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Building what matters

Water Treatment Plant – Whale Tail Dike

Agnico Eagle Mines Limited – Whale Tail

Design Report

653281-0001-40ER-0001_0

June 21, 2018

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LIST OF REVISIONS

Revision				Revised Pages	Remarks
No.	By	Rev.	Date		
A	IG	TG, BA, MG, ALN	2018-06-19		Issued for client comments
0	IG	TG, BA, ALN	2018-06-21		Final emission

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1. Introduction

1.1 Site Location and Access

Agnico Eagle is developing the Project in the Kivalliq Region of Nunavut (65°24’25”N, 96°41’50”W). The 99,878-hectare Amaruq property is located on Inuit-owned and federal crown land, approximately 55 km north of the Meadowbank mine. The Meadowbank mine is accessible from Baker Lake, located 70 kilometers to the south.

1.2 Site Facilities

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is developing Whale Tail Pit and Haul Road Project, a satellite deposit located on the Amaruq property, to extend mine operations and milling at Meadowbank Mine. The proposed open-pit mine, mined by truck-and-shovel operation, will produce 19 M tons of ore grading at 3.68 g/t for a total of 2.1 M ounces from 2019 to 2025.

The Amaruq Mineral Deposit is considered to be an extension of the currently operating Meadowbank mine and most positions will be filled by Meadowbank employees. A conventional open pit mining operation is forecast on the Whale Tail deposit. Access to the site is via a 64-kilometer road from Meadowbank mine. On-site facilities will include a power plant, maintenance facilities, tank farm for fuel storage, construction water treatment plant (CWTP), sewage treatment plant, drinking water treatment plant, as well as accommodation and kitchen facilities for approximately 400 people.

In order to start the open pit development, a dike needs to be built in the Whale Tail Lake and water pumped from the north section of the lake.

During dike construction, lake sediment will likely be re-suspended. Two rows of turbidity barriers will be installed before initiating construction on each side of the dewatering dikes to contain the sediment within the work area. Turbidity barriers are floating devices used in lakes or rivers. They are made with geotextile preventing sediment migration in water.

During dike construction on Whale Tail Lake, contact water originating from affected areas in the lake will be pumped and treated by the Construction water treatment plant (CWTP) prior to discharge to the receiving environment. Figure 1 illustrates the location of the CWTP. Note that this report present the design of the CWTP used during 2018. A new report will be submitted to the NWB 60 days prior construction-modification of the water treatment plant for 2019 operation because the process will be significantly different compare to the CWTP.

