Appendix O

Tailings Dam Breach Analysis

Tailings Dam Breach Analysis

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1.0 Introduction

Ausenco has completed a Tailings Dam Breach Analysis (TDBA) for the Crawford Tailings Management Facility (TMF), as part of the information required for the permitting process. The TDBA was completed in alignment with the Canadian Dam Association (CDA) guidelines and was based on WSP Golder's final Feasibility Study (FS) design for the tailing's facility.

The objective of the TDBA is to evaluate the tailings runout impacts downstream of the TMF in the very unlikely event of a dam failure and release of tailings and water.

1.1 Objective

The objective of the analysis was to perform a Tailings Dam Breach Analysis (TDBA) in accordance with the "Dam Safety Guidelines - 2013 Revision" (CDA, 2013) and the "Technical Bulletin of Tailings Dam Breach Analysis" (CDA, 2021) to determine hypothetical runout extents of various dam breach scenarios. Results were provided to Stantec, who undertook effects assessment and consequence assignment.

1.2 Scope of Work

The scope of work was:

- Review previous geotechnical and TMF engineering information.
- Develop credible failure modes.
- Develop hypothetical failure breach, hypothetical volume released, failure time, dam breach hydrographs.
- Develop numerical dam breach models in FLO-2D PRO.
- Output of dam breach model are maps of maximum flow depths, maximum flow velocity, and time for 30 centimeters.

2.0 Information for Analysis

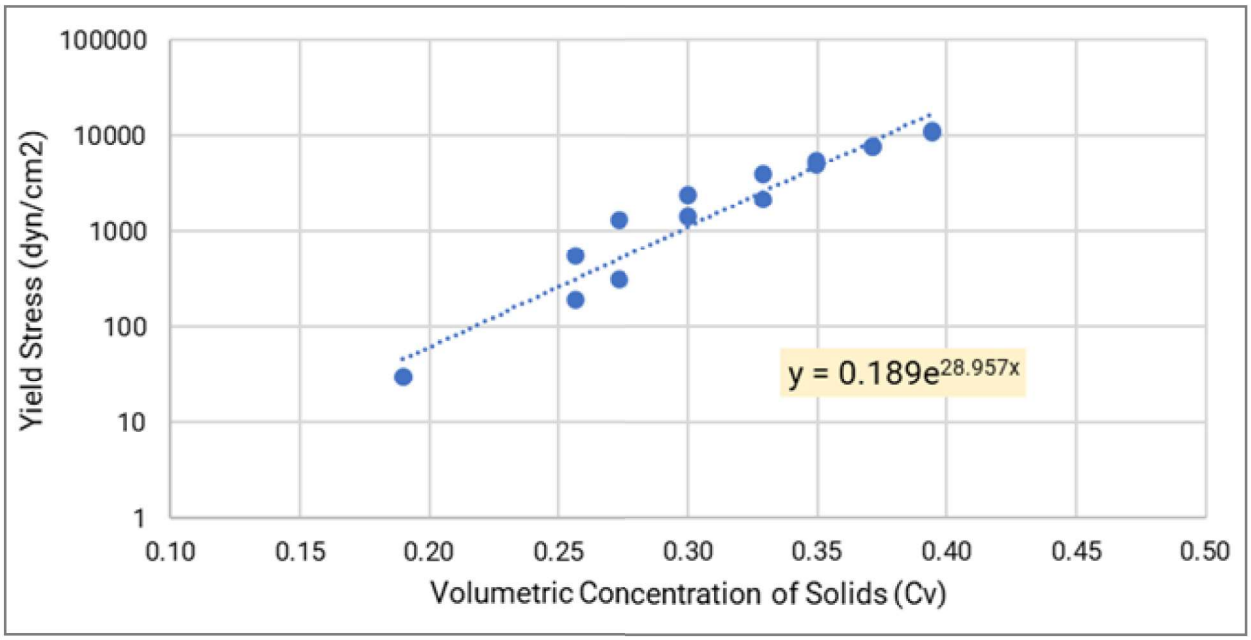
2.1 Rheology Information

Rheological characterization is outlined in the “Analysis Criteria memorandum 104945-WM-04100-22000-501” (Ausenco, 2024a); the rheological information for the TDBA was based on the test conducted in "Crawford Project Feasibility Study: Rheological Characterization Laboratory Testing" (WSP, 2022).

The results of the yield stress and dynamic viscosity tests from the "Final Tailings Blend" sample for both ramp up and ramp down, were used to estimate the coefficients of the exponential adjustment curve to be used in this analysis.

