with groundwater EC, but almost always higher, suggesting evapoconcentration. Pit lake pH was generally similar to groundwater pH (Figure 2), though with weaker correlation (R= 0.41).

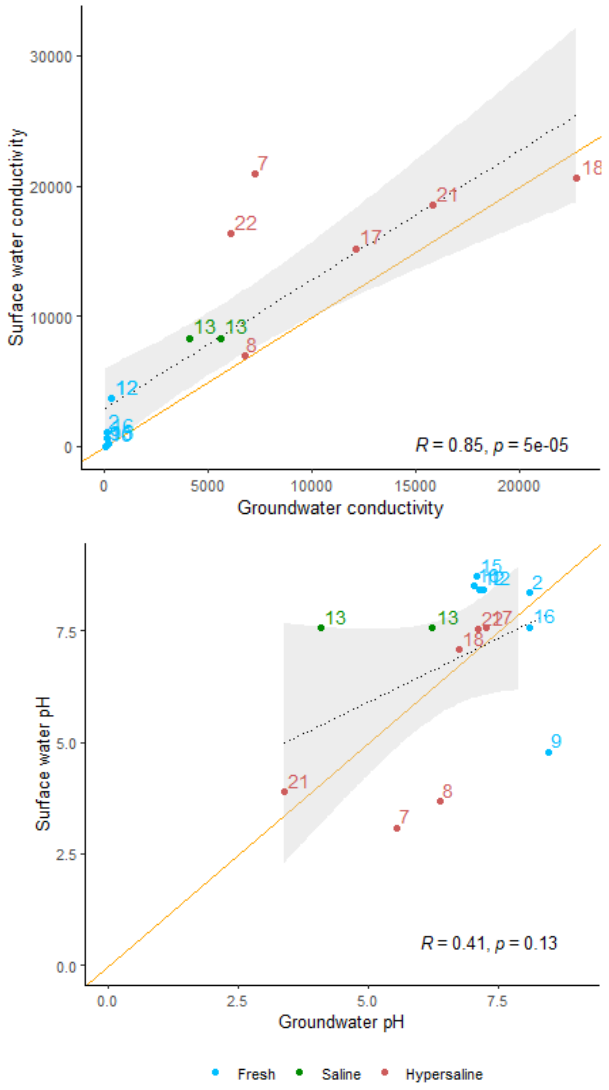


*Figure 2: Comparison of pit lake and groundwater electrical conductivity (top) and pH (bottom), for pit lakes classified as fresh (blue), saline (green) and hypersaline (red). The dotted line shows the Pearson linear regression model for all pit lakes, while the 1:1 line is shown in orange.*

**Pit lake classification based on water quality**

The hydrochemistry of pit lake waters is influenced by water input, evaporation, commodity mined, local geology, and exposure of pit walls (INAP, 2009). One method to describe pit lake hydrochemistry involves assessing pH, sulfate concentration (related to acid production from oxidation of sulphides), and the sum of the concentration of selected base metals (Zn, Cu, Cd, Pb, Co and Ni, µg/L) to classify pit lake water as neutral, saline or acid rock drainage (INAP, 2009, Plumlee, 1997).

Figure 3 shows the range of pH and sulfate concentrations observed in the 26 studied mine pit lakes, with the size of the marker indicating the sum of the concentration of base metals, and the colour

representing local groundwater salinity. The regions that are classified as acid rock drainage (pH < 6), neutral mine drainage (pH > 6), and saline drainage (pH > 6 and sulfate >1000 mg/L are also indicated.