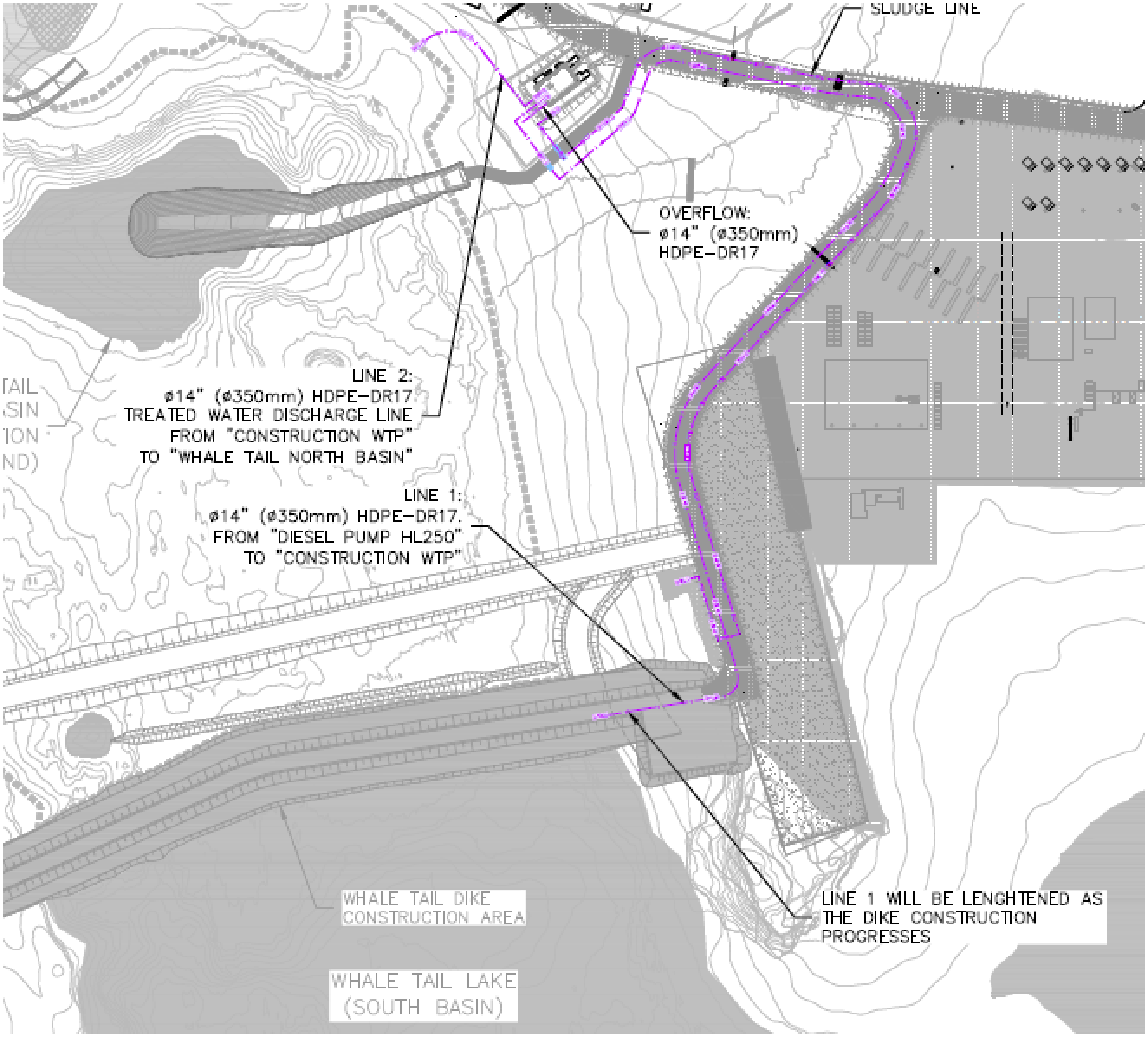


Figure 1 : Location of CWTP à changer

1.3 Purpose of Document

This report includes the final design and construction drawings for the CWTP. The water treated at the CWTP will be sourced from Whale Tail Lake. The effluent water from the CWTP will be pumped back through a pipeline in Whale Tail Lake.

The following infrastructure will also be covered into this document:

- Sludge water discharge design;
- CWTP intake design;
- Batch plant freshwater intake design.

1.4 Scope of Work

SNC Lavalin was retained by Agnico Eagle to design the feed pump, pipelines, and effluent water outfall to Whale Tail Lake. SNC Lavalin and AEM were in charge of the CWTP design and construction. This report describes the CWTP, pumps and pipelines design. Construction drawings of the listed infrastructure are presented in Appendix A of this report. Note that the CWTP will be operated only during approximately two months in summer 2018 during the Whale Tail dike construction. Dewatering activity of the Whale Tail North Basin is not covered into this report.

2. Design Methodology

2.1 Water Management Strategy

During dike construction, lake sediment will likely be re-suspended. Two rows of turbidity barriers will be installed before initiating construction on each side of the dewatering dikes to contain the sediment within the work area.

Turbidity barriers are floating devices used in lakes or rivers. They are made with geotextile preventing sediment migration in water. An example is provided in the following figure.

Figure 2 : Typical Sediment Barrier for Turbidity / Sediment containment[1]

In the Water Quality Monitoring and Management Plan for Dike Construction and Dewatering (AEM, 2017), AEM proposes an action plan for Total Suspended Solids (TSS) management. This plan implies pumping water impacted by the construction activities, and the installation of two rows of turbidity barriers in the downstream and upstream side of the dike location (see **Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.**).

The design is based on technical documentation from the suppliers and the experience acquired in the deployment of turbidity barriers at Meadowbank during the 2008, 2009 and 2010 construction seasons. The generation of TSS will be strongly influenced by the composition of the lakebed, the rockfill used for the dike construction, the meteorological conditions, and the method of construction.