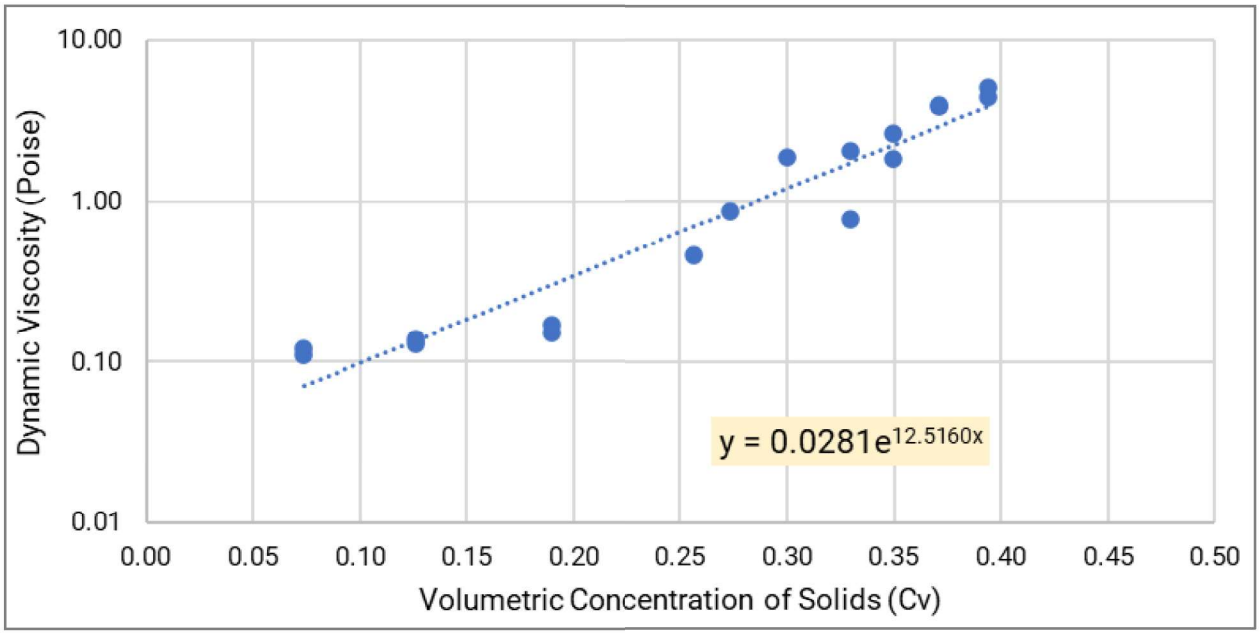
The adjustment curves are presented in the **Figure 2-1** and **Figure 2-2**. It should be noted that the specific gravity of TMF sample was 2.55 (WSP, 2022), which was used in the estimation of the volumetric concentration of solids (C_V) of the samples.

The TMF does not have internal tailings ponds; runoff is directed to two external tailings ponds. This approach reduces the frequency and extent of tailings saturation and the risk of saturation-induced liquefaction.



Source: WSP (2022).

Figure 2-1 Yield Stress vs. C_V

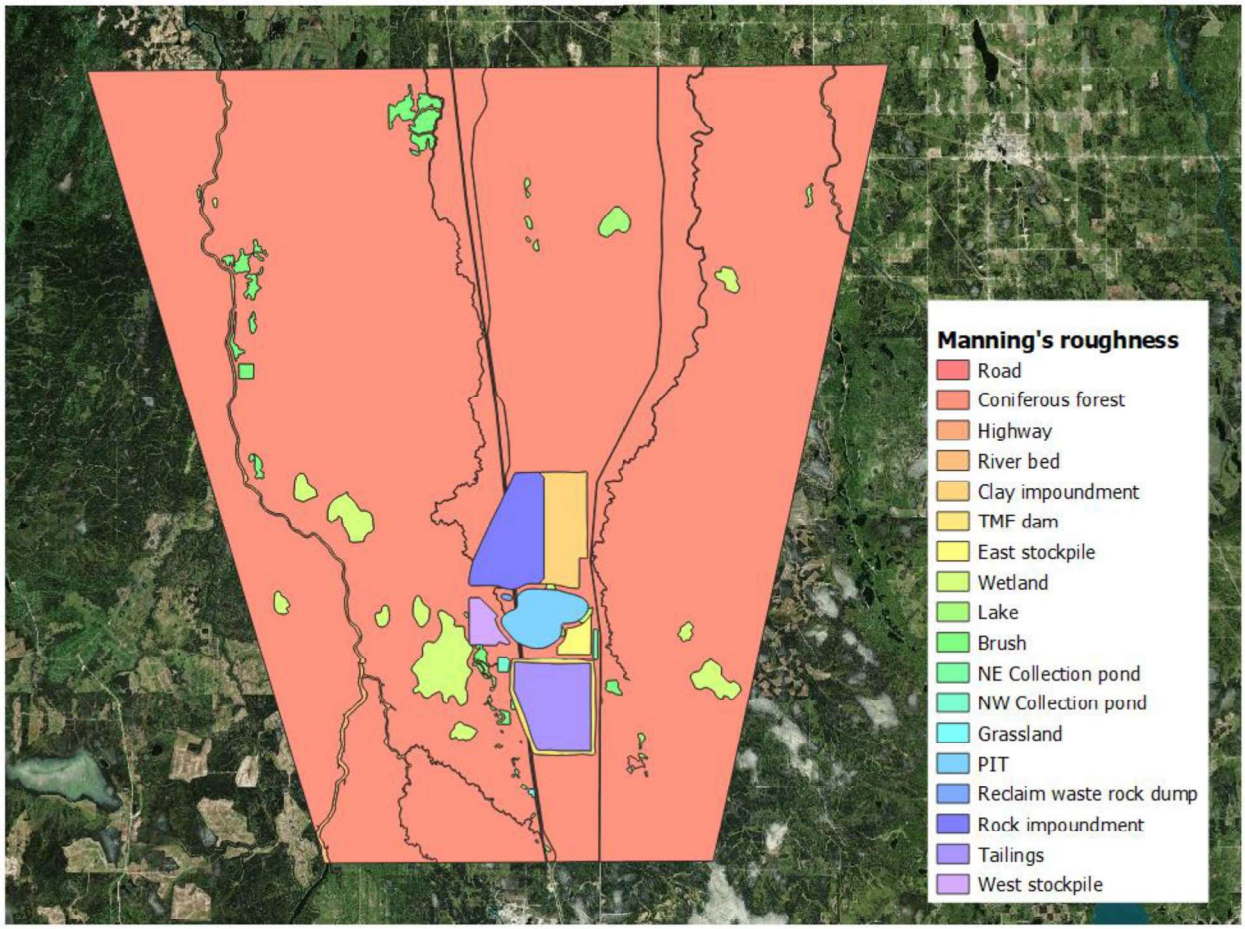


Source: WSP (2022).

Figure 2-2 Dynamic viscosity vs. C_V

2.2 Manning's Roughness Coefficient

For this analysis of flooding that results from the discharge of tailings and water, Manning's roughness coefficients were estimated based on a comparison of site conditions with bibliographic references. In the **Figure 2-3** the classification of surfaces of the study area is shown, according to Google Earth satellite images and the projection of the project components.



