Use of Reclaim Water Turret Intake in a Cold Climate at the Porcupine Mine, Canada

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Newmont Porcupine is a gold mining and milling operation located in Porcupine, Ontario, Canada, as shown in Figure 1. The climate in Porcupine averages 3m of snow yearly with daily average freezing temperatures from November to March, and extreme temperatures as low as -45°C. The active tailings management area, 6TMA, is approximately 590 hectares in area and 12.5 km in circumference. Tailings deposition at the facility is done by the end spill and spigot method at densities ranging from 32% to 40% solids. Process water for milling operations is nearly 100% reclaimed from the reclaim water pond at 6TMA.

Figure 1 - Location of Newmont Porcupine, Canada (Courtesy maptrove.ca)

The original reclaim water system, as shown in Figure 2, included four vertical turbine pumps drawing water from a well at the reclaim water pond, fed from an inverted intake pipe at the bottom of the reclaim water pond. The intake has an underwater decant structure with stop logs to prevent tailings sediment from entering the reclaim water intake. The well, reclaim pumps and effluent treatment plant feed pump were housed inside a concrete block building with concrete floor.

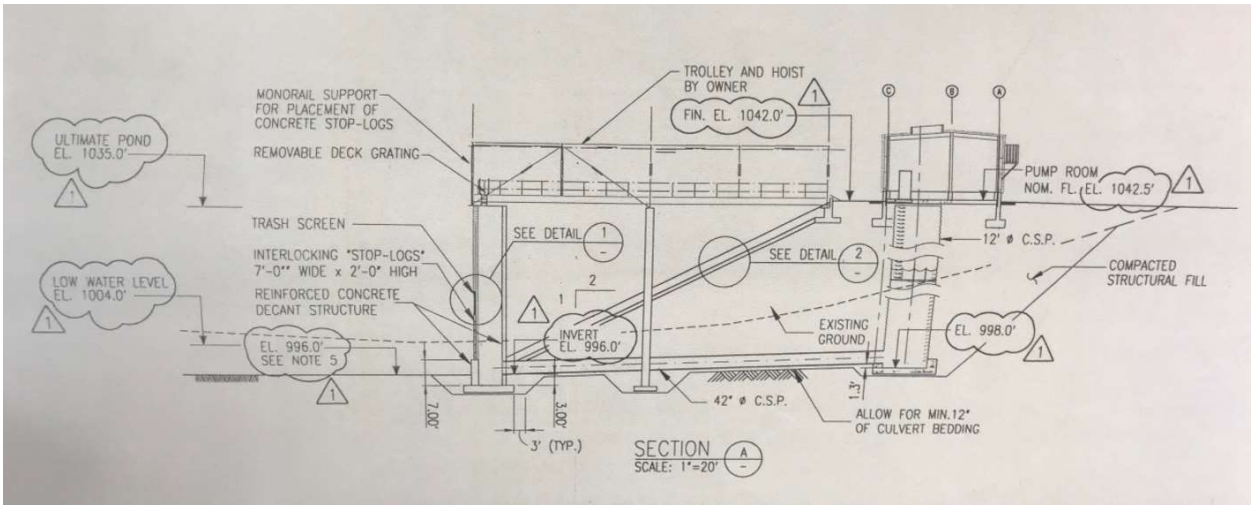

Figure 2 – Original reclaim bottom-draw inverted intake and well (Courtesy of Newmont and Kilborn)

As the dam raises progress, the reclaim pumphouse is required to be raised periodically and has been raised five times. These raises are quite involved and costly. In addition, the Tailings Management Plan involves transitioning the reclaim water pond to the central area of 6TMA, involving depositing tailings in the reclaim pond and creating beaches along the dam. This deposition in the pond will impact the reclaim water intake so transition to a top-draw intake system, with the ability to be repositioned was required. Mining operations in cold climates in the area generally use barges with short vertical turbine pumps, anchored to shore, with de-icing using agitation or aeration.

A study was undertaken to develop options for installation of a barge. Various examples of barge installations were reviewed. Barges in warmer climates can be open to the elements, and more economical. For northern climates dealing with freezing conditions, considerations are required to prevent freezing around the barge, freezing of standby equipment, maintenance of the system in the winter, and access to the barge. The resulting concept involved a heated enclosure with lifting beams, access gallery, and de-icing, leading to a robust barge and costly option, with some practicality issues remaining.