Other mitigation measures will be implemented during the dike construction such as the CWTP to treat water downstream of the construction platforms, the selection of appropriate material for the dike construction. However,

[1] Turbidity barrier during Goose Bay dike construction

the objective of the turbidity barrier is to limit the release of TSS into the environment by blocking the plume of turbid water within the construction sector. Sludge coming from the water treatment plant (TSS removal) will be managed to prevent any discharge into the environment. Sludge management consists of:

- Discharging CWTP sludge at a minimum distance of 31 m from the Whale Tail Lake North Basin shore;
- Sludge will be discharge on an energy dispenser to avoid erosion of the tundra;
- Rockfill berm will be built to reduce velocity of the effluent flow to limit erosion of the lake shore;
- Sludge effluent will reach Whale Tail North Basin in between the Dike and the turbidity barrier number B.

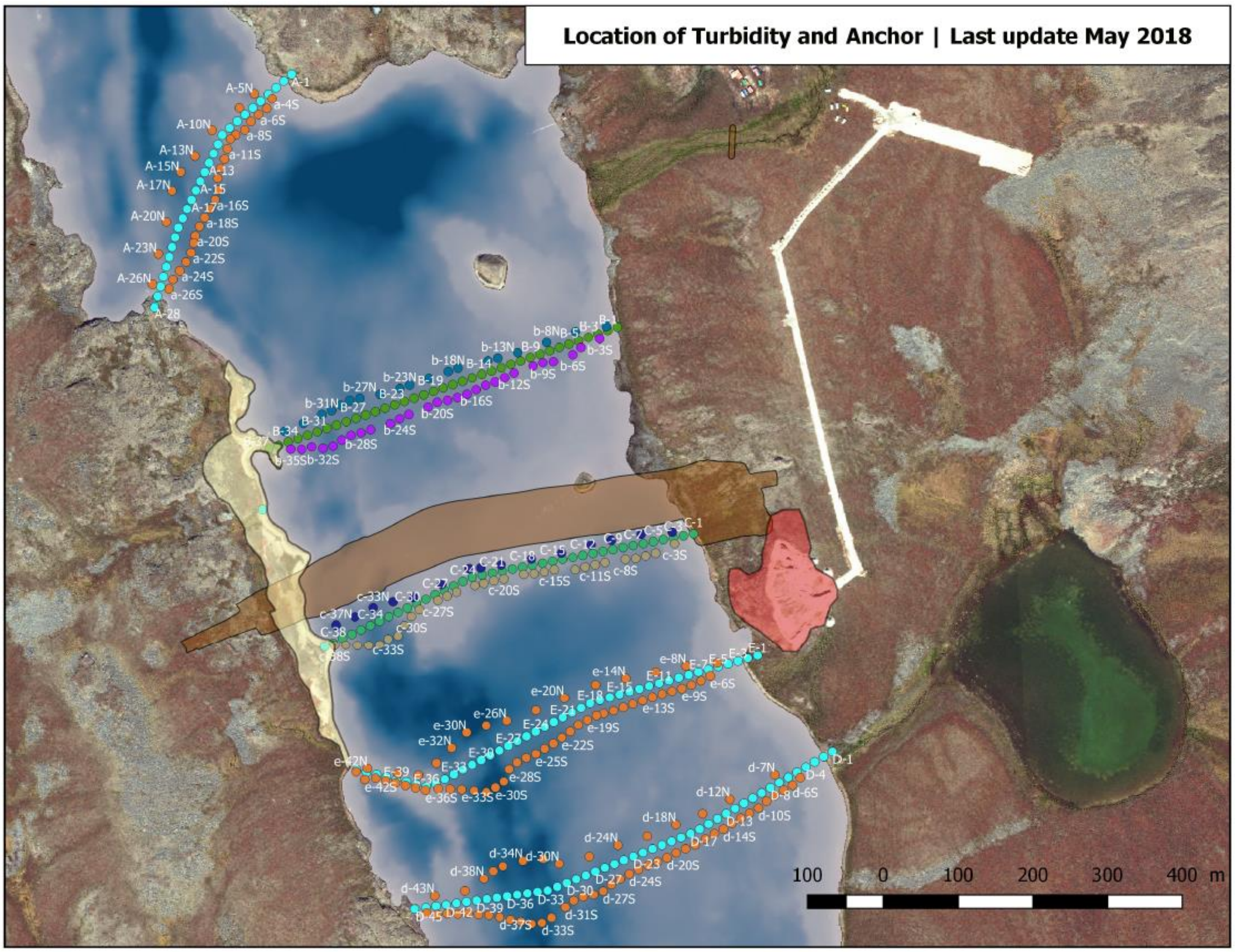


Figure 3 : Concept for the location of the Turbidity Barrier

2.2 Methodology

Water volume to be treated was estimated with the assumption that this volume is equal to the volume of rockfill and aggregate placed or excavate during dike construction in Whale Tail Lake. Treatment of 10,000m^3 per day is planned during the excavation of lake bed sediment located in the Whale Tail Dike key trench. Then, the design of the decommissioned Actflo® from Meadowbank was reviewed and fit with the current need for the Whale Tail Lake dike construction.

3. General Site Conditions and Other Data Input For Design

3.1 Environmental Data

The Amaruq Mineral Deposit is located in the tundra region of the central sub-Arctic (the Barrenlands) at the lower end of the Northern Arctic Ecozone, and within the Wager Bay Plateau Ecoregion. The physical features of the region have largely been determined by glaciation. The terrain consists predominantly of broadly rolling uplands and lowlands with little topographical relief (very few hills). Strung out across the landscape is long, sinuous eskers. This undulating landscape is studded with innumerable lakes, ponds, and wetlands. Cryosols are the dominant soils, and are underlain by continuous permafrost with active layers that are usually moist or wet throughout the summer. Large boulder field areas are encountered.

The topography in the immediate area of the project is generally flat, with relief in the order of 10 to 12 m near the main deposit areas, and as high as 50 m locally. Elevations vary from about 150 meters above sea level (masl) along the shoreline of Whale Lake to about 200 masl. Much of the limited topographic relief in the area can be attributed to land features typical of glaciated and permafrost terrain.