Source: The Atlas of Canada - Canada's Land Cover Interactive Map (2015) and updated by Ausenco (2024).

Figure 2-3 Surface Classification for Manning's Coefficient

In the **Table 2.1** the values of Manning's roughness coefficient assumed for the project are shown, based on bibliographic references.

Table 2.1 Manning's Roughness Coefficients

Surface Type	Manning's Roughness Coefficients
NE Collection pond. NW Collection pond	0.015
Asphalt roads	0.016
Affirmed Paths	0.020
West stockpile, East stockpile, Dam, Clay impoundment	0.025
Tailings	0.030
Reclaim waste rock dump, Rock impoundment	0.033
Grassland	0.035
Riverbed, Lake	0.038
Wetland, Scrub	0.070
Coniferous forest	0.100

Source: Ven Te Chow (1959)

2.3 Credible Failure Modes

In the memorandum "Credible Failure Modes" 104945-WM-04100-22000-502 (Ausenco, 2024b) credible failure modes for the TMF of the Crawford project were analyzed, under the "Dam Safety Guidelines - 2013 Revision" (CDA, 2017) and the "Technical Bulletin of Tailings Dam Breach Analysis" (CDA, 2021).

Based on the credible failure modes assessment for sunny-day and flood-induced scenarios presented, Ausenco has chosen those failure modes that hypothetically represent the highest release of tailings and water downstream of the TMF. **Table 2.2** summarizes the selected credible failure modes to be modelled for each scenario.

Table 2.2 Failure Modes by Scenario to Model

Scenario	Failure Modes	Description
Sunny-day	Collapse	The collapse failure mode is considered the critical failure mode for this scenario, in areas of the dam that are higher and that mobilizes greater volumes of stored tailings, and whose flood footprint generate greatest impacts.
Flood Induced	Overtopping	The overtopping failure mode considers the IDF (2/3 between 1/1000 year event and PMF because the preliminary consequence classification was Very High) overtops the dam's crest and cause failure due to the erosion of the downstream side of the embankment.

Source: Ausenco, 2024b.

3.0 Hypothetical Failure

The methodology used in the estimation of the potential volume of tailings and water discharge, the duration of the storm-generated runoff hydrographs, and the breach hydrographs will be detailed below.

3.1 Hypothetical Failure Breach

For the sunny day scenario, the following considerations were considered:

- The breach/failure location was chosen based on the following criteria:
  - where the height of the dam is greatest
  - where the potential breach volume of tailings to be released is higher
  - where the potential foundation soft soils are higher
  - where the potential downstream impacts would be greater.
- According to CDA (2021), the height of the breach would be equal to the height of the dam, i.e. down to the foundation of the dam.
- The breach width would correspond to 5 times the height of the dam in the sector selected for the failure, according to the recommendations of FERC (2015) y USACE (2007).
- The side slopes of the breach through the dam were considered to be 1H:1V.
- The slope of the post-failure tailings surface was 2° (two degrees), which is within the range recommended by the CDA (2021).

For the flood-induced scenario, the following considerations were considered:

- The location of the breach was chosen in the place of the TMF where the greatest volume of water from the storm event accumulates and where the possible impacts are the greatest.
- The height of the breach was considered equal to the height of the dam, i.e. down to the foundation of the dam.
- The side slopes of the breach through the dam were considered to be 1H:1V.
- The slope of the post-failure tailings surface was 2° (two degrees), which is within the range recommended by the CDA (2021).
- The breach width was obtained through an iterative process using the Froelich formula/equation (2008):

$$B_B = \pi 0.27\, k_0\, V^{1/3}$$

Where:

B_B= Average breach width.

k_0= Coefficient 1.3 for overtopping.

V = Volume of water and tailings released.

The breach width (B_0) is an estimation based on an iterative process with which a released tailings volume is calculated (using the breach geometry defined in the previous bullets). This calculated volume (along with the volume of water) must satisfy when applying the Froelich formula, the breach width obtained (B_B) has a difference less than 5% with respect to the assumed breach width (B_0).

