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# Critical pathways for selecting paste backfill process for Rio Tinto Kennecott mine

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## Abstract

*Rio Tinto Kennecott's Integrated Skarn Project is completing a feasibility level of design for the future underground mine that consists of a number of ore zones: Low Commercial Skarn, North Rim Skarn (NRS), Middle Block, Fortuna, NRS – Extension, and Carr Fork. The ore zones are located under the northern wall of the existing open pit, Bingham Canyon Mine. The underground mine will contribute a relatively small fraction of the overall ore stream with the bulk coming from the open pit. The ore will be processed at the existing Copperton Concentrator.*

*Responsible Mining Solutions was retained by Rio Tinto to complete a feasibility level study for paste backfill and to complete the testing campaign to support the broader study. Concurrently, the testing campaign supported the paste backfill process design and paste backfill recipe development to meet the required backfill strengths. The tailings required for the paste backfill would be sourced from the final tailings sump and would be processed at the Copperton Concentrator area. The feasibility design has the tailings transported through an 8 km long pipeline to the paste backfill plant located at 6190 area of Bingham Canyon Mine.*

*There were a few challenges that were encountered within the final tailings stream such as fluctuation within particle size distribution associated with large particle sizes (i.e. > 12 mm) and concentration by weight ($C_w$) fluctuations. These identified characteristics affected the paste backfill process design.*

*To mitigate observed challenges, a vibrating screen with 4 mm square openings will be installed at the process onset, to protect downstream equipment and to facilitate process dewatering. Also, it was observed that the final tailings stream can contain more than 35% passing 20 µm class, which can affect process dewatering (thickening and filtration) and binder consumption. To mitigate this effect, a radial hydrocyclone cluster will be employed to produce the cyclone underflow stream with 20% passing 20 µm, to improve dewatering performances, reduce binder consumption and to maintain critical paste properties such as rheology.*

*To reduce the paste backfill plant footprint at the 6190 area and to improve water management (quality and quantity), a single high compression thickener was selected. The thickener is planned for installation at the Coppertone Concentrator tailings area to recycle the water and to produce non-segregating thickened tailings at $C_w$ of about 65% and concentration by volume ($C_v$) of 40%. The thickened tailings as such call for a 200 mm (8 inch) pipe diameter and will be transported over the 8 km long pipeline with less power consumption due to lower volumetric flowrates. This scenario also mitigates the risk of material settling along the tailings pipeline. Additionally, the overall approach requires two operating vacuum disc filters and a single standby disc filter, which reduces the paste backfill plant footprint area. This paper outlines the key design characteristics, the approach and the solution for selection paste backfill process design for Rio Tinto Kennecott underground mine.*

**Keywords:** *Rio Tinto Kennecott, skarns, paste, backfill*

# 1 Introduction

Rio Tinto Kennecott (RTK) is currently completing a feasibility engineering study for the paste backfill plant within its Integrated Skarn Project (ISP). RTK is a copper molybdenum mine located in the southwest region of Salt Lake City, Utah, USA. RTK is planning to expand the existing surface (open pit) mining operation to include concurrent underground mining. ISP consists of the following group of discrete ore bodies: 1) Low Commercial Skarn, 2) North Rim Skarn (NRS), 3) Middle Block, 4) Fortuna, 5) NRS – Extension, and 6) Carr Fork. These ore bodies are shown in Figure 1.