Throughout the Nunavut Territory, the vegetation is composed of dwarf shrubs, sedges and grasses, mosses, and lichens. A short but intense summer produces many small but brilliant flowers, including purple saxifrage, sedge, lousewort, fireweed and wintergreen. Other common flowers in the south of the Amaruq region include dandelions, chamomile daisies, harebells and buttercups. About 200 species of flowers grow in the Barrenlands.

The animal population in the Amaruq region includes mammals such as caribou, muskox, barren-ground grizzly bear, wolf, wolverine, fox, ermine, lemming and hare. Caribou alone outnumber Nunavut's human population 25 to 1. Bird species include gyrfalcon, snowy and short-eared owl, rough-legged hawk, golden eagle, ptarmigan, jaeger, snow goose, pintail and long-tailed duck, goldeneye duck, lesser scaup and green-winged teal. Fish include lake trout, arctic grayling, arctic char, walleye, whitefish and northern pike. Mosquitoes breed in the shallow tundra lakes.

Arctic winter conditions occur from October through May, with temperatures ranging from +5 to -40ºC. Light to moderate snowfall is accompanied by variable winds up to 70 km/h, creating large, deep drifts and occasional whiteout conditions. Summer temperatures can range from -5 to +25ºC, with isolated rainfall increasing through September. In the area of the Amaruq Mineral Deposit, ice is present on lakes from mid-September to mid-July.

3.2 Characteristics of the Effluent

The design of the CWTP is mainly directed by the flow rate and the TSS concentration. TSS concentration is expected to be close to 500 ppm maximum during dike construction within the first curtain and the dike. Flow rate to be treated is assumed to be equal to the volume of rock placed or removed for dike construction and during excavation of the key trench soft sediment.

CWTP will treat mainly TSS and the discharge water quality will meet the License A criteria. Metals to be treated are not expected during the treatment period in summer 2018.

Sludge will be discharged into an energy dispenser located at a minimum of 31 m from the Whale Tail Lake shore as presented in section 4.

3.3 Effluent Flow Rates

As mentioned earlier, flow rate to be treated is expected to be equal to the volume of rock placed for dike construction and key tranch excavation.

TSS concentration of 500 ppm and flow rate of 500 m3/h were chosen for design purpose of Actiflo®.