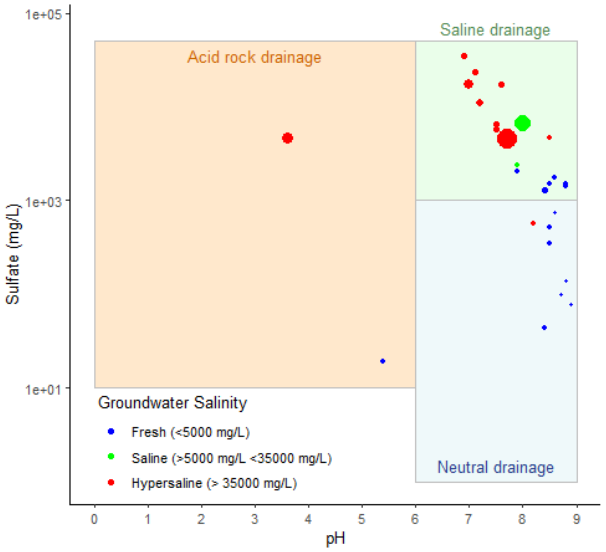


*Figure 3: Pit lake pH and sulfate concentration, showing classification as acid rock drainage (pH < 6), neutral mine drainage (pH > 6), and saline drainage (pH > 6 and sulfate >1000 mg/L) for pit lakes classified as fresh (blue), saline (green) and hypersaline (red). The size of the marker indicates the sum of the concentration of base metals.*

Only 2 pit lakes (PL 21, gold, and PL 10, other) were classified as acid rock drainage, although the pH of PL 10 (5.4) was only just below pH 6, and its total base element concentration (3.8 mg/L) was very low. Eight pit lakes were classified as neutral drainage, with very low total base element concentrations (2 – 23 mg/L), and all with fresh (< 5000 mg/L) local groundwater, except for PL 6. PL 6 had hypersaline groundwater, but (as described previously) had a much lower surface EC compared to bottom waters (Figure 1) attributed due to freshwater runoff.

Nineteen pit lakes were classified as saline drainage with very variable base metals concentration (40 - 19000 mg/L, median 360 mg/L). While these pit lakes had fresh (n = 7), saline (n =2) and hypersaline (n = 10) groundwater, there is a clear trend for higher sulfate and lower pH for hypersaline pit lakes.

Figure 4 shows pH and sulfate concentrations classified by commodity or geographical region, instead of salinity. The relationship between these concentrations and commodity type is unclear due to the large number of gold mine pits in the dataset. However, trends with geographical region are more apparent, particularly in the Goldfields, which almost exclusively have saline or hypersaline local groundwater, and saline drainage, and in the Murchison, which is more likely to have fresher local groundwater and neutral or slightly saline drainage.

**Screening Water Quality Risk Assessment**

Figure 5 summarises the risk quotients (RQ), calculated as the ratio of the pit lake surface water concentration to the water quality guidelines listed in Table 1. While 56 analytes were considered, each guideline included between 18 (Livestock) and 28 (ADWG) parameters for comparison. No guidelines were available for 19 elements (Au, Br, Bi, Ce, Cs, K, In, Ga, Nb, S, Rb, Pt, Pd, Sc, Si, Tl, Ti, Th, Sr).

The highest number of pit lakes exceeding guidelines were for B (21, irrigation only), Ca (20, aquaculture), Cl (24 for irrigation, 22 for recycled/non-potable and drinking), EC (24, irrigation), Mg (24 for aquaculture, 23 for recycled/non-potable and drinking), total N (23, ecosystem), Na (24 for aquaculture, 23 for recycled/non-potable and drinking), Zn (20, aquaculture), and total dissolved solids (24, irrigation and drinking). For B and Zn, the high percentage of exceedances reflects the comparatively low guideline values for B in irrigation and Zn for aquaculture use, compared to guideline values for other water uses. The high number of exceedances for Cl, Mg, EC, Na and total dissolved solids is primarily due to the elevated salinity of these lakes. Since EC is a reliable indicator of salinity, pit lakes with high EC also tend to have higher levels of these ions, leading to more frequent exceedances of water quality guidelines. This is also apparent for pit lakes with fresh or brackish local groundwater.