3.2 Breach Locations

3.2.1 Sunny Day Scenario

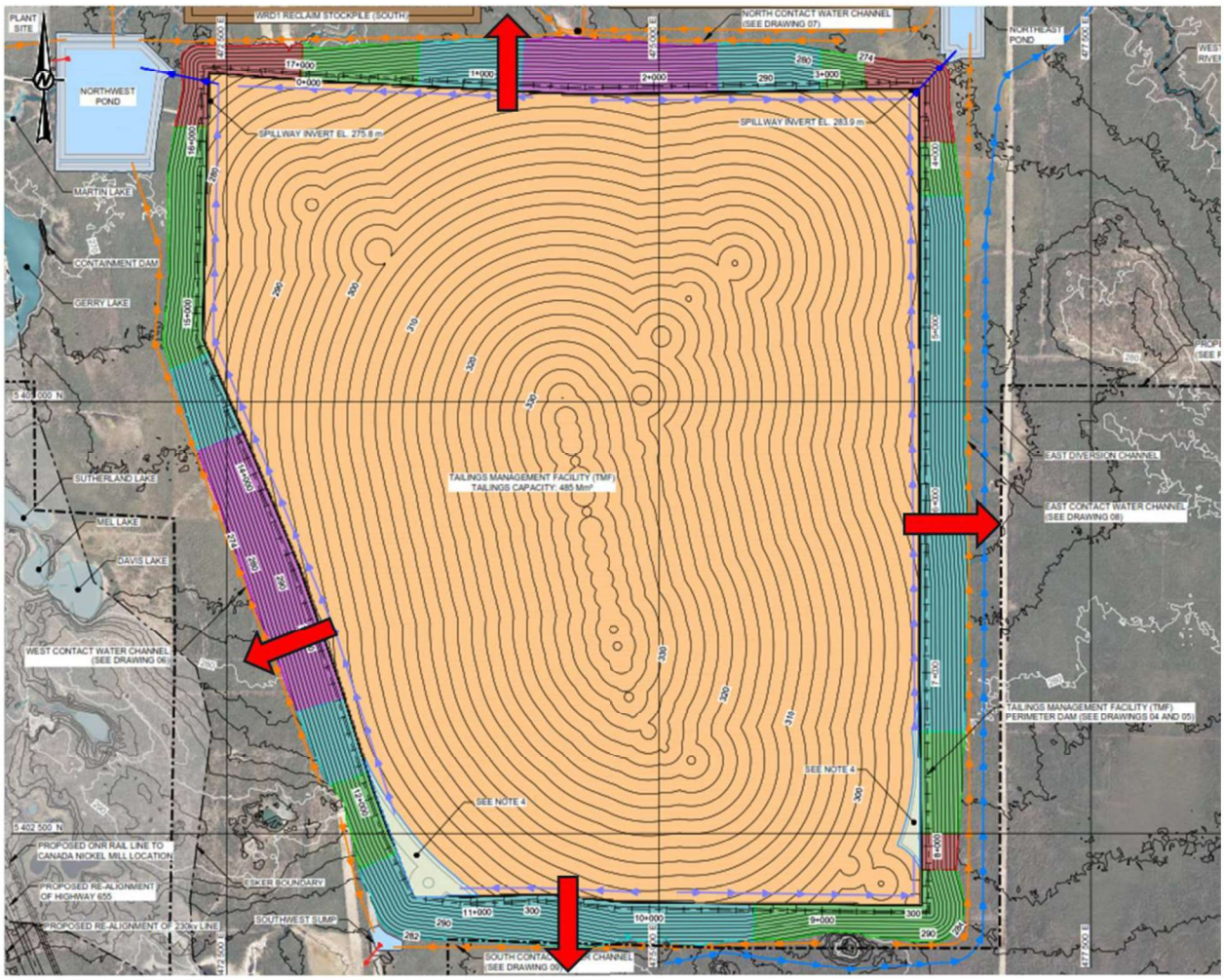
The main criteria for selecting the locations modelled breaches were the locations which would have the greatest impacts downstream.

Due to the topographic characteristics of the project, two breach locations were modelled:

- A dam breach on the west side of the TMF that would carry the tailings flow towards the process plant facilities, surrounding areas and local waterbodies associated with the North Driftwood River.
- A dam breach on the east side of the TMF that would carry the tailings flow towards the natural streams and rivers (e.g. the West Buskegau) with the potential to transport the tailings toward the north and create an impact in the ecosystem surroundings.
- A dam breach on the north side of the TMF that would carry the tailings flow towards the truck shop, the crusher and surrounding areas.
- A dam breach on the south side of the TMF that would carry the tailings flow towards the natural streams and rivers like the Jocko Creek with the potential to transport the tailings down this river and create an impact in the ecosystem surroundings.

Considering the nature of the failure mode, which involves a decrease in strength in the foundation, breaches could be expected to occur in the highest sections of the dam and the stored tailings due to unforeseen increases in pore pressure in the foundation soils.

Figure 3-1 shows the breach locations selected. These locations were selected as they have the greatest dam height on each side (~24 m on the west side, ~ 15 m on the east side, ~ 17 m on the south side and ~20 m on the north side), which would result in the largest volume of released material in the event of a breach.

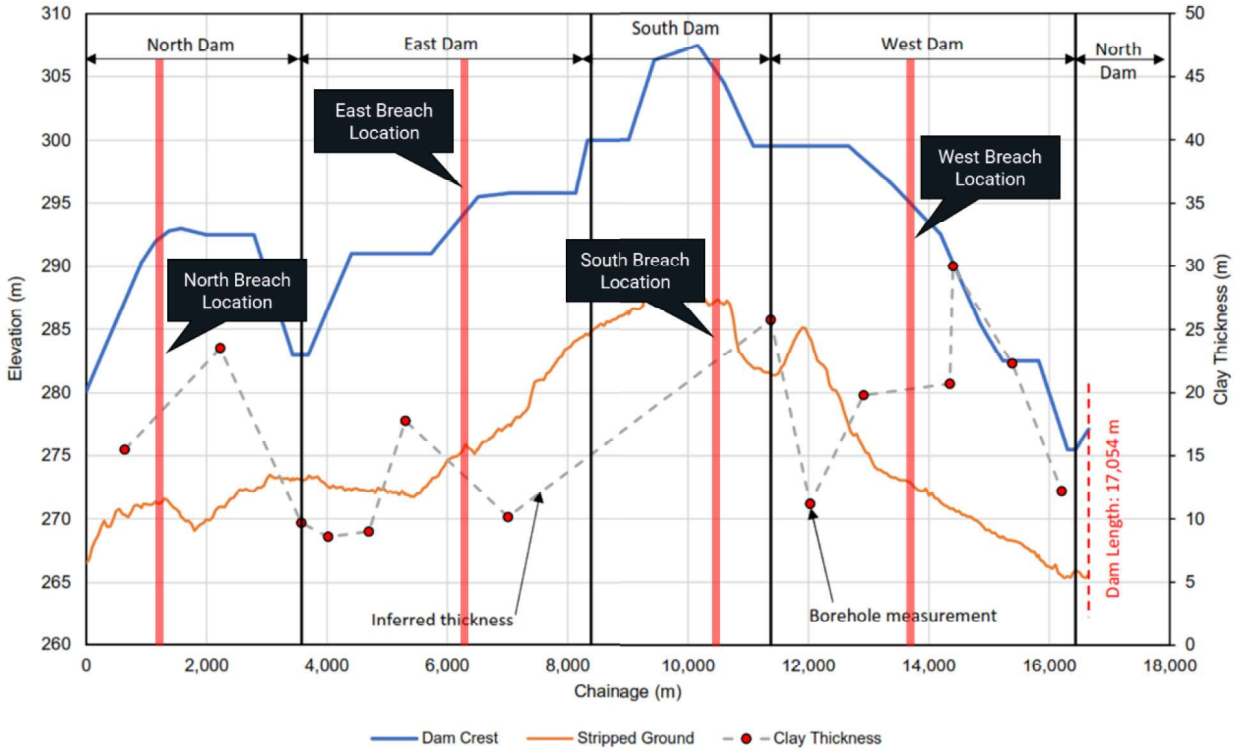


Source: WSP (2023). Breach locations in plan view identified by Ausenco.