4. Design of the Water Treatment Plant (WTP)

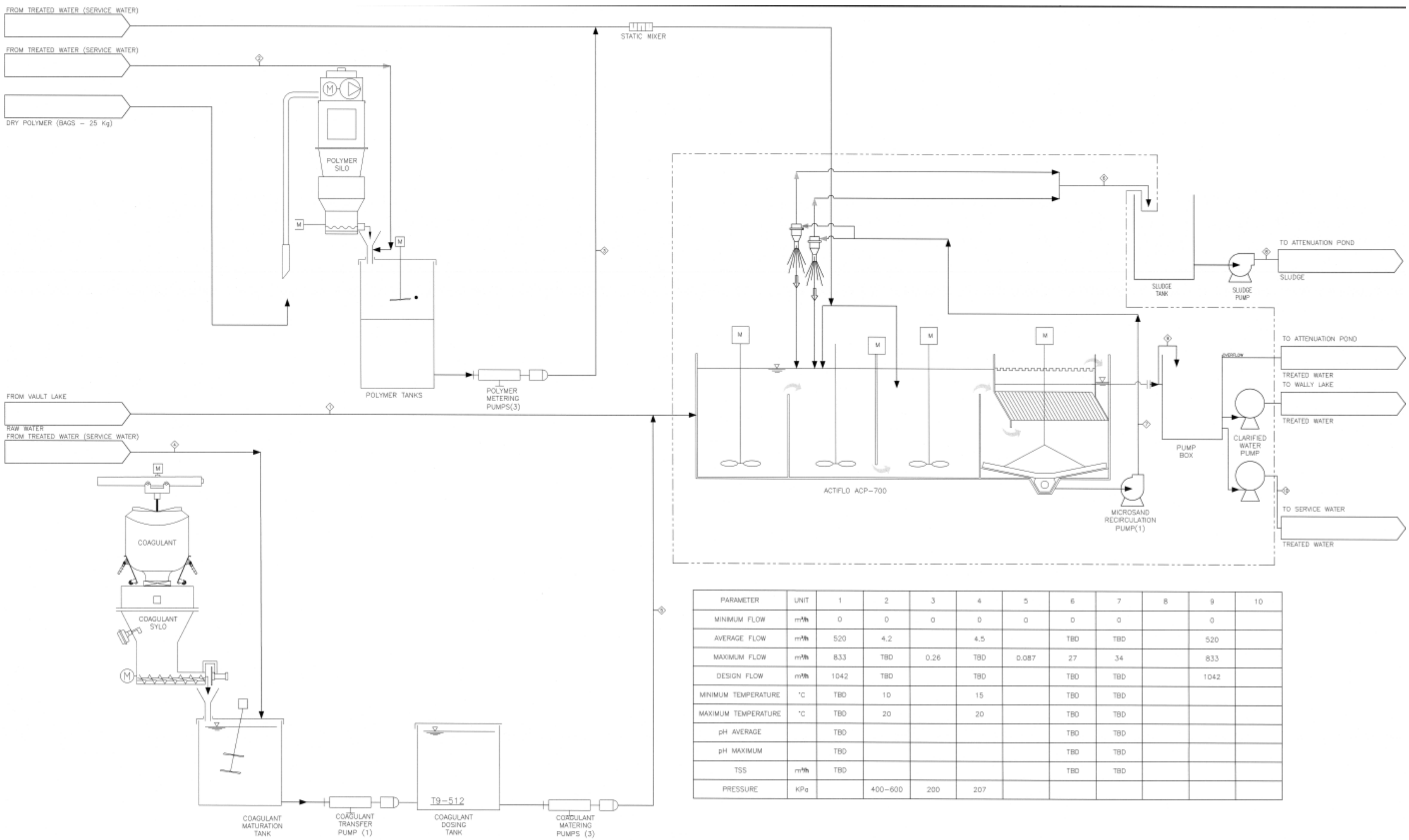
4.1 Process summary

The purpose of the CWTP (ACP-700R) is to remove Total Suspended Solids (TSS) from the influent water pumped from Whale Tail Lake, close to the dike construction. The equipment has an operational range of approximately 6,250 to 19,200 m^3/d. It is expected that the CWTP will be in use only during the dike construction, approximately two (2) months in 2018 (July and August).

The equipment chosen for the CWTP was the current Actiflo® used in the past at Meadowbank mine. The plant was disassembled and reassembled at Amaruq site. The Actiflo® ACP 700 R as an operational rang in the same order of magnitude that what is required for the present project (max capacity of approximately 800 m3/h).