Overall, the fewest exceedances were observed for livestock and recreational/non-potable use, while the most exceedances occurred for aquatic ecosystems and drinking water. Nevertheless, two pit lakes (PL 1 and PL 10) met ADWG for the parameters tested, suggesting that very fresh pit lakes could potentially provide potable water, after suitable treatment.

**'Typical' pit lake water quality in the Goldfields and Murchison regions.**

Given the large number of pit lakes from the Goldfields (n = 12) and Murchison (n= 10) in the dataset, 'typical' pit lake water quality was assessed for each region to provide insight into potential post-mining uses. Median values and ranges for selected analytes are reported in Table 3, while Figure 6 shows RQ for the water quality guidelines for recreation.

Generally, pit lake pH was circumneutral in each region, though individual pit lakes were acidic (e.g. Figure 4). The median concentration of most elements was higher in pit lakes in the Goldfields rather in the Murchison, and this probably reflects the higher salinity in Goldfields groundwater (TDS = 7000 – 35,000+ mg/L) than in Murchison groundwater (0 – 7000 mg/L) (Allen, 1997). Elements with a higher median in Murchison were total N, nitrate, Si, V and As.

*Figure 6: Risk quotients (RQ) calculated from median pit lake water concentrations in the Goldfields (top) and Murchison (bottom) and recreational water guidelines (Table 1).*

Mine closure risk assessments often assume evapoconcentration will make pit lake water saline within a short timescale (1-5 years), making the water unpalatable for livestock. While this study largely supports the assumption that freshwater pit lakes become more saline over time, further research is needed to better understand this evolution in salinity. The median TDS concentrations in pit lakes in the both the Goldfields (130,000 mg/L) and Murchison (5300 mg/L) exceed the TDS guideline for livestock (4000 mg/L) and thus unpalatable, suggesting livestock and other similar animal receptors are unlikely to drink from these pit lakes with additional treatment or supplementation.

Both the Goldfields and Murchison are arid inland regions of Western Australia, and pit lakes near remote towns could be used as recreational waterbodies. Figure 6 shows that RQ from recreational water guidelines were below one for all elements, except for Ca, Cl, Mg, and Na for both regions, and sulfate and TDS in the Goldfields. However, for most of these elements (Na, Mg, Ca and Cl), the recreational guidelines align with the ADWG aesthetic values, meaning they do not pose a health risk for recreational use. In particular, we note that median concentrations of Ca (175 mg/L), Cl (2350 mg/L), Mg (287 mg/L) and Na (1200 mg/L) in the Murchison are well below typical seawater values (Ca ~ 400 mg/L, Cl ~ 19,000 mg/L, Mg ~1300 mg/L, Na ~ 11,000 mg/L) (de Angelis, 2005), further suggesting that elevated concentrations of these elements do not pose a risk for recreational use of pit lakes in the Murchison.

In addition to chemical hazards, recreational water quality guidelines also consider microbial water quality and physical hazards (NHMRC, 2008). To-date studies of microbial quality in pit lake water are limited. However, physical hazards associated with accessing mine pit lakes are well-documented. Steep pit walls, unstable edges, sudden depth changes and risks of wall failure, falls and drowning present significant hazards (McCullough and Lund, 2006). Further assessments of both water quality and other physical risks are essential for safe, post-mining recreational use.

## CONCLUSION

This study provides a novel dataset of mine pit lake water quality, focusing on arid Western Australia. Pit lake water quality was largely controlled by groundwater quality, particularly for major ions, pH and salinity. Regional variations in groundwater composition are likely to have a significant impact on the water quality of Western Australian pit lakes. This link highlights the importance of thorough assessment of groundwater and surface water coupling at individual sites to better understand and predict water quality evolution in a future pit lake.

Trace element concentrations in pit lakes did not consistently reflect groundwater values, indicating that the geochemical controls of trace elements are complex and remain difficult to predict.

