Short Water Recirculation during the Flotation of a UG2 Cu-Ni-PGM Ore: Effects on Tailings Dewatering and Quality of the Recovered Water

Malibongwe Manono, Michael Ngau, Kirsten Corin

West Virginia Mine Drainage Task Force Symposium & 15th International Mine Water Association Congress

Morgantown, West Virginia, USA, 20-26 April 2024

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad

WVTF IMWA 2024

malibongwe.manono@uct.ac.za

www.cmr.uct.ac.za

CMR CENTRE FOR MINERALS RESEARCH

CENTRE FOR BIOPROCESS ENGINEERING RESEARCH CeBER

FUTURE WATER

m2m minerals to metals

Collaborators within UCT

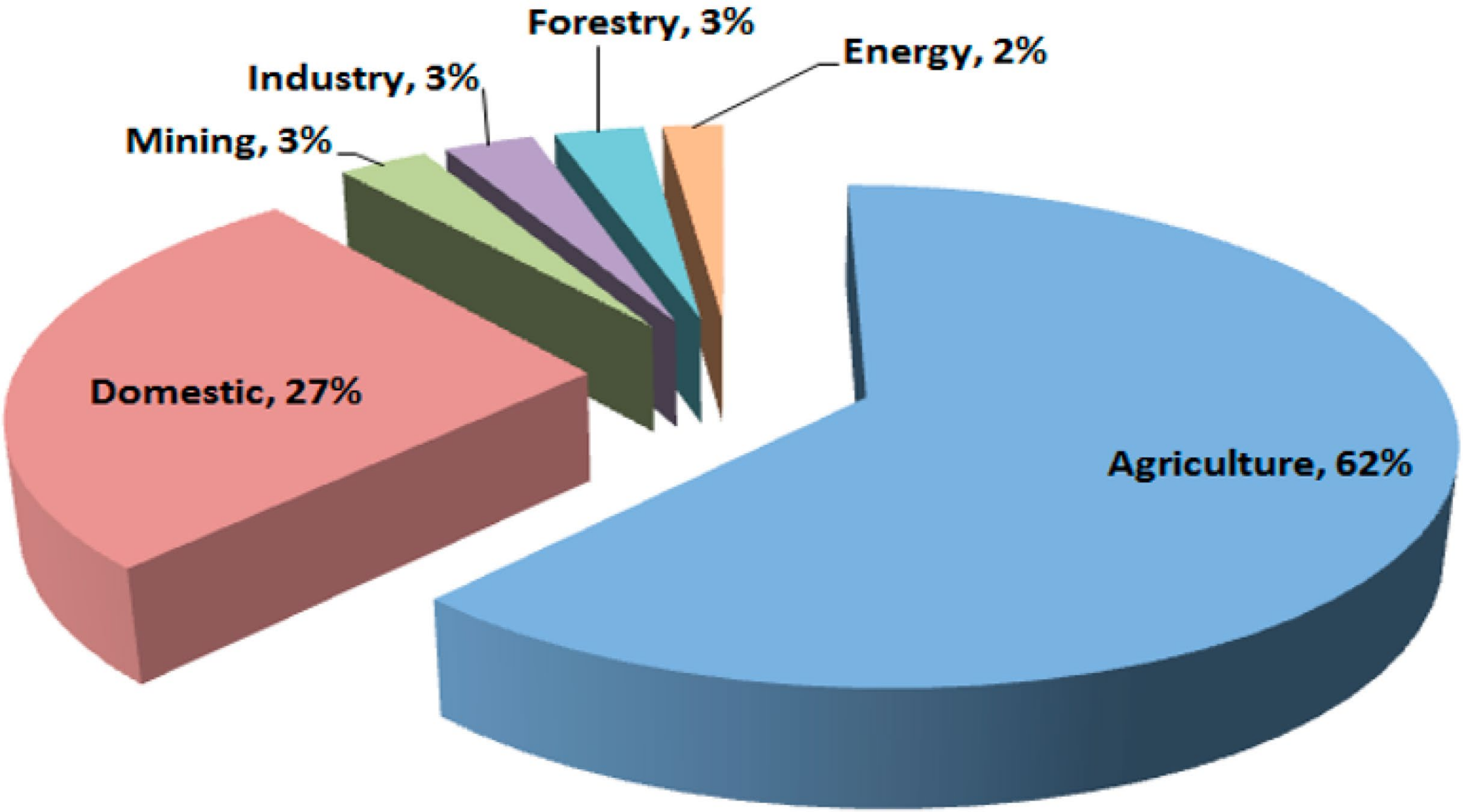
CMR CENTRE FOR MINERALS RESEARCH

Addressing the Sustainable Development Goals

Responsible water usage for maximising grades and recoveries of minerals and ensure optimal production of Cu-Ni-PGM which are critical resources.

Efficient use of water is maximized through onsite recycling which reduces dependence on municipal or fresh water, hence allowing for the availability of more fresh water.