Figure 3-1 Location of Sunny Day Scenario Breaches (red arrows)

The information from the boreholes completed in the TMF area (up to 2023) by WSP indicates that, in general, the foundation material consists of layers of clay and till with depths ranging from 8 meters to over 30 meters.

Figure 3-2 it is shown that the proposed breaches are in areas with considerable clay thickness (~15 m to ~20 m) in the foundation, supporting the mechanism of failure due to *loss of strength* in a weak foundation, i.e. due to unforeseen increases in pore pressure in the foundation soils.



Source: WSP, 2023. Breach locations in profile identified by Ausenco.

Figure 3-2 Interpreted Clay Thickness

3.2.2 Flood Induced Scenario

For this scenario, the drainage areas within the impoundment of the facility were considered. Five sectors (drainage areas) were identified, northeast, southeast, northwest, southwest and north (**Figure 3-3** and **Figure 3-4**), according to their geographic location with respect to the center of the TMF. The four lowest elevations for those sectors are marked with blue arrows for modeling the flood induced scenario.

All flood-induced scenarios were modeled with the IDF runoff event occurring in both the TMF and the surrounding areas (in local receivers).

For modeling the flood induced scenario for northwest and northeast sectors (breach locations), it was considered that in the case of extreme storm events, the water stored in the southwest and southeast drainage areas would flow by gravity toward the north (See green arrows in **Figure 3-8**), consequently no overtopping could occur in the southern sections.

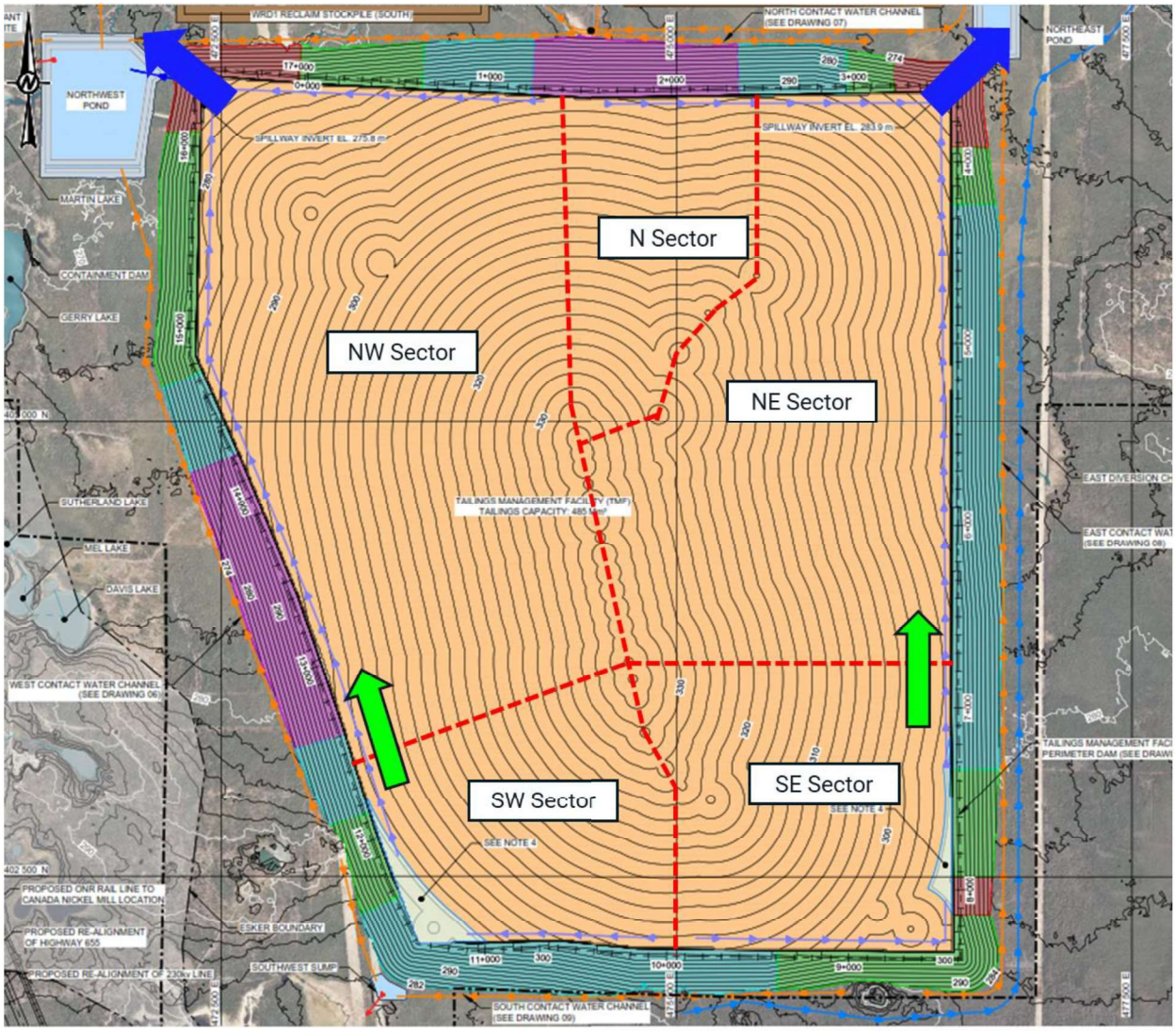
Likewise, in the case of modeling the flood induced scenario for North and South sectors (breach locations) was considered that runoff on north and southwest drainage areas wouldn't drain towards other sector, and after accumulating, overtopping would begin. In other words, for the breach located in the north, the north drainage area was considered. Likewise, for the breach located in the south, the southwest drainage area was considered.