The screening water quality risk assessment revealed that exceedances of water quality guidelines were more frequent for major ions and total dissolved solids, with salinity emerging as the key limitation for water reuse, rather than the trace

metal and metalloids. Comparison of 'typical' pit lake water quality for the Goldfields and Murchison suggest potential opportunities for recreational use of pit lakes in the Murchison, but further evaluation of physical and microbial risks is necessary.

## ACKNOWLEDGMENT

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## REFERENCES

Allen, A. D. 1997. Groundwater: the strategic resource - a geological perspective of groudnwater occurence and importance in Western Australia. Perth, WA: Geological Survey of WA.

ANZECC & ARMCANZ 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality Paper 4 National Water Quality Management Strategy. Canberra: Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

ANZG. 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* [Online]. Canberra ACT, Australia: Australian and New Zealand Governments and Australian state and territory governments. Available: Available at www.waterquality.gov.au/anz-guidelines.

Bekele, E., Sagar, N., Knight, A., Bourgault du Coudray, C., Davis, G. & Linge, K. Pit Lake Types Across Australia: Developing Tools to Assess Risks and Beneficial End Use Options. Extended Abstract/Presentation. Groundwater and Mining Symposium - Minimising Risk and Maximising Opportunity, 19-20 February 2025 Perth, Western Australia. Australasian Land & Groundwater Association.

Castro, J. M. & Moore, J. N. 2000. Pit lakes: their characteristics and the potential for their remediation. *Environmental Geology,* 39, 1254-1260.

Cook, P., Black, S., Cote, C., Kahe, M. S., Linge, K., Oldham, C., Ordens, C., McIntyre, N., Simmons, C. & Wallis, I. 2021. Hydrological and geochemical processes and closure options for below water table open pit mines. Perth, Australia.

de Angelis, M. 2005. Major Ions in Seawater. *In:* LEHR, J. H. & KEELEY, J. (eds.) *Water Encyclopedia, Volumes 1-5.* Hoboken, NJ, USA: John Wiley & Sons, Inc.

DoH 2014. Contaminated Sites Ground and Surface Water Chemical Screening Guidelines. Perth: Government of Western Australia Department of Health.

Doupé, R. G. & Lymbery, A. J. 2005. Environmental risks associated with beneficial end uses of mine lakes in southwestern Australia. *Mine water and the environment,* 24, 134-138.

Eary, L. E. 1999. Geochemical and equilibrium trends in mine pit lakes. *Applied Geochemistry,* 14, 963-987.

INAP 2009. Global Acid Rock Drainage (GARD) Guide. International Network for Acid Prevention.

Johnson, S. L. & Wright, A. H. 2003. Mine Void Water Resource Issues in Western Australia. Report No. HG 9, Western Australia: Water and Rivers Commission.

Linge, K., Black, S., Kuhar, L. L., Li, J. & Allen, D. 2022. Mine Pit Lakes. Their Characterisation and Assessment for In-Situ Metal Recovery Opportunities and Cost-Effective Environmental Management. Results of research carried out for MRIWA (Project M0478) and CRC CARE (2.2.03-17/18). Perth, Western Australia: Minerals Research Institute WA.

Linge, K. L., Blair, P., Busetti, F., Rodriguez, C. & Heitz, A. 2012. Chemicals in Reverse Osmosis-treated Wastewater: Occurrence, Health Risk, and Contribution to Residual Dissolved Organic Carbon. *Journal of Water Supply: Research and Technology - AQUA,* 61, 494-505.

McCullough, C. D. & Lund, M. A. 2006. Opportunities for Sustainable Mining Pit Lakes in Australia. *Mine Water and the Environment,* 25, 220-226.

NHMRC 2008. Guidelines for Managing Risks in Recreational Water. ISBN 1864962666, Canberra, ACT: National Health and Medical Research Council.