South African Water Usage by Sector



CENTRE FOR MINERALS RESEARCH

Askham and Van der Poll (2017)

PGM Mining in South Africa

SA PGMs

90% Pt Reserves

17% SA GDP

Water Scarcity

Environment

Allison and O'Connor (2011), Hudgson and Agar (1989), Rüttinger *et al.*(2020)

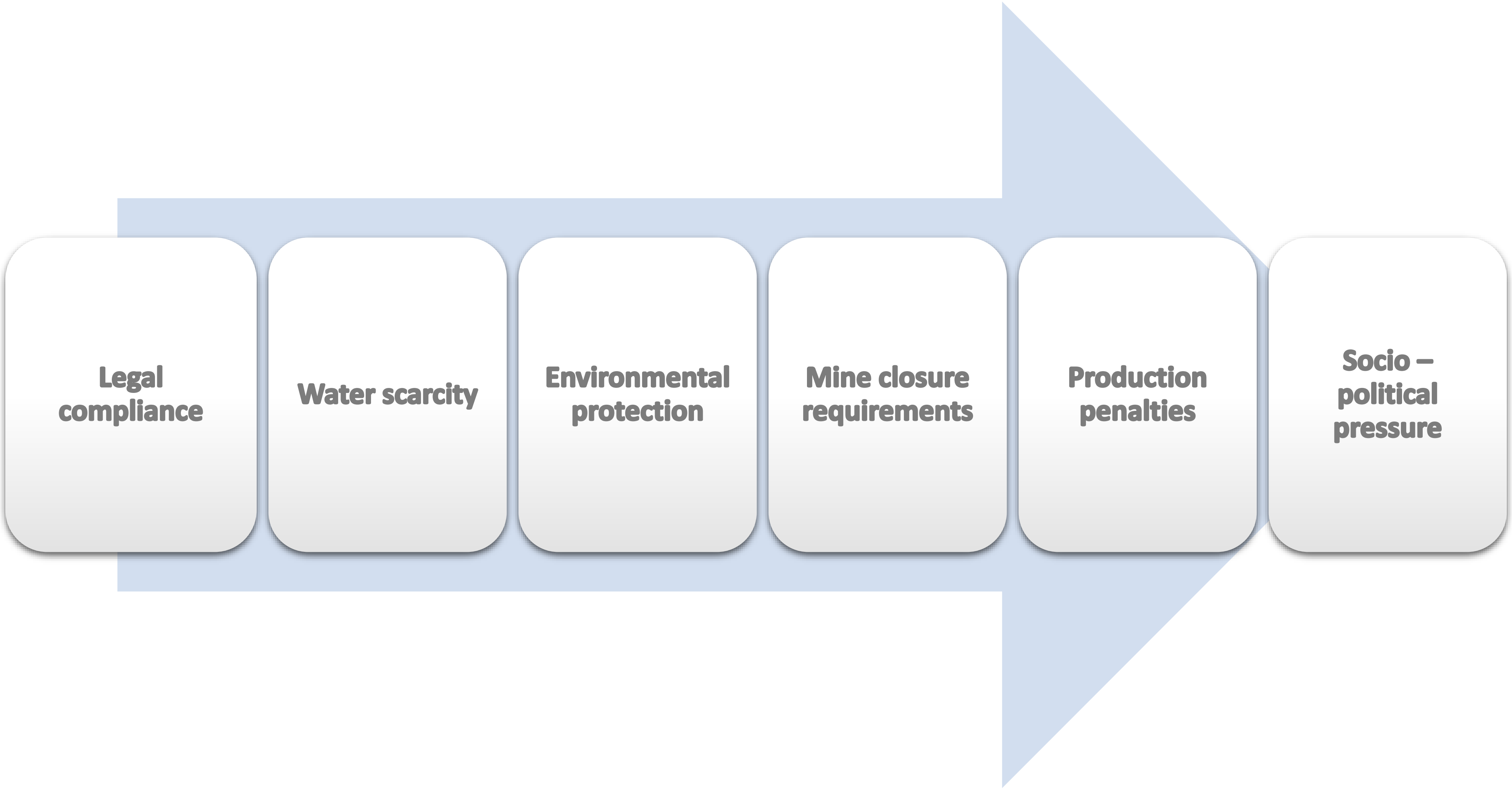
CENTRE FOR MINERALS RESEARCH

Challenges on Water Use in the South African Mining and Resources Industry

Water recirculation (recycling) is a Water Management Strategy developed in response to Water Scarcity.

(Slatter et al., 2009; Ikumapayi et al., 2012; Boujounoui et al., 2015, Harrison et al., 2018)

South African Mining Industry Motivation to Use Less Water



CENTRE FOR MINERALS RESEARCH

South African Mining and Resources Industry’s R&D Thrust to Focus On

Reduction Of Freshwater Consumption

The Removal Of Contaminants From Mine Water Seepages And Effluent

Highly Water Efficient Processing Plants.