A breach in the northwest sector would generate greater downstream consequences in terms of human and material losses, since it could impact the mine processing structures, processing plant, administrative offices, etc.

In the case of the northeast sector, tailings and water from a potential dam failure would impact a small sector of the East Stockpile, and then flow through the natural drainage system and the West Buskegau river (in this case the environmental impacts could be greater).

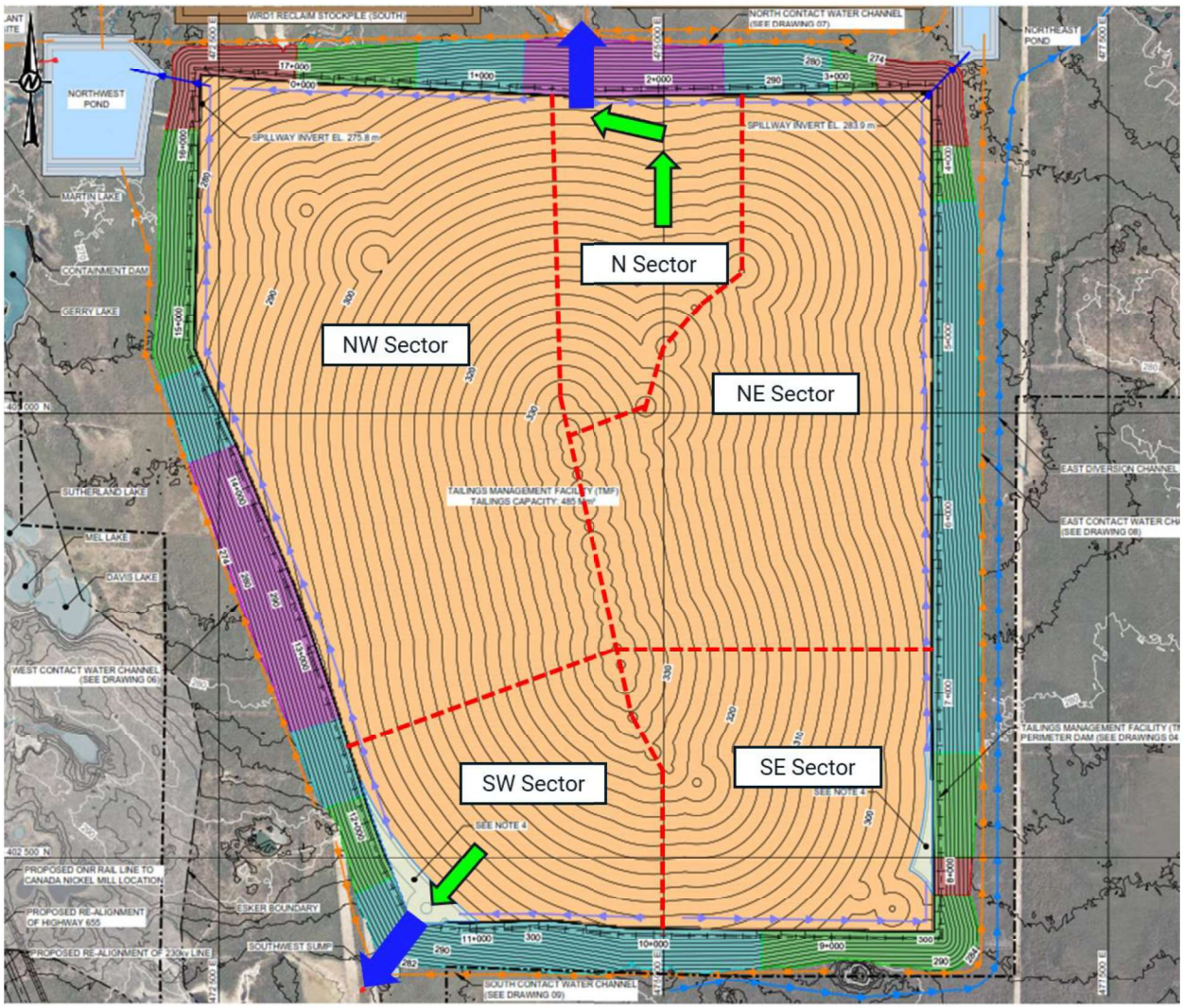
A breach in the north sector would generate greater downstream consequences in terms of human and material losses, since it would impact the open pit, truck shop, the crusher, and surrounding areas.

In the case of the southwest sector, tailings and water from a potential dam failure would flow through the natural drainage system and the Jocko Creek and reach the Mattagami River.



Source: WSP (2023). Blue Arrows by Ausenco.

Figure 3-3 TMF Drainage Areas – West Side and East Side



Source: WSP (2023). Blue Arrows by Ausenco.

Figure 3-4 TMF Drainage Areas – North End and South End

3.3 Hypothetical Released Volume

3.3.1 Sunny Day Scenario

In **Table 3.1** the main geotechnical parameters determined for the discharged materials (tailings and dam material) are shown. In this table, the following were considered:

- The settled tailings (after free water is released) in the TMF have a C_W (solids contend by weight) of 60% (WSP, 2023),
- Ausenco has conservatively considered that 50% of the volume of the dam is saturated and the other 50% has a 5% moisture content by weight.
- The specific gravity for the dam is estimated from the specific gravity data of the foundation materials.