It was suggested to Newmont Porcupine to explore the option of using a turret intake with a pump on shore as used in Australia. The advantages of the turret intake include requiring only 1 m depth of water as well as flexibility to be relocated easily. Figure 3 shows a turret intake installation in Australia.

Figure 3 – Turret intake installation at Newmont – Boddington, Australia
(Courtesy of Turret Engineering Pty Ltd)

Contact was made with the company that designs and supplies turret intakes for Newmont Boddington, Australia. There was a high level of confidence that the turret intake system would work in our application, and the challenge was to ensure that it would not be impacted by freezing conditions. Criteria in the design included de-icing, maintenance of the pumps in the winter and an easily moveable system. The turret supplier began design of a de-icing system while Newmont Porcupine worked with a multi-disciplinary consultant for engineering of the piping, electrical and enclosure. A de-icing pipe with nozzles was designed on each side of the suction pipe and around the turret intake. The first idea was to recirculate a small amount of water from the discharge. In order to maximize the water supplied from the pumps, an alternative was considered to use a blower to supply air to the de-icing ring, however the volume of air required a large blower as well as heating for the intake air. This increased the complexity, required power and cost significantly. The final de-icing design reverted to the original idea of using re-circulated water from the discharge. A cone was added to the 3m diameter turret intake to prevent snow and ice build-up. A self-priming centrifugal pump is used with the turret intake. A 6 m sea container was

modified with a reinforced floor, doors, electrical, ventilation and heating to house the pump. Figures 4, 5, 6 show the components of the turret system.

Figure 4 – Turret intake with cone and de-icing piping (author provided)

Figure 5 – Modified sea container pumphouse (author provided)

Figure 6 – Self-priming centrifugal pump (author provided)

A trial was conducted during the winter of 2022-2023 by installing one turret system. The turret pump discharge was connected to the existing header for the vertical turbine pump system. The one centrifugal pump was trialed during the winter in conjunction with the existing vertical turbine pumps to confirm the ability of the suction intake and pump to supply sufficient flow, and the effectiveness of the de-icing system. The trial was successful and confirmed the ability of the turret pump to supply the mill, with supplement from an additional pump when required. The de-icing system worked better than expected. Figure 7 shows the effectiveness of the de-icing system and Figure 8 shows the turret intake and de-icing system.

Figure 7 – Effectiveness of turret de-icing (author provided)

Figure 8 – Turret intake and de-icing (author provided)

Following the success of the initial winter trial, work began to expand the turret system from one turret to three turrets. Refinements were made to the design and a header was incorporated to tie the three pumps together into the reclaim piping system. The reclaim water system and effluent treatment plant feed has been fully transitioned to supply from the three turret pumps. Figure 9 shows the arrangement of the three-turret system.

Figure 9 – Three-turret system (author provided)

The following functionality is incorporated into the system design:

- All three turret pumps are powered by variable frequency drives for variable flow demands
- All three pumps can supply the mill reclaim water demand providing redundancy
- Two of the three pumps are piped to supply the effluent treatment plant providing redundancy
- One pump is able to supply normal reclaim water demands with ability to be supplemented by a second pump for increased flow requirements
- One pump is able to supply effluent treatment plant demand
- De-icing rings can be back-fed from the operating pump or pumps to ensure all three intakes remain de-iced.
- Access to the side of each sea container to remove pump if needed to take to shop for repairs
- Flexibility to take one turret pump offline to raise or relocate while the others are operating

This turret system provides the following benefits over the existing fixed bottom-draw reclaim system:

- Ability to easily relocate with pond transition
- Turrets can be co-located or can be located in different areas of the pond (once power feed is routed where required).
- Ability to deposit tailings and beach in the area the existing fixed reclaim water intake that is now redundant
- Ability to reduce the amount of water contained in the reclaim pond due to dead zone created by the existing stop log intake
- Ability to pump in shallow water, as little as 0.4m depth
- Ability to extend intake further into pond
- Easier maintenance of the centrifugal pumps compared to vertical turbine pumps with extended shafts

The innovative design of a turret intake developed in Australia has been further adapted for suitability in cold climates such as Porcupine to withstand the winter conditions, providing operational flexibility and benefits. This is an example of a 'Down Under' design adapted for the 'Great White North.'