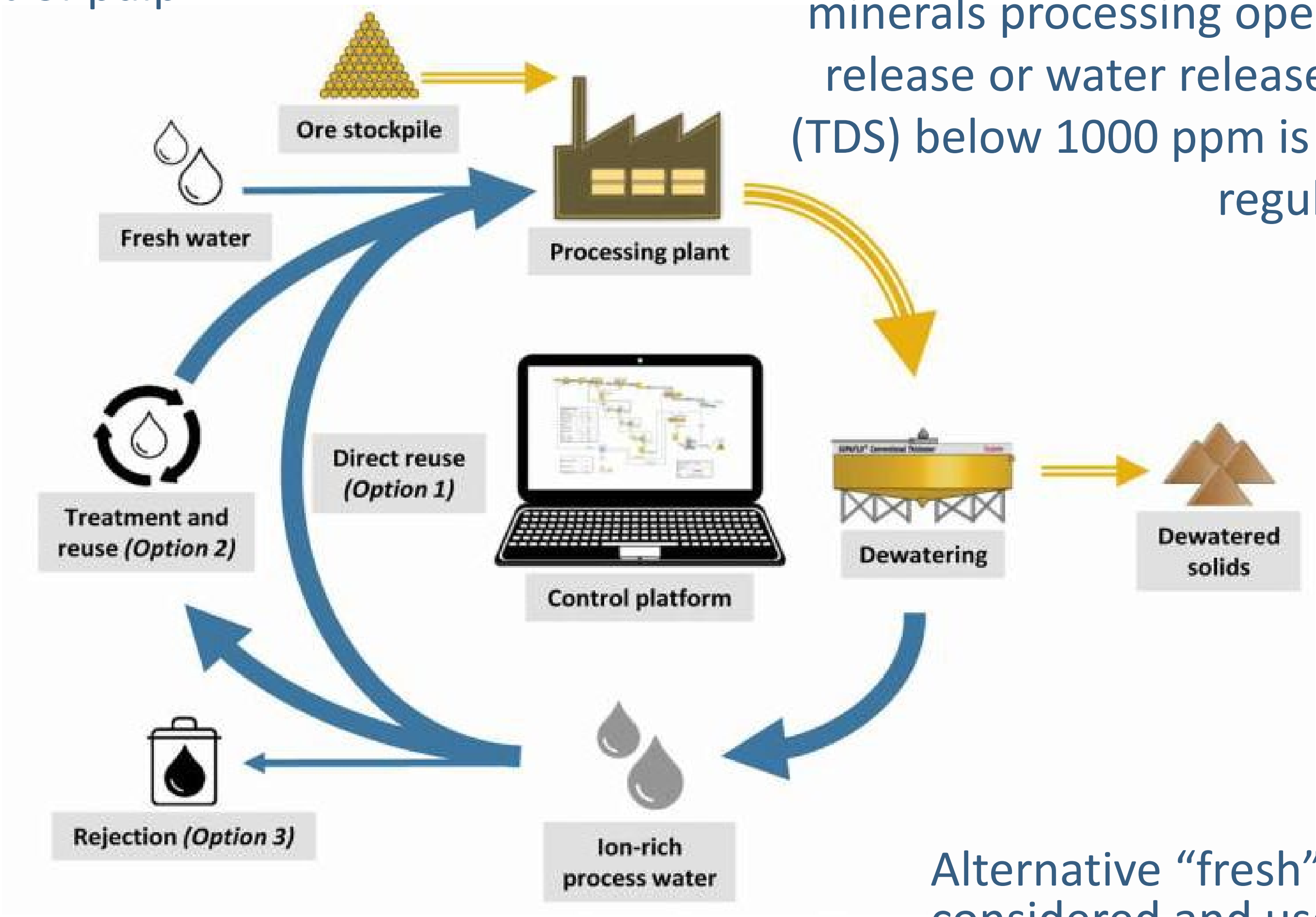
Supporting The Establishment Of **“Closed Water Concentrators”** In The Minerals Processing Industry.

Manono and Corin (2022)

The Closed Water Circuit in Minerals Processing

Water makes up 60 – 85 % of pulp volume. (Muzenda, 2010)

“It is well known that there are now mining and minerals processing operations in which zero water release or water release with total dissolved solids (TDS) below 1000 ppm is required by environmental regulation.” (Levay et. al., 2001)



Michaux et al. (2019)

Alternative “fresh” water sources are being considered and used, eg. ground, grey and recycling streams. (Muzenda, 2010, Slatter et al., 2009)

CENTRE FOR MINERALS RESEARCH

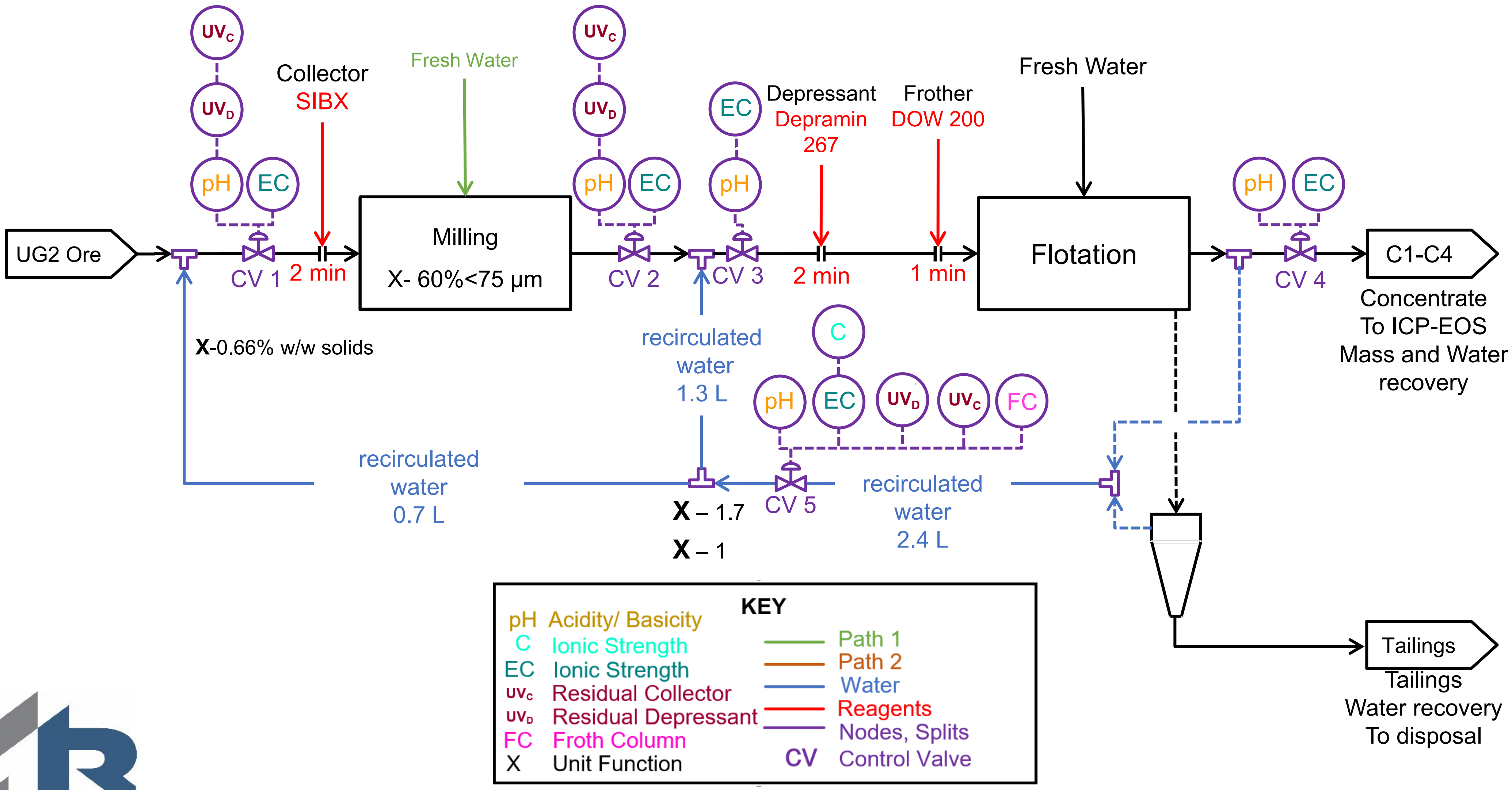
Strategy Towards Concentrator Water Management: Initial Identification of Waters Negatively Affecting Values Recovery