Table 3.1 Geotechnical Parameters of Tailings and Dam

Parameter	Unit	Tailings	Saturated Sector Dam	Unsaturated Sector Dam
Specific Gravity	Adim.	2.55(1)	2.7(2)	2.7(2)
Solids content by weight	%	60(3)	--	--
Total Density	t/m³	1.57	2.24	2.07
Dry Density	t/m³	0.94	1.97	1.97

Notes:
1 Golder (2022),
2 Specific gravity for foundation (SRK, 2023),
3: WSP (2023)

Table 3.2 to **Table 3.5** estimate volumes of water and solids released from the tailings and dam are shown. The volumetric content of solids (C_V) is estimated to be 0.38, for the breach on the west side, east side, north end, and south end of the deposit.

Table 3.2 Released Volumes - Sunny Day Scenario West Side

Material	Solids Volume (Mm³)	Water Volume (Mm³)	Total Released Volume (Mm³)
Tailings	5.52	9.38	14.89
Saturated Dam	0.13	0.05	0.18
Unsaturated Dam	0.13	0.02	0.15
Total	**5.78**	**9.44**	**15.22**
% of Total	38% (C_V)	62%	100%

Source: Ausenco (2024).

Table 3.3 Released Volumes - Sunny Day Scenario East Side

Material	Solids Volume (Mm³)	Water Volume (Mm³)	Total Released Volume (Mm³)
Tailings	2.26	3.84	6.10
Saturated Dam	0.08	0.03	0.11
Unsaturated Dam	0.08	0.01	0.09
Total	**2.41**	**3.88**	**6.29**
%	38% (C_V)	62%	100%

Source: Ausenco (2024).

Table 3.4 Released Volumes - Sunny Day Scenario North End

Material	Solids Volume (Mm³)	Water Volume (Mm³)	Total Released Volume (Mm³)
Tailings	3.52	5.99	9.51
Saturated Dam	0.10	0.04	0.14
Unsaturated Dam	0.10	0.01	0.12
Total	**3.73**	**6.04**	**9.77**
%	38% (C_V)	62%	100%

Source: Ausenco (2024).

Table 3.5 Released Volumes - Sunny Day Scenario South End

Material	Solids Volume (Mm³)	Water Volume (Mm³)	Total Released Volume (Mm³)
Tailings	2.71	4.61	7.32
Saturated Dam	0.08	0.03	0.11
Unsaturated Dam	0.08	0.01	0.09
Total	**2.87**	**4.65**	**7.52**
%	38% (C_V)	62%	100%

Source: Ausenco (2024).

3.3.2 Flood Induced Scenario

This scenario considers routing over spillways/storage and consequent overtopping of the IDF (design storm event, 2/3 between the 1:1000 event and the PMF). The values and assumptions made for the **Table 3.1**, are also applicable for this scenario. **Table 3.6** and **Table 3.7** estimate volumes of water and tailings for the outflow materials (tailings and dam material) for the west side and east side are shown. The volumetric content of solids (C_V) of the mixture (solids and water) was calculated by Ausenco to be 2% for the east side and west side.

Table 3.6 Released Volumes - Flood Induced Scenario West Side

Material	Solids Volume (Mm³)	Water Volume (Mm³)	Total Released Volume (Mm³)
Flood	--	1.780	1.780
Tailings	0.025	0.043	0.068
Saturated Dam	0.010	0.004	0.014
Unsaturated Dam	0.010	0.001	0.011
Total	**0.045**	**1.829**	**1.873**
% of Total	2.4% (C_V)	97.6%	100%

Source: Ausenco (2024).

Table 3.7 Released Volumes Flood Induced Scenario East Side

Material	Solids Volume (Mm³)	Water Volume (Mm³)	Total Released Volume (Mm³)
Flood	--	1.840	1.840
Tailings	0.022	0.039	0.061
Saturated Dam	0.010	0.004	0.014
Unsaturated Dam	0.010	0.001	0.011
Total	**0.042**	**1.884**	**1.926**
% of Total	2.2% (C_V)	97.8%	100%

Source: Ausenco (2024).

For the north sector, the dam breach time was estimated at 1 hour. This time was divided according to progressive erosion over the dam:

- In the first 0.3 hours, it was considered that 40% of the dam's volume and stored water in the north sector (See **Figure 3-4**) and IDF (2/3 between the 1:1000 year event and the PMF) will be released. The volumetric content of solids (C_V) of the mixture (solids and water) was estimated around of 0.30.
- In the next 0.7 hours, it was considered that 60% of the dam's volume and remaining stored water, IDF and tailings will be released. For this second period, a C_V equal to 0.37 was estimated.
- For the rest of the hydrograph, it was considered that the flow comes only from the remainder of the IDF. For this period, a C_V equal to 0 was considered. **Table 3.8** shows the estimated values of tailings and water released.

Table 3.8 Released Volumes - Flood Induced Scenario North End

Material	Solids Volume (Mm^3)	Water Volume (Mm^3)	Total Released Volume (Mm^3)
Flood	--	0.44	0.44
Tailings	4.73	8.05	12.78
Saturated Dam	0.13	0.05	0.18
Unsaturated Dam	0.09	0.01	0.10
Total	**4.94**	**8.55**	**13.50**
% of Total	37% (C_V)	63%	100%

Source: Ausenco (2024).

The volume of solids at the north end is much greater than that on the east and west sides because on both sides, the breaches were located in the northeast and northwest corners, where the volume of tailings is much less compared to the north end. Likewise, the volume of water generated from the PMF is much greater on the east and west side, which would explain the large difference between the Cv of the northern end and the east and west side.