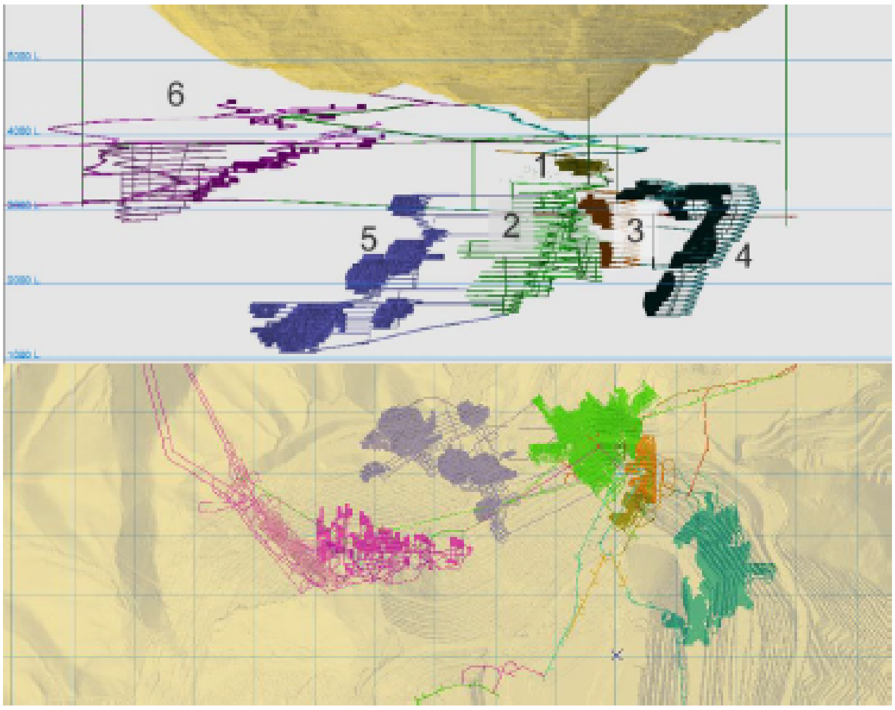

**Figure 1 Cross-section and plan view of all skarns including pit topography (Pavlovic et al. 2019)**

The ore bodies are generally located under the northern wall of the existing Bingham Canyon Mine. Most of the ore would still be sourced from the open pit while the underground mine would contribute a small fraction of the overall stream. The ore would be processed at the Copperton Concentrator which is located roughly 9 km from the mine. The Copperton Concentrator processes a nominal ore throughput of 120,000 tpd.

In parallel with the paste backfill study, RTK is executing underground development to access two underground ore bodies: the Lower Commercial Skarns (LCS) and the NRS, which is sub-divided into NRS-1 and NRS-2. The intention for initial mining of the LCS and NRS-1 ore bodies, with bottom-up mining, is to backfill the underground stopes using cemented rockfill (CRF) that is trucked down from the surface shotcrete plant. Subsequently, NRS-2 would be mined top-down with paste backfill.

Rio Tinto Kennecott commissioned Responsible Mining Solutions (RMS) to complete a feasibility level study for paste backfill and to carry out the testing campaign to support the study. The testing campaign aimed to support the paste backfill plant design and to define the paste backfill recipes to satisfy required strengths. The tailings required for the backfill will be sourced from the final tailings sump and processed at the Copperton Concentrator area. Also, the feasibility study includes the tailings transport over an 8 km long pipeline (via pipeline corridor) to the paste backfill plant located at 6190 area of Bingham Canyon Mine.

RTK has provided the range of underground mining throughputs from 1.4 Mtpy (lower case) to 3 Mtpy (upper case), considering the mining throughput of 2.3 Mtpy (central case) as the most relevant for the paste backfill plant design. This paper outlines the key design characteristics, the general approach, and the selected paste backfill process design for Rio Tinto Kennecott underground mine.

# 2 Critical process parameters and drivers

## 2.1 Overview

To better understand the tailings characteristics, RMS has reviewed previous reports and testing programs completed by other consultants. The following three major threats for the backfill process were identified:

1. The existing thickening circuit thickens the general mill tailing (GMT) at concentration by weight ($C_w$) from 45 to 55%.
2. Particle size distribution (PSD) can fluctuate significantly based on the ore types being processed and the residence time in the grinding circuit. Statistical analysis is shown in Figure 2.
3. Oversized particles (diameter >12 mm) were observed in the final tailings sump, which could cause damages to downstream process equipment.