1. **Grade Recovery Curve for Each Test Water**
2. Identify the water(s) with detrimental effect on recovery/ grade
3. Identify water(s) where recovery/ grade not adversely affected
4. Compare analyses of identified waters
5. Identify elements having a negative effect
6. **Treatment/ Management Plan**

Simple lab based techniques that could highlight water issues without having to run a large number of tests.

CENTRE FOR MINERALS RESEARCH

Water Recirculation Simulation



CENTRE FOR MINERALS RESEARCH

UCT Synthetic Plant Water (SPW)

"The ionic concentrations were based on the typical values found at one selected concentrator. Because of the nature of the gangue minerals, it would be expected that similar type water was being used at other concentrators." Wiese et al. (2005)

Based on an actual Cu-Ni-PGM Concentrator in early 2000's

Water Type	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	Cl^{-} (mg/L)	SO_4^{2-} (mg/L)	NO_3^{-} (mg/L)	CO_3^{2-} (mg/L)	TDS mg/L	I [M]
SPW	80	70	153	287	240	176	17	1023	0.0242

Multiplying concentration 3-fold, *increase by the same magnitude*

Water Type	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	Cl^{-} (mg/L)	SO_4^{2-} (mg/L)	NO_3^{-} (mg/L)	CO_3^{2-} (mg/L)	TDS mg/L	I [M]
3SPW	240	210	459	861	720	528	51	3069	0.0727

CENTRE FOR MINERALS RESEARCH

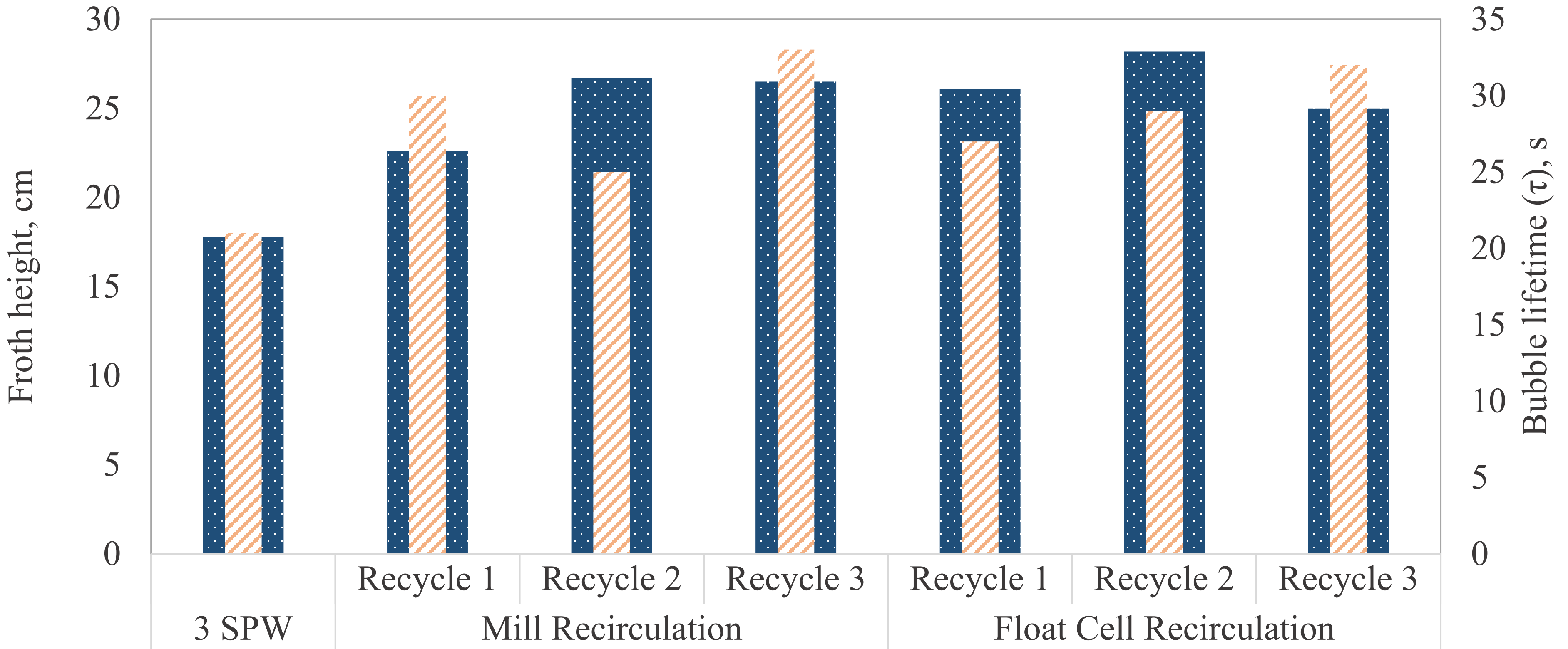
Wiese *et al.* (2005), Manono *et al.* (2018)