NHMRC & NRMMC 2011. Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. Commonwealth of Australia, Canberra. Updated August 2018.: National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Plumlee, G. S. 1997. The Environmental Geology of Mineral Deposits. *In:* PLUMLEE, G. S., LOGSDON, M. J. & FILIPEK, L. F. (eds.) *The Environmental Geochemistry of Mineral Deposits: Part A: Processes, Techniques, and Health Issues Part B: Case Studies and Research Topics.* Society of Economic Geologists.

*Table 2: Summary of percentage detection, minimum, maximum and median concentrations for all analytes detected at least once in a pit lake surface water sample.*

| Analyte | Percentage Detection | Concentration (mg/L) | | | Analyte | Percentage Detection | Concentration (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Median | | | Max. | Min. | Median |
| **Ag** | 12% | 0.008 | 0.0001 | 0.004 | **Mg** | 100% | 21,600 | 6.8 | 580 |
| **Al** | 27% | 190 | 0.01 | 0.03 | **Mn** | 92% | 15 | 0.0008 | 0.16 |
| **Alkalinity** | 92% | 430 | 39 | 170 | **Mo** | 46% | 0.09 | 0.002 | 0.01 |
| **As** | 50% | 3.9 | 0.001 | 0.04 | **NO3** | 54% | 330 | 4.9 | 45 |
| **Au** | 19% | 0.04 | 0.0004 | 0.01 | **Total N** | 100% | 76 | 0.2 | 5.7 |
| **B** | 100% | 17 | 0.08 | 2.7 | **Na** | 100% | 104,000 | 39 | 4900 |
| **Ba** | 92% | 0.3 | 0.003 | 0.06 | **Ni** | 62% | 19 | 0.001 | 0.04 |
| **Be** | 8% | 0.004 | 0.0003 | 0.002 | **Pb** | 31% | 0.5 | 0.0001 | 0.008 |
| **Br** | 92% | 250 | 0.4 | 32 | **Pd** | 12% | 0.004 | 0.0005 | 0.001 |
| **Ca** | 100% | 2400 | 4.3 | 200 | **Pt** | 4% | 0.0003 | 0.0003 | 0.0003 |
| **Cd** | 19% | 0.07 | 0.004 | 0.006 | **Rb** | 100% | 0.5 | 0.001 | 0.06 |
| **Ce** | 8% | 0.7 | 0.001 | 0.4 | **SO4** | 100% | 34,800 | 19.2 | 1900 |
| **Cl** | 100% | 190,000 | 51 | 11,000 | **Sb** | 35% | 0.04 | 0.0003 | 0.007 |
| **Co** | 65% | 1.8 | 0.0001 | 0.02 | **Sc** | 4% | 0.001 | 0.001 | 0.001 |
| **Cr** | 31% | 0.03 | 0.0006 | 0.002 | **Se** | 38% | 0.08 | 0.001 | 0.003 |
| **Cs** | 77% | 0.3 | 0.0001 | 0.006 | **Si** | 100% | 34 | 0.65 | 6.8 |
| **Cu** | 81% | 0.03 | 0.0001 | 0.004 | **Sn** | 8% | 0.001 | 0.001 | 0.001 |
| **DOC** | 96% | 37 | 1.2 | 4.1 | **Sr** | 100% | 33 | 0.06 | 2.0 |
| **F** | 15% | 1.5 | 0.1 | 0.6 | **Ti** | 8% | 0.002 | 0.0007 | 0.001 |
| **Fe** | 19% | 0.3 | 0.006 | 0.03 | **Tl** | 12% | 0.002 | 0.0001 | 0.002 |
| **Ga** | 4% | 0.02 | 0.02 | 0.02 | **U** | 73% | 0.07 | 0.0008 | 0.004 |
| **K** | 100% | 2800 | 2.2 | 100 | **V** | 88% | 0.06 | 0.0001 | 0.006 |
| **La** | 15% | 0.4 | 0.0001 | 0.005 | **Zn** | 81% | 2.3 | 0.001 | 0.05 |
| **Li** | 100% | 0.5 | 0.001 | 0.03 | | | | | |