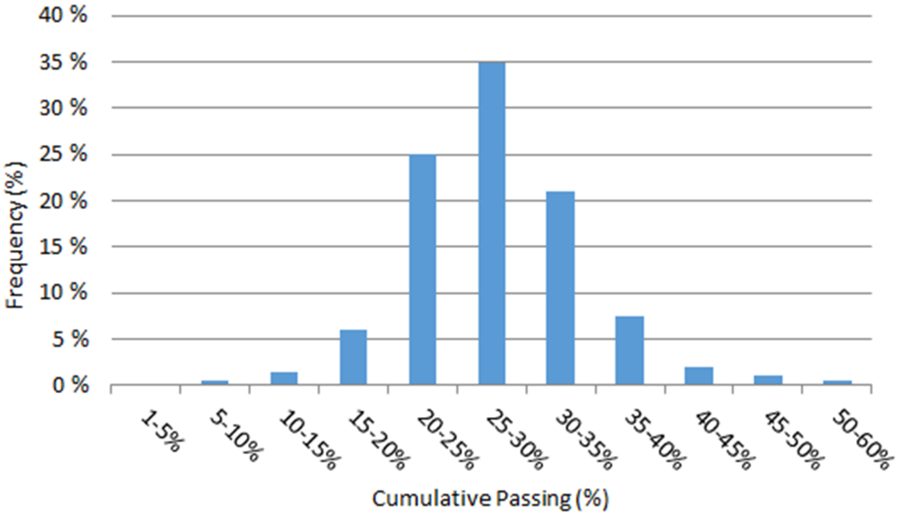

**Figure 2 Statistical analysis (frequency) of cumulative passing of 20 microns class (Stadler & Lee 2022)**

From a PSD perspective, a rule of thumb often utilised is that tailings have a minimum of 15% passing 20 microns to be suitable for paste production. Based on the statistical analysis (Figure 2), it was found that the most frequent cumulative passing of the sub-20 micron class spans from 20 to 35% (total frequency of about 80% counted for the bin values 20–25%, 25–30% and 30–35%). It means that, at 80% of operating time, on the yearly basis, the Copperton Concentrator produces the tailings with cumulative passing of the sub-20 micron class from 20 to 35%. In accordance with the mentioned results and to meet the rheological properties, the ultimate paste backfill PSD would rely on the target cumulative passing of 20% of the sub-20 micron class.

Beyond the above outlined process threats in terms of PSD and fluctuation of $C_w$ within the GMT stream, the 6190 area has limited available footprint to support the addition of new facilities.

### *2.1.1 Initial concept*

To mitigate the risk of large oversize in the tailings sump, a vibrating screen was selected to receive the GMT stream and scalp the oversized fraction, allowing the undersized friction to be subjected to slimes removal via hydrocycloning.

To mitigate the risk of excessive sub-20 µm particles, a radial hydrocyclone cluster (cyclopack) would be employed to deslime the GMT achieving targeted 20% passing of 20 micron in the hydrocyclone underflow (CUF) stream. When cumulative passing of 20 micron drops below 20%, the paste backfill would rely on the GMT stream only. According to this initial concept design, the GMT and CUF were subjected to a laboratory testing campaign.

# 3 Key testing data

Both the GMT and CUF samples were subjected to a testing campaign including material characterisation, hydrocycloning, rheology, thickening (settling testing), vacuum filtration and unconfined strength (UCS) test. The key testing program will be outlined in this paper that was crucial for the paste backfill process selection.

## 3.1 Mineralogy

The major mineral constituents identified by X-ray diffraction (XRD) analysis were quartz and minerals with colloidal properties such as mica (biotite) and clay (illite, kaolinite).

## 3.2 Particle size distribution

Table 1 summarises the fundamental PSD parameters.

**Table 1 Particle size distribution**

| Sample | % passing of 20 microns | P30 (microns) | P50 (microns) | P80 (microns) |
|---|---|---|---|---|
| GMT | 31 | 22 | 71 | 205 |
| Hydrocyclone underflow | 20 | 24 | 69 | 199 |

## 3.3 Hydrocycloning

The hydrocycloning testing campaign was carried out initially using a single laboratory hydrocyclone with a diameter of 75 mm. This testing aimed at achieving a lower per cent passing 20 micron class in the CUF stream. The results are tabulated in Table 2.

**Table 2 Hydrocyclone testing and scale up results**

| Process parameters | Units | Laboratory testing | Scale up |
|---|---|---|---|
| $d_{50c}$ (cutting particle diameter) | microns | 17 | 32 |
| Bypass fraction[1] | % | 44% | 32% |
| Hydrocyclone underflow $C_w$ | % | 60% | 65% |
| Solid mass split underflow/overflow | % | 84/16 | 73/27 |
| Hydrocyclone diameter | mm | 75 | 250 |
| Feed $C_w$ | % | 40% | 40% |
| Feed pressure | kPa | 50 | 48 |
| Vortex finder (DU) | mm | 23 | 70 |
| Apex/spigot (DO) | mm | 23 | 70 |
| Ratio DU/DO | – | 1 | 1 |

[1] The bypass fraction comprises of the fine particles which are associated with the soft minerals that were not classified by hydrocycloning and report to the hydrocyclone underflow stream.

## 3.4 Rheology

The paste concentrations by weight were determined by using Abrams 12 in (300 mm) cone testing (ASTM C143) . The results are provided in Table 3.

**Table 3 Paste densities and static yield stress**

| Sample | Slump (mm) | $C_w$ (%) | Static yield stress (Pa) |
|---|---|---|---|
| GMT | 175 | 74.5 | 570 |
| | 250 | 73 | 300 |
| Hydrocyclone underflow | 175 | 76.2 | 550 |
| | 250 | 75 | 340 |

Static yield stress and viscosity results for GMT and CUF samples are illustrated in Figures 3 and 4.

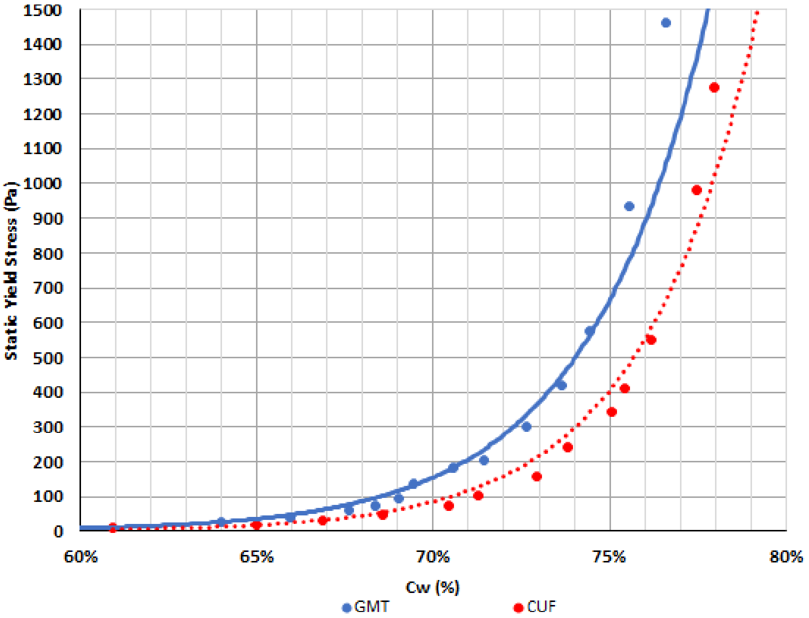

**Figure 3** Static yield stress for GMT and hydrocyclone underflow (CUF)

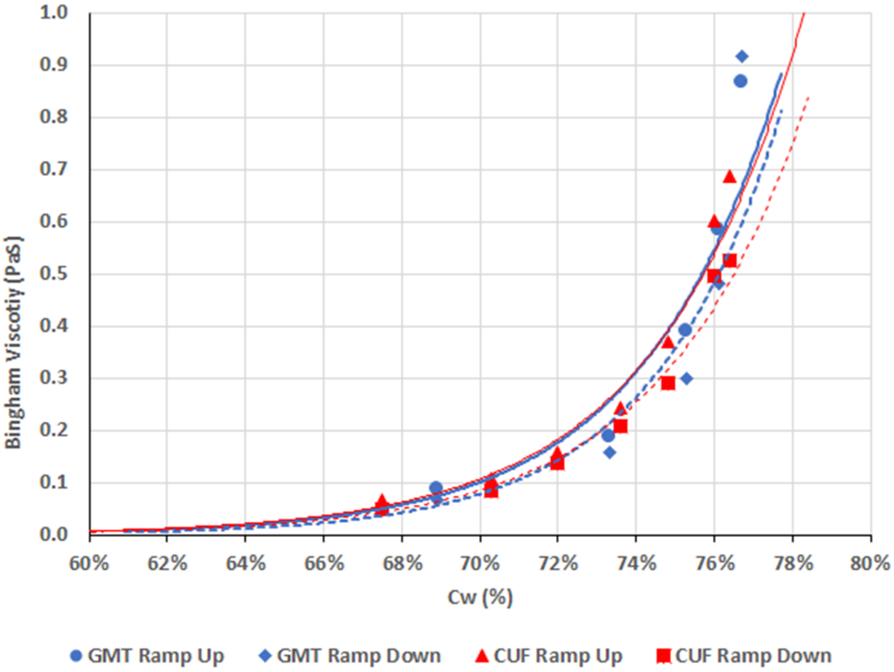

**Figure 4** Dynamic viscosity for GMT and hydrocyclone underflow (CUF)

## 3.5 Thickening settling test

Thickening testing including flocculant type and dosage, feed density screening, static and dynamic thickening was completed on both the GMT and CUF samples. It was found that both samples settle rapidly with the currently used flocculant AF 307 (provided by RTK) and an alternative flocculant (945 VHM) with a dosing rate of 30 g/t and thickener feed $C_w$ of 10%. Dynamic settling tests showed that both samples settle well at a flux rate of 0.8 t/m$^2$/h. Dynamic thickening test results are tabulated in Table 4.

**Table 4 Dynamic thickening test results**

| Sample/ stream | Flux rate (t/m$^2$/h) | Flocculant dose (g/t) | Underflow $C_w$ (%) | Overflow clarity (mg/l) | Unsheared yield stress (Pa) |
|---|---|---|---|---|---|
| GMT | 0.5 | 30 | 57 | 20 | 39 |
| | 0.8 | 30 | 57 | 37 | 10 |
| | 0.8 | 10 | 61 | 71 | 137 |
| | 1.0 | 10 | 61 | 148 | 105 |
| Hydrocyclone underflow | 0.8 | 10 | 65 | 47 | 136 |
| | 0.5 | 30 | 72 | 55 | 286 |
| | 0.8 | 30 | 61 | 79 | 64 |
| | 0.8 | 10 | 67 | 108 | 141 |
| | 0.8 | 20 | 62 | 42 | 87 |

## 3.6 Vacuum disc filtration test

Vacuum disc filtration test was completed with vacuum pressures ranging from 0.65 to 0.44 Bar using three filter feed consistencies at $C_w$ of 60, 65 and 70% for GMT and CUF sample. The standard cycle times of 60, 75, 90, 120 and 150 s were applied. These considered parameters enable the vacuum filtration operating envelope to be created. This enhanced testing provides a wide spectrum results; however, only those results that are critical for the vacuum filtration operation were outlined in Table 5.

**Table 5 Vacuum disc filtration results**

| Sample/stream | Feed $C_w$ (%) | Vacuum pressure (bar) | Cycle time (s) | Cake thickness (mm) | Filter cake $C_w$ (%) | Filtration rate (kg/m$^2$/h) |
|---|---|---|---|---|---|---|
| GMT | 65 | 0.65 | 60 | 10 | 81 | 780 |
| | | | 75 | 10.3 | 81 | 650 |
| | | | 90 | 11.3 | 82 | 600 |
| | | 0.44 | 60 | 7.5 | 81 | 640 |
| | | | 75 | 9.5 | 81 | 600 |
| | | | 90 | 10 | 81 | 540 |
| Hydrocyclone underflow | | 0.65 | 60 | 8 | 82 | 710 |
| | | | 75 | 9 | 83 | 590 |
| | | | 90 | 11 | 83 | 560 |
| | | 0.44 | 60 | 7 | 82 | 590 |
| | | | 75 | 8 | 82 | 490 |
| | | | 90 | 8 | 82 | 460 |

# 4 Integrated process design

Understanding the future of the overall paste backfill project was a critical component, including design considerations, permitting, operation and risk. It is important to understand the integrated process operation from the tie-in point to final paste backfill product. This encompasses the critical process parameters and material properties that appear to be risky for the entire backfill process, i.e. equipment damages, surface and underground pipelines blockages, process failures and other uncertainties etc. The paste backfill process preparation was divided into the two plants: the thickening plant located at the Copperton Concentrator tailings area and paste backfill plant located at 6190 area. The thickening plant incorporates tailings classification, thickening and pumping, while the paste backfill plant includes vacuum filtration, binder storage and mixing.

## 4.1 Process design criteria

The process design criteria shown in Table 6 was determined based on the mine throughputs and paste properties determined by the laboratory testing campaign.

**Table 6 Process design criteria**

| **Paste backfill properties** | | | | |
|---|---|---|---|---|
| **Sample** | **Slump (mm)** | **$C_w$ (%)** | **Consolidated wet density (t/m$^3$)** | **Consolidated dry density (t/m$^3$)** |
| GMT | 175 | 74.4 | 1.89 | 1.41 |
| | 250 | 73 | 1.85 | 1.35 |
| CUF | 175 | 76.2 | 1.93 | 1.47 |
| | 250 | 75 | 1.91 | 1.43 |
| **Description** | | **Lower limit** | | **Upper limit** |
| Solids paste backfill throughput | | 200 t/h | | 250 t/h |
| Underground pipe for paste backfill transport | | 8 in (200 mm) Sch 80 and Sch 40 | | |
| Transport velocity | | 1.3 m/s | | 1.6 m/s |
| Paste backfill plant utilisation | | 57% | | 60% |

The paste backfill plant would be able to process the solids throughput of 200 and 250 t/h to meet the underground ore throughputs without substantially increasing the paste backfill transport velocity (laminar flow), maintaining the annual paste backfill plant utilisation at about of 60%.

## 4.2 Tailings tie-in and supply

Multiple tie-in points were analysed at the project onset; however, the final tailings sump that receives the thickened GMT stream at $C_w$ of about 45% from the existing thickeners was selected for sourcing the tailings for paste backfill. This final tailings sump also receives the excess water streams, which dilute the tailings consistency to $C_w$ of about 40%. The large particle sizes (i.e. > 12 mm) could be found within the tailings sump and were identified as a threat for the entire process. For tailings to be supplied to the paste backfill thickener, a set of submersible slurry pumps (operating and standby) were selected with protective mesh with 6 mm opening around the pump intake. This solution aimed to prevent impeller damages and tailings pipeline blockages to the thickening plant.

However, the tailings slurry would still contain the large particle sizes up to 5 mm that appear risky for the downstream processes. To enable a steady tailings supply, a twinned process pipeline was envisioned to span from the final tailings sump to the scalping screen installed at the thickening plant.

## 4.3 Tailings screening

A single vibratory screen with 4 mm square openings would be installed at the beginning of the thickening plant to receive the GMT stream and to prevent large particles entering the backfill process. The available screening area of 10 $m^2$ was determined based on the GMT's PSD. To ensure a stable and efficient screening process, the screen would be fitted with a vibratory mechanism and high pressure washing unit. The oversized fraction would be scooped and disposed to an assigned location, while the undersized fraction would be subjected to hydrocycloning.

## 4.4 Hydrocycloning

To mitigate the fluctuation of the 20 micron class within the GMT, a 250 mm diameter hydrocyclones were selected with a total of 10 hydrocyclone units (8 operating and 2 standby). These hydrocyclones will be radially arranged in a single hydrocyclone cluster (cyclopack). The cyclopack was designed to meet the solid tailings throughput of 200 and 250 tph in the hydrocyclone underflow stream.

From the vibratory screen, the undersized fraction (scalped GMT) would be delivered by gravity to an agitated hydrocyclone feed tank, where process water could be added to control hydrocyclone feed $C_w$, when required. The hydrocyclone overflow stream (COF) would be returned to the final tailings sump by gravity. PSD would be automatically measured in the hydrocyclone feed and CUF stream by a single PSD analyser that would measure one stream at a time within a desired time sequence. According to statistical analysis and PSD variation within GMT stream, the following hydrocyclone operating scenarios were identified (Table 7) to maintain a minimum 20% passing of 20 micron class in the CUF stream.

Based on testing data, the hydrocyclone would be able to produce $C_w$ of about 65% in the CUF; however, this density could drop below this value when hydrocyclone feed $C_w$ drops below 40%, or in the case when hydrocyclone optimisation is required.

**Table 7 Hydrocyclone operating scenarios**

| Scenario | % passing of 20 microns in GMT | Description |
|---|---|---|
| 1 | % passing < 20% | GMT would be pumped to the thickener feed tank, bypassing the cyclopack. |
| 2 | 20% < % passing <35% | CUF and GMT would be blended into the thickener feed tank to accomplish targeted 20% passing 20 microns, if 20 micron class drops below 20% passing (i.e. 15%, 16% etc.) in CUF. Likewise, blending will not occur if hydrocyclone continually produces 20% passing 20 micron class in CUF. |
| 3 | 35% < % passing | The cyclopack would process the total GMT with possible process optimisation (feed density and pressure control etc.). |

GMT: general mill tailings = hydrocyclone feed; CUF: hydrocyclone underflow; COF: hydrocyclone overflow

## 4.5 Thickening

Depending on the hydrocyclone scenario outlined in Table 7, the tailings would be prepared in an agitated hydrocyclone underflow tank. The process water will be also delivered to dilute the tailings slurry and to prepare the mixture for the thickening process. The tailings slurry will be transported to the thickener feed tank and mixed with the flocculant and further diluted by autodilution system (integrated with thickener) to $C_w$ of 10%, within thickener feedwell.

Based on the testing data and process design criteria, a single 22 m diameter high compression thickener or high density thickener with 14° cone slope and 4 m sidewall was selected for thickening either GMT or CUF. According to its geometry, this thickener type offers a deeper compression zone and aggressive thickening. It enables a steady thickened tailings production at $C_w$ of about 65% which is equivalent to concentration by volume ($C_v$) of about 40%. The thickened tailings with this consistency have non-segregating properties, which can be conveyed by overland pipeline at lower velocities than those required for a Newtonian (slurry) mixture (Slatter 2005). Additionally, the non-segregating thickened tailings would have less possibility to settle along the overland pipeline, which reduces the risk for pipeline blockages (Graham et al. 2001).

### *4.5.1 Tailings thickener location trade-off analysis*

The tailings thickener location was determined by an initial trade-off study. Concurrently, the tailings thickener installed at the Coppertone Concentrator tailings area (Location 2 in Table 8) showed that the thickened tailings could be transported with less power draw and utilising a smaller pipeline diameter of 8 in (200 mm). The thickened tailings transport would be designed with half the slurry flow rate, contributing to the smaller power draw (Wilson & Thomas 2006).

**Table 8 Tailings transport trade-off analysis**

| Thickener location | Solid rate (t/h) | $C_w$ (%)/ $C_v$ (%) | Flow rate ($m^3$/h) | Pipe diameter (in/mm) | Transport velocity (m/s) | Total developed head (bar) | Power required (kW) |
|---|---|---|---|---|---|---|---|
| 1 | 250 | 40/20 | 467 | 10/250 | 3.1 | 82 | 1,115 |
| 2 | 250 | 65/40 | 226 | 8/200 | 2.5 | 115 | 762 |

Note:

Location 1: Thickener installed at 6190 area. Tailings slurry transport from the Copperton Concentrator to thickener at paste backfill plant at 6190 area.

Location 2: Thickener installed at Coppertone Concentrator tailings area. Thickened tailings transport from thickener at the Copperton Concentrator to paste backfill plant at 6190 area.

Beyond the stated benefits, additional benefits were identified with installing the tailings thickener at the Coppertone Concentrator tailings area:

- Quick recovery of the thickener overflow water and gravity transport to Concentrator.
- 8 in (200 mm) pipe offers easier maintenance and installation as well as occupying less footprint along the overland pipeline corridor and reducing costs.
- Reduces paste backfill plant footprint at 6190 area by reducing the quantity of the vacuum disc filter units in the paste backfill plant.

## 4.6 Thickened tailings transport

The thickened tailings at $C_w$ of 65% would be pumped from the tailings thickener to an agitated storage tank. The agitated storage tank has an eight hour live storage capacity which mitigates density fluctuations, providing a steady feed to the piston diaphragm (PD) pumps. For thickened tailings to be conveyed via an 8 km long pipeline and to exceed a positive elevation difference of about 320 m, the PD pumping arrangement was selected that consists of one operating and one standby PD pump (Slatter 2005).

To satisfy pressure distribution and transport velocity, the overland tailings transfer pipeline would consist of the following pipes:

- Carbon Steel, 8 in (200 mm) Sch 80 with 6.35 mm rubber liner.
- Carbon Steel 8 in (200 mm) Sch 40 with 12.5 mm rubber liner.
- 10 in (250 mm), HDPE DR7.
- Dual contained pipe with outer pipe: 14 in (350 mm), HDPE DR 13.5 and inner pipe: 10 in (250 mm), HDPE DR7. As per RTK standards, any pipeline that spans over the 6190 area will be buried to a certain depth due to frequent equipment traffic. Concurrently, dual contained pipeline would prevent thickened tailings spillages to underground and can sustain greater pressures caused by equipment on surface.

#### *4.6.1 Environmental mitigation*

Environmental mitigation is essential for permitting. The tailings transfer pipeline will be fitted with a proactive leak detection system to prevent environmental spillages. Failure of the rubber liner can be detected proactively by monitoring the pressure between the rubber liner and the steel pipe with a pressure gauge mounted on the steel pipe. When a breach of the rubber liner occurs the pressure between the two pipes will increase which trips a pressure sensing device that would transfer the signal to the operator (remote control room). This system would identify a failure in a section of pipeline arrangement before any spillage occurs. The worn piping section can be drained and replaced.

An additional leak detection system was envisioned to be used that is more reactive since it only senses a leak after the spill to the environment. Fundamentally, the system works by monitoring pressure and flow rate at strategic locations on the pipeline, during all phases of operation. After ‘learning’ how the pipeline operates normally, the leak detection system can determine when and, to some degree, where the leak has occurred. The leak detection system will be able to identify quite small leaks, down to around 1% of flow.

### 4.7 Vacuum disc filtration

The thickened tailings at $C_w$ of 65% would be discharged and stored in the agitated filter feed tank with an eight hour residence time offering steady backfilling process for one shift if unpredicted upstream interruptions occur. To meet targeted paste densities, one portion of the total solid tailings throughput would be filtered to filter cake consistency at $C_w$ of 82% by vacuum disc filters and dropped onto the filter cake weigh conveyor. The filtrate would be collected to an agitated process water tank; hence it would be delivered to a third sump (locally known as low quality water sump). The filter cake would be conveyed to a twin shaft mixer and blended with thickened tailings and binder as per the targeted backfill recipe. Once blended, the prepared cemented paste would be delivered to the underground stopes by piston (paste) pumps and via an underground distribution system (UDS). The paste pump would be applied to allow high density paste backfill to be distributed to underground stopes. After completing the backfill process, the paste pump would be used for cleaning the UDS by pig, which reduces the risk of potential blockages.

The vacuum disc filtration circuit would consist of two operating and one standby vacuum disc filter, where each disc filter unit features 15 discs with a disc diameter of 3.8 m. Feeding vacuum disc filters with the thickened tailings at $C_w$ of 65% or higher improves filtration performance, which calls for two vacuum disc filter units to be used continuously.

The overall approach with producing and conveying the thickened tailings from the thickening plant at the Coppertone Concentrator to the paste backfill plant results in a smaller number of the vacuum disc filter units and reduces the overall paste backfill plant footprint.

## 5 Conclusion

The impacts of the identified process threats such as PSD variation associated with oversized particles, $C_w$ fluctuation in the GMT and a limited footprint available for the paste backfill plant at 6190 area were identified at the project onset. Additionally, the fluctuations of the cumulative percentage passing from 15 to

40% of the 20 microns class, that is a critical for the paste rheology, would have a strong impact on the downstream dewatering processes.

To mitigate this impact, a scalping screen would be installed at the thickening plant along with the hydrocyclone arrangement, upstream from the tailings thickener. This approach would protect downstream process equipment from the potential damages and prevent pipeline blockages. Additionally, hydrocycloning would alleviate variability of the cumulative percentage passing of the 20 micron class, enabling a steady PSD for the paste backfill.

The clay and mica minerals detected by XRD analysis could be found in the larger quantities over the life of mine. These minerals with their colloidal properties affect the process dewatering. Therefore, aggressive thickening was required to allow steady thickened tailings production. In addition, the high compression thickener was added at the Copperton Concentrator tailings area to allow thickened tailings transport via the 8 km long pipeline and to quickly recycle the process water to the Copperton Concentrator. This type of thickener would continuously densify the tailings to a $C_w$ of about 65% ($C_v$ of 40%), which would have a non-segregating (non-settling properties) properties. The thickened tailings with this consistency (non-Newtonian fluid) could be transported at a lower velocity (i.e. 1.8 to 2 m/s), which calls for less power draw and results in less power consumption. Additionally, due to their non-segregating properties, the thickened tailings have inherently less risk in terms of settling and pipeline blockages and managing of the transport velocity is less critical.

Concurrently, the overland tailings transfer pipeline that is comprised of 8 in (200 mm) pipe facilitates easier maintenance and requires a smaller footprint area over the pipeline corridor.

Lastly, maintaining the thickened tailings production at $C_w$ of 65% calls for a filtration arrangement that consists of two operating and a single standby vacuum disc filter to be installed at the paste backfill plant located at 6190 area. The vacuum disc filtration arrangement as such occupies less footprint area within the paste backfill plant.

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