Results on Short Water Recirculation for a Selected Cu-Ni-PGE Ore Benchscale Flotation

- Frothability of Tailings
- Residual Xanthate in Recirculated Water
- EC of Recirculated Water
- Cation and Anion Analyses of Recirculated Water

CENTRE FOR MINERALS RESEARCH

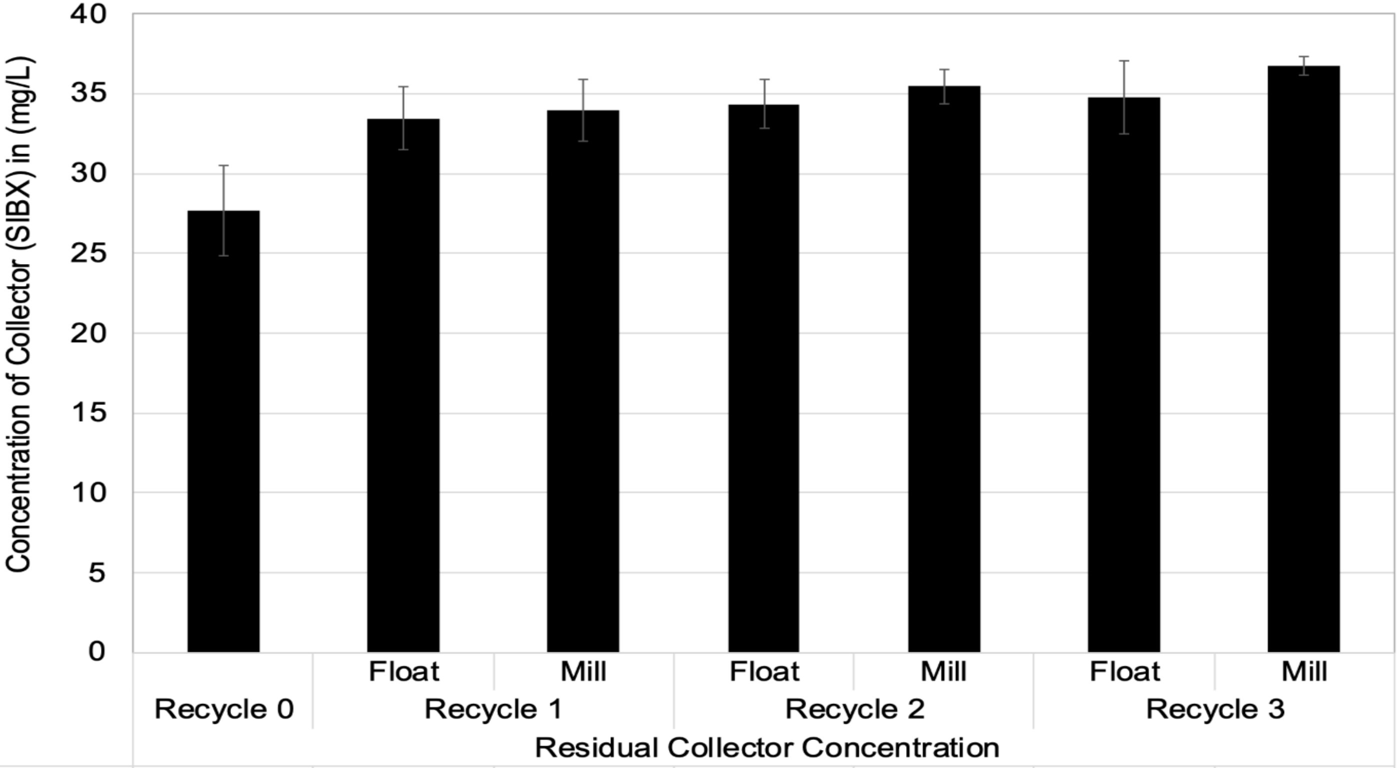
Frothability of Tailings as a Measure of Residual Frother



	3 SPW	Mill Recirculation Recycle 1	Mill Recirculation Recycle 2	Mill Recirculation Recycle 3	Float Cell Recirculation Recycle 1	Float Cell Recirculation Recycle 2	Float Cell Recirculation Recycle 3
Hmax	18	23	27	27	26	28	25
Tau	21	30	25	33	27	29	32

Short water recirculation results in tailings water with better frothing properties, suggesting the presence of residual frother.

Residual Xanthate in Recirculated in Recirculated Process Water

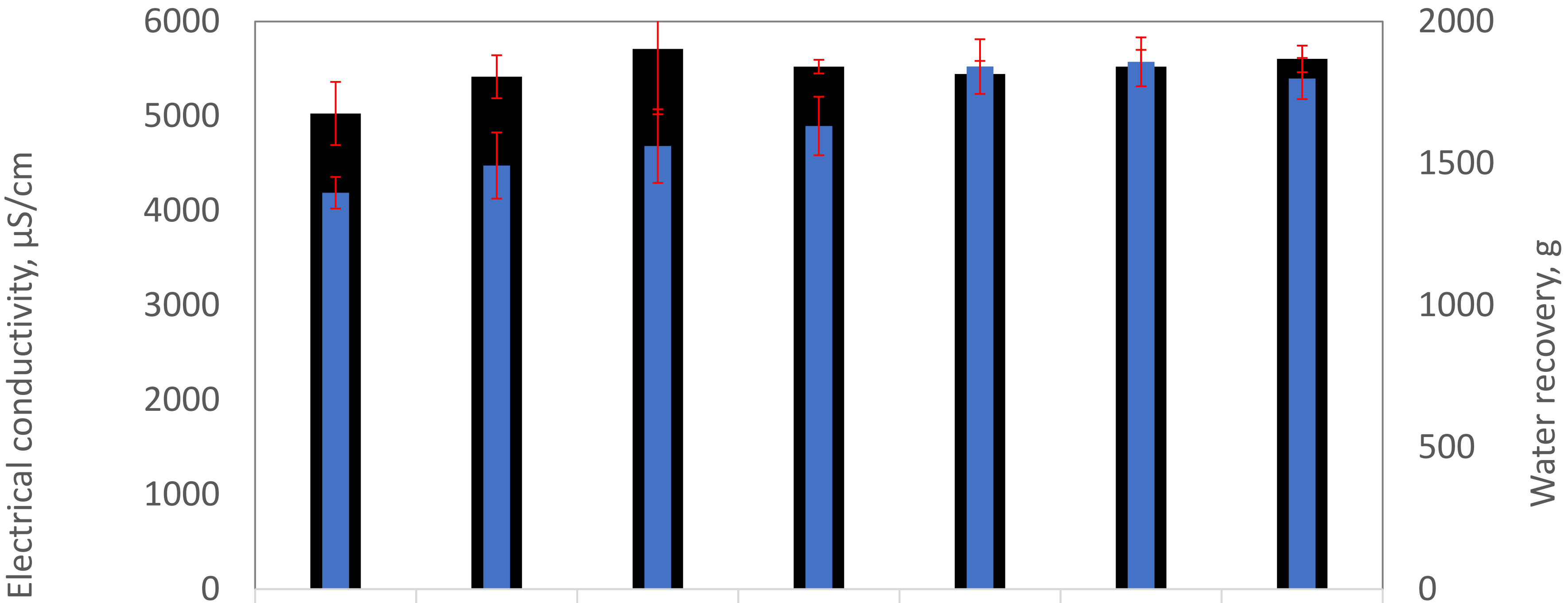


	Recycle 0	Recycle 1 Float	Recycle 1 Mill	Recycle 2 Float	Recycle 2 Mill	Recycle 3 Float	Recycle 3 Mill
Tailings	12	16	15	16	16	15	16
Concentrate	15	18	19	18	20	19	20
■ Overall	28	33	34	34	35	35	37

Recirculated water recovered from tailings contains residual concentrations of xanthate collector, this may imply a reduction of fresh xanthate dosing, thus a reduction in Opex .

CENTRE FOR MINERALS RESEARCH

Electrical Conductivity of Recirculated Process Water



	3 SPW	Mill Recirculation Recycle 1	Mill Recirculation Recycle 2	Mill Recirculation Recycle 3	Float Cell Recirculation Recycle 1	Float Cell Recirculation Recycle 2	Float Cell Recirculation Recycle 3
Tailings Water EC, µS/cm	5028	5416	5709	5523	5444	5523	5604
Water Recovery, g	1397	1492	1561	1632	1841	1858	1799

Recirculated water recovered from tailings had a higher EC compared to fresh water (3 SPW)

CENTRE FOR MINERALS RESEARCH

Concentration of Selected Ions in Recirculated Process Water in mg/L

Mill Recirculation

[Ca^{2+}] fairly constant
[Mg^{2+}] decreases
[SO_4^{2-}] and [Cl^-] increases

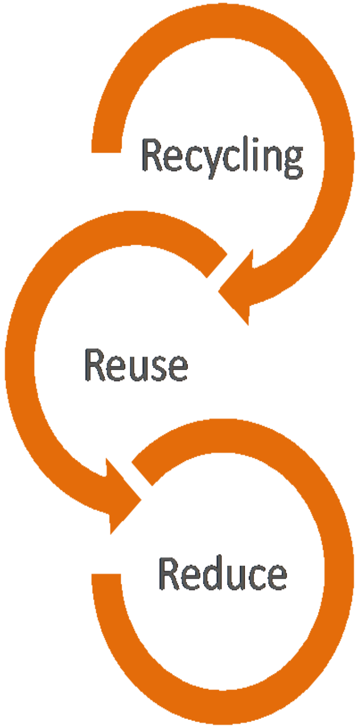
Float Recirculation

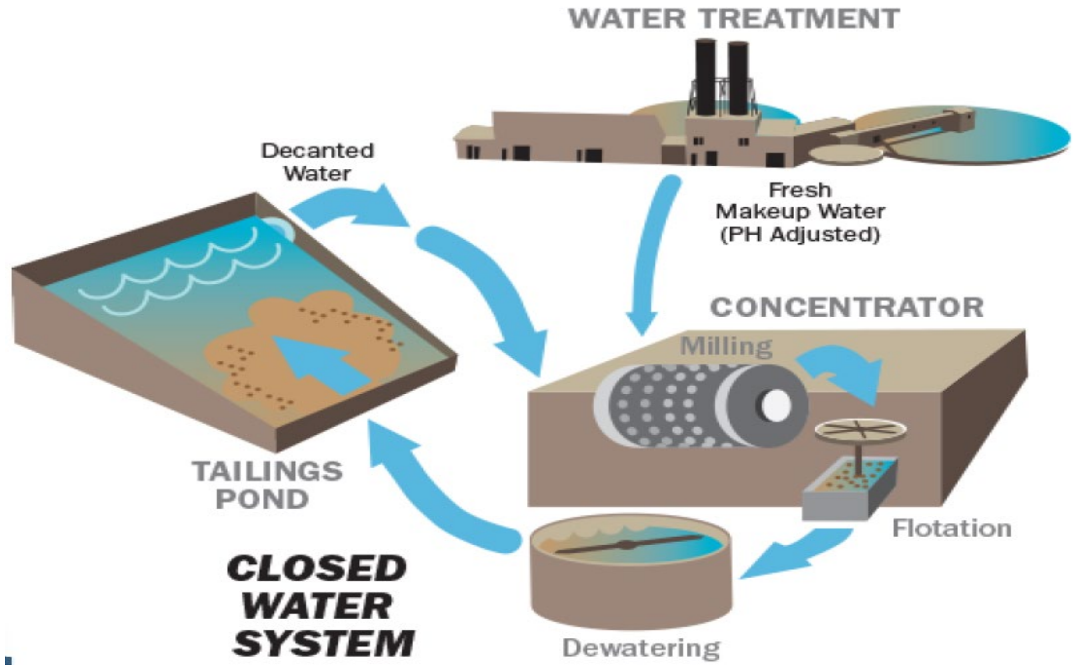
[Ca^{2+}] increases
[Mg^{2+}] decreases
[SO_4^{2-}] and [Cl^-] increases

	SPW	Recycle 1		Recycle 2		Recycle 3	
		Mill	Float	Mill	Float	Mill	Float
Ca^{2+}	240	237 ± 6	248 ± 1	234 ± 6	254 ± 2	241 ± 6	258 ± 6
Mg^{2+}	212	207 ± 12	242 ± 7	193 ± 1	198 ± 3	164 ± 12	191 ± 12
SO_4^{2-}	719	708 ± 14	804 ± 57	740 ± 9	805 ± 17	783 ± 14	813 ± 14
Cl^-	861	1057 ± 15	999 ± 120	1032 ± 12	1027 ± 128	1054 ± 15	1021 ± 15

CENTRE FOR MINERALS RESEARCH

Conclusions





Recirculation of water increases the salinity of water which is good for **concentrator recoveries**.

Residual reagents in recirculated water may **reduce the costs of reagent refreshment**.

Closed process water circuits to improve mineral processing aspects such as froth stability

Water recirculation to increase **resource efficiency** and **reduce fresh-water withdrawals**.

CENTRE FOR MINERALS RESEARCH

science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad

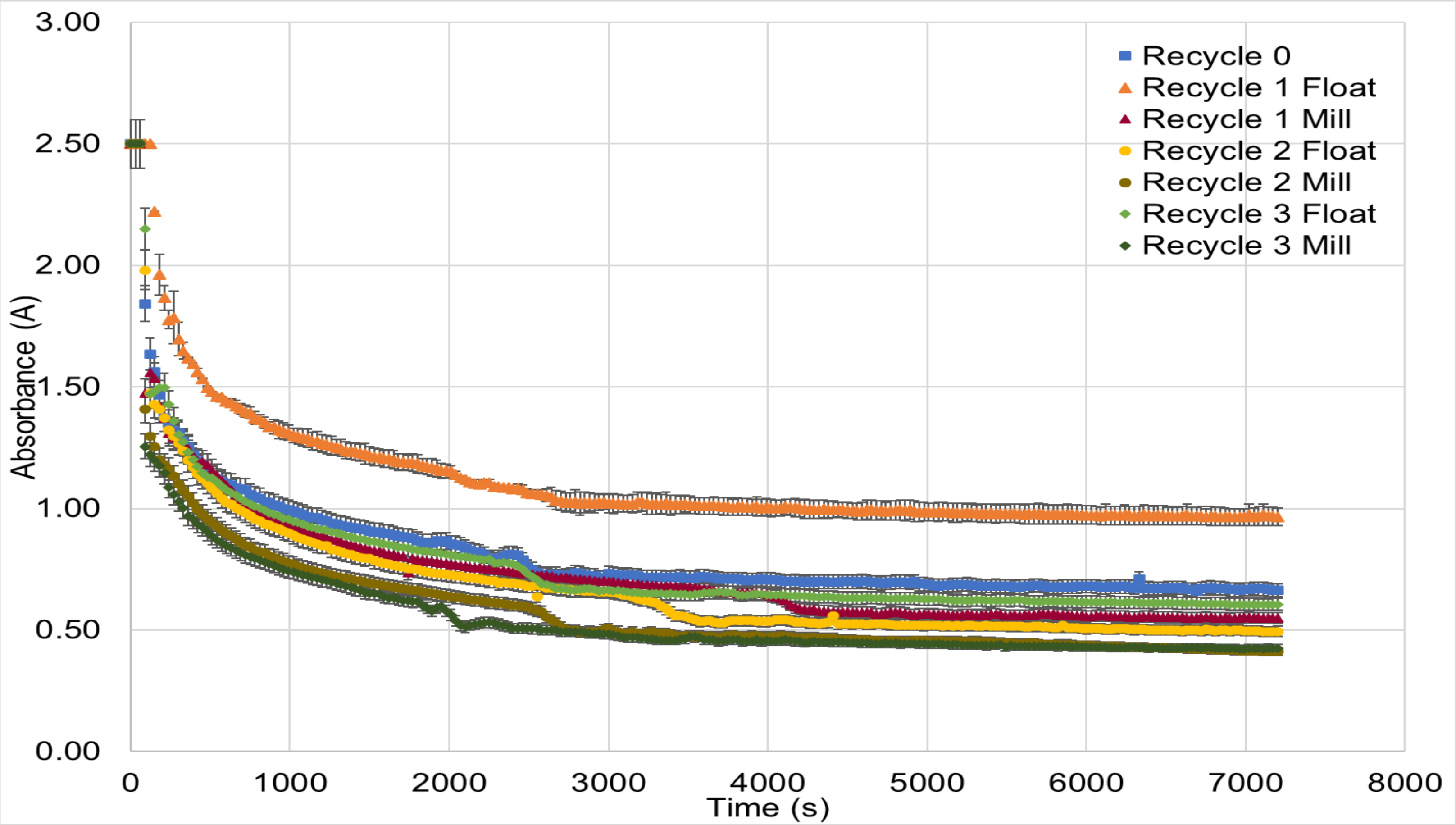
SPES BONA

malibongwe.manono@uct.ac.za

www.cmr.uct.ac.za

CMR
CENTRE FOR MINERALS RESEARCH

Settling of Tailings: Absorbance (A) of Tailings after Short Circulation

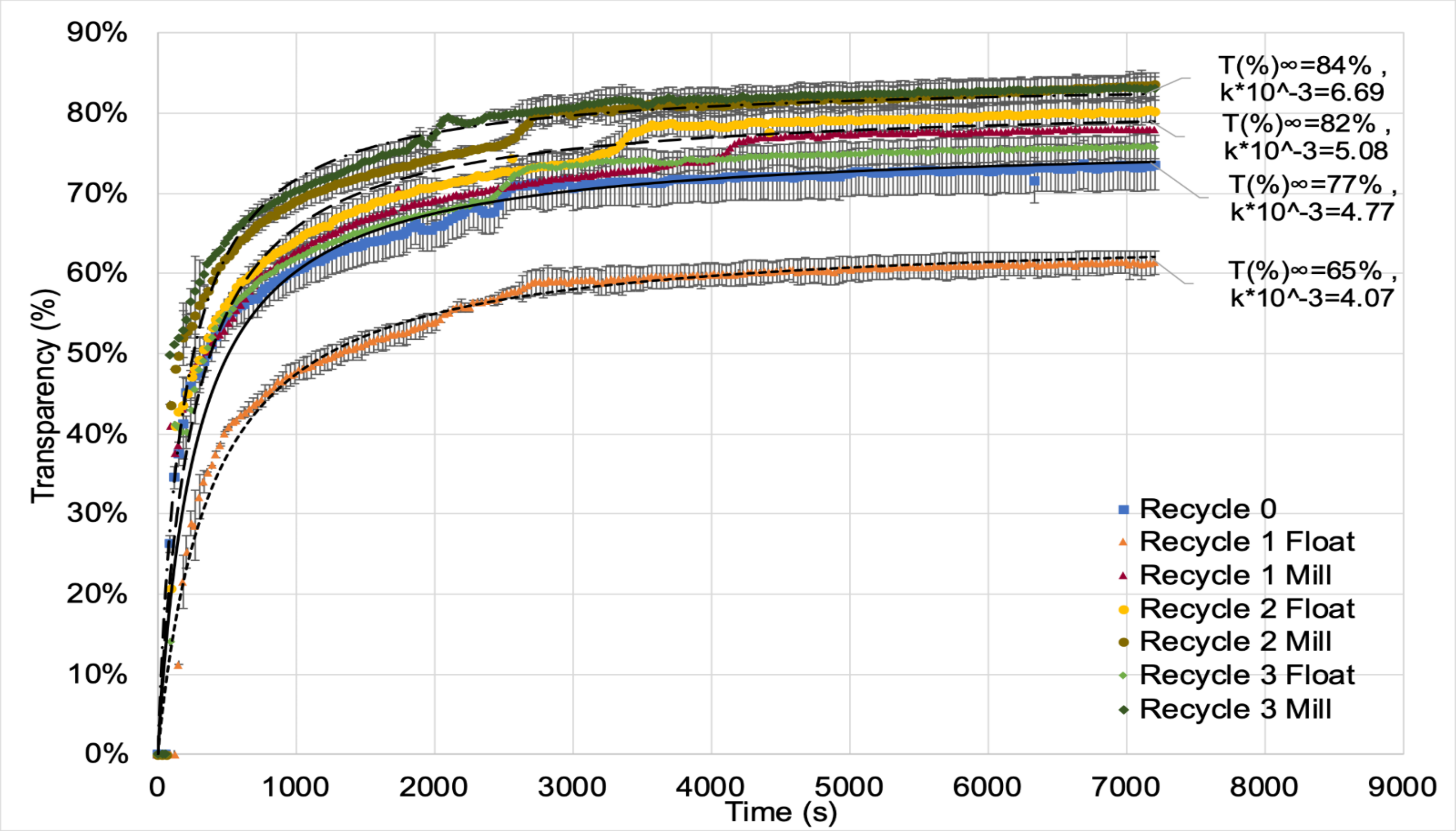


RF: Water and solids recoveries increase with each recycle loop.

RM resulted in lower water and solids recoveries compared to RF

CENTRE FOR MINERALS RESEARCH

Second Order Kinetic Models Fitted to the Tailings Transparency T (%)



RF: Water and solids recoveries increase with each recycle loop.

RM resulted in lower water and solids recoveries compared to RF

CENTRE FOR MINERALS RESEARCH