The main treatment component consists of one Actiflo® clarifier with two (2) recirculation lines and two (2) hydrocyclones. The Actiflo® can be operated with one (1) or two (2) lines, depending on the influent flow rate and TSS content. The hydrocyclone overflow is sent to the discharge location at a minimum 31 m of the shore. The TSS is passively removed from the water by percolating onto the rock fill structure located in the energy dispenser and water will flow by gravity back into Whale Tail Lake. The Actiflo® overflow is designed to meet the final effluent discharge criteria for TSS concentrations. The final effluent is monitored for pH and turbidity, which are monitored continuously. The flow rate is measured continuously in the feed pipe of the Actiflo®.

The CWTP general flow diagram is illustrated in Figure 5. The following sections describe the CWTP components. Note that the flowsheet represents the water treatment plant installed at Vault, in Meadowbank mine. This plant was transported to Amaruq project and will be built according to the plan from Meadowbank.



PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10
MINIMUM FLOW	m³/h	0	0	0	0	0	0	0		0	
AVERAGE FLOW	m³/h	520	4.2		4.5		TBD	TBD		520	
MAXIMUM FLOW	m³/h	833	TBD	0.26	TBD	0.087	27	34		833	
DESIGN FLOW	m³/h	1042	TBD		TBD		TBD	TBD		1042	
MINIMUM TEMPERATURE	°C	TBD	10		15		TBD	TBD			
MAXIMUM TEMPERATURE	°C	TBD	20		20		TBD	TBD			
pH AVERAGE		TBD					TBD	TBD			
pH MAXIMUM		TBD					TBD	TBD			
TSS	m³/h	TBD					TBD	TBD			
PRESSURE	KPa		400-600	200	207						

Figure 4 : CWTP Overall Process Flow Diagram (adapted from Meadowbank water treatment plant)

Based on the Meadowbank equipment design, it is expected to produce for the design criteria of 500 m^3/h of feed water at 500 ppm TSS, approximately 446 m3/h of clarified water below 15 ppm TSS and 54 m^3/h of sludge at 0.5% solid.

4.2 Actiflo®

The Actiflo® clarifier uses sand ballasted settling, a high rate coagulation-flocculation-sedimentation process. In the coagulation basin, TSS are destabilized under the action of the coagulant and start to form small aggregates (also called flocs). The coagulant is a trivalent soluble metal compound, usually iron or aluminum, which will cause coagulation when it reaches a certain concentration. Once the coagulant has performed the destabilizing effect, it will precipitate as a metal hydroxide and will participate in the formation of the aggregates. Water then flows into a second tank called the injection tank. There, micro-sand and polymer are added. The polymer acts as a flocculant aid, binding the destabilized solids together with the micro-sand particles by forming polymer bridges. The micro-sand provides a large contact area for floc attachment and acts as a ballast, thereby accelerating the settling of the flocs. From the injection tank, water flows into the maturation tank where flocs formed in the previous stage agglomerate and grow into high density flocs known as micro-sand ballasted flocs. Water then overflows to the settling section of the tank, and with the help of the lamella system, a solid-liquid separation is achieved resulting in clarified water exiting from the system via a collection trough or weirs. The clarified water is monitored for pH, turbidity and flow rate prior to final discharge. The flow rate signal is also connected to a flow totalizer.

The flocs settle in a portion of the system where they are collected by a rake mechanism. A proportion of the unit's design raw water flow is continuously withdrawn from the clarifier and pumped to a hydrocyclone system which separates the micro-sand from the sludge. The recovered micro-sand is reused in the process. A small quantity of the micro-sand is not recovered by the hydrocyclones and remains within the sludge. The lost micro-sand needs to be replaced periodically by adding more to the process. After micro-sand separation, the sludge is sent to discharge location point (expected solid content from 0.5 to 3 % solid depending on TSS feed water quality).

4.3 Service Water System

The service water system consists of two (2) multimedia filters, two (2) heaters, one (1) filtered water tank and two (2) service water pumps. Service water is used in the preparation of dry chemicals and for polymer makeup systems. The coagulant and polymer require filtered heated water. Treated water from the Actiflo® is used to produce service water.

4.4 Reagents

One (1) polymer as well as a coagulant is used to treat the water that flows through the Actiflo®, each is supplied by a dosing system that is adjusted according to the influent flow rate. Treated water from the Actiflo® is used for the mixing of the reagents.