For the south sector, the dam breach time was estimated at 0.7 hour. This time was divided according to progressive erosion over the dam:

- In the first 0.3 hours, it was considered that 60% of the dam's volume and stored water in the southwest sector (See **Figure 3-4**), tailings and IDF (2/3 between the 1:1000 event and the PMF) will be released. For this first period, the volumetric content of solids (C_V) of the mixture (solids and water) was calculated by Ausenco to be 0.20.
- In the next 0.4 hours, it was considered that 40% of the dam's volume and remain stored water, IDF and tailings will be released. For this second period, a C_V equal to 0.37 was estimated.
- For the rest of the hydrograph, it was considered that the flow comes only from the remain of the IDF. For this period, a C_V equal to 0 was considered. According to this, on **Table 3.9** shown estimated volumes of water and tailings for the outflow materials (tailings and dam material).

Table 3.9 Released Volumes Flood Induced Scenario South End

Material	Solids Volume (Mm^3)	Water Volume (Mm^3)	Total Released Volume (Mm^3)
Flood	--	0.54	0.54
Tailings	0.56	0.95	1.50
Saturated Dam	0.03	0.01	0.04
Unsaturated Dam	0.05	0.01	0.05
Total	**0.63**	**1.51**	**2.14**
% of Total	30% (C_V)	70%	100%

Source: Ausenco (2024).

The released volumes predicted for the flood induced scenarios for the west, south and east (<2.4 Mm^3) are substantially lower than for the sunny day scenarios (>6.3 Mm^3), because:

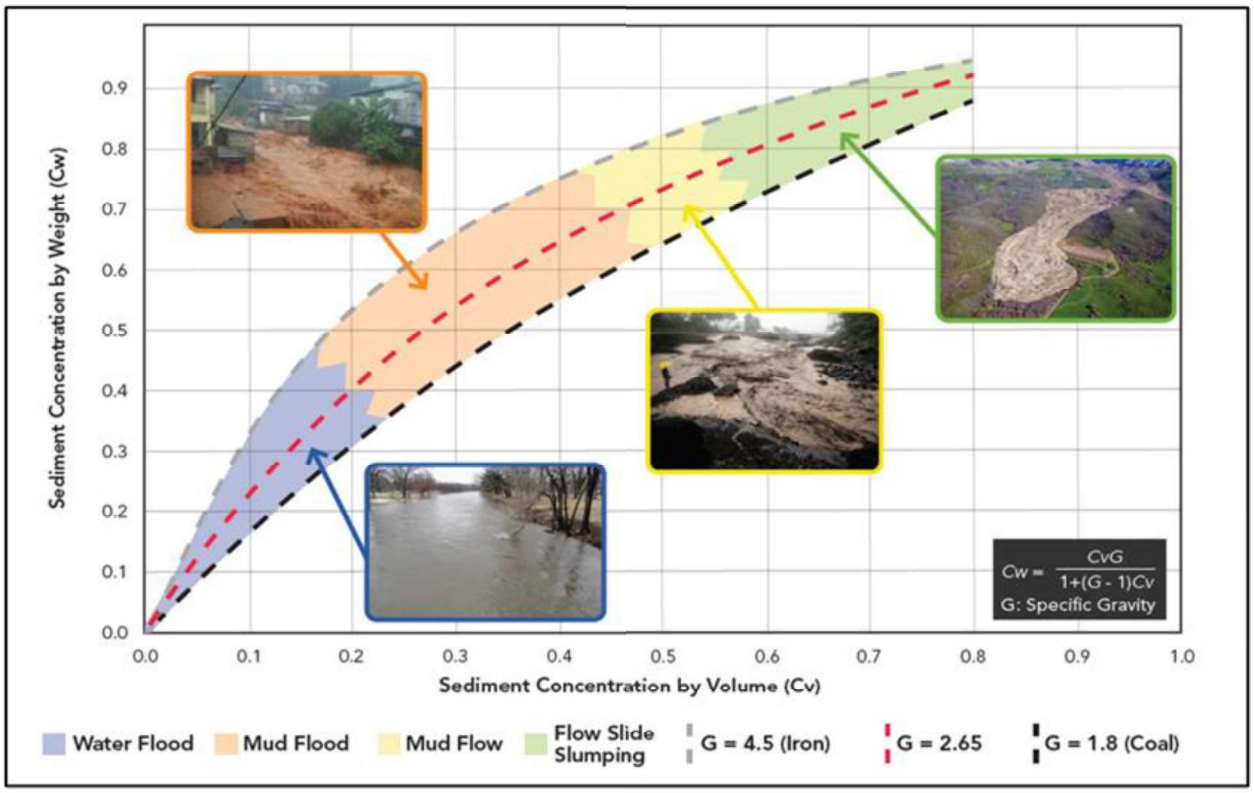
- The flood induced breaches are located in dam sectors with lower height (~7 m against +15 m), as explained in **Figure 3-3** and **Figure 3-4,** the breaches can only be located at those places; and
- Location of breaches are in the corners, except for the north sector, limiting the potential volume that can be released.

The released volume for the north end breach is much greater (13.5 Mm^3) compared to breaches in the other sectors, because it was considered that the failure would originate at a higher dam and tailings height (see **Figure 3-4**), which entails a greater volume released than the other sectors. This location was chosen for modelling primarily due to the larger potential downstream effects (impact on the mining infrastructure and crusher buildings north of the TMF); this location is not believed to be a higher probability zone of flood-induced risk, as drainage flows away from the breach location.

3.4 Flow Type

Depending on the concentration of solids, it is possible to distinguish two types of flow: flows with Newtonian behavior (water and low solids concentration) and flows with non-Newtonian behavior. Within this last group, different hydraulic behaviors are identified depending on the increase in solids concentration (**Figure 3-5**).

According to what is shown in **Table 3.2** to **Table 3.9**, the sediment concentration by volume (C_v) values in the scenarios are between 2% and 38%, so their behavior would be that of mud flow for some cases and water flow for others according to the **Figure 3-5**.



Source: CDA (2021).

Figure 3-5 Type of Flows Depending on the Concentration of Solids

3.5 Failure Time