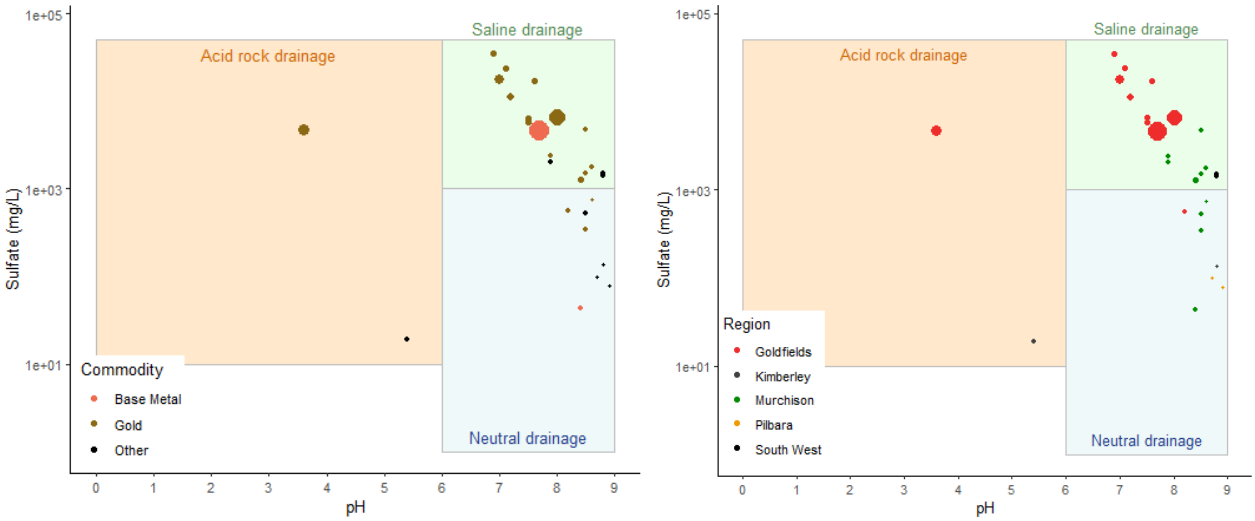


*Figure 4: Pit lake pH and sulfate concentration, showing classification as acid rock drainage (pH < 6), neutral mine drainage (pH > 6), and saline drainage (pH > 6, for pit lakes classified by commodity (left) and geographical region (right). The size of the marker indicates the sum of the concentration of base metals.*

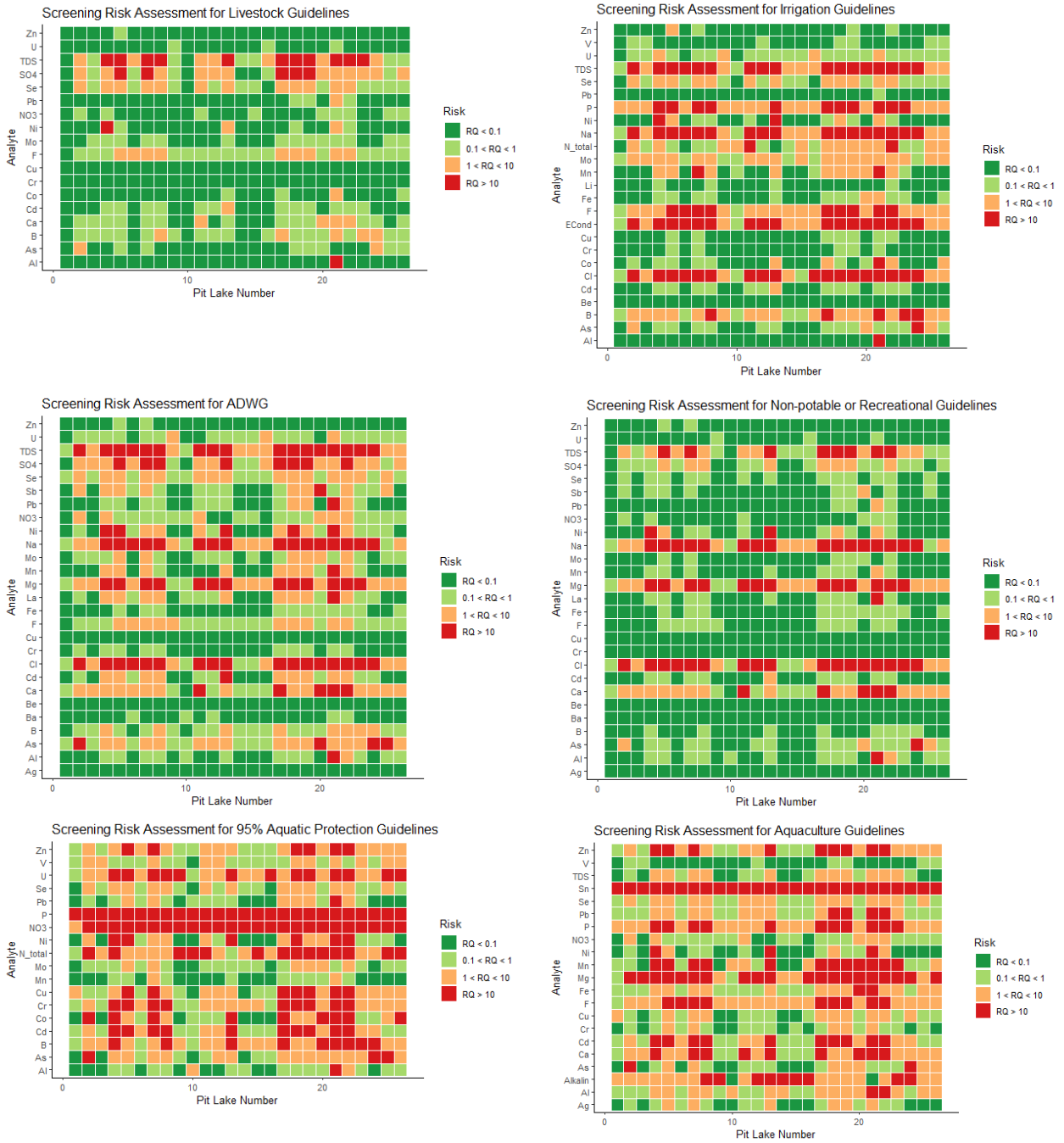


*Figure 5: Risk quotients (RQ) calculated from comparison of mine pit lake water quality to water guidelines.*

*Table 3: Median and range for selected analytes for pit lakes in the Goldfields and Murchison regions*

| Analyte | Goldfields (n= 12) | | Murchison (n = 10) | |
|---|---|---|---|---|
| | **Median ± SD** | **Range** | **Median ± SD** | **Range** |
| **TDS (mg/L)** | 130000 ± 52800 | 14880–167200 | 5300 ± 17500 | 213–57280 |
| **pH** | 7.5 ± 1.2 | 3.6–8.2 | 8.5 ± 0.26 | 7.9–8.6 |
| **As (mg/L)** | 0.03 ± 0.015 | 0.005–0.05 | 0.066 ± 1.2 | 0.001–3.9 |
| **Cl (mg/L)** | 95000 ± 68600 | 8600–190000 | 2300 ± 9400 | 51–30000 |
| **Nitrate (mg/L)** | 20 ± 58 | 2–160 | 31 ± 102 | 0.2–330 |
| **Ni (mg/L)** | 0.13 ± 5.9 | 0.006–19 | 0.006 ± 0.013 | 0.001–0.042 |
| **Se (mg/L)** | 0.02 ± 0.016 | 0.005-0.05 | 0.005 ± 0.024 | 0.001–0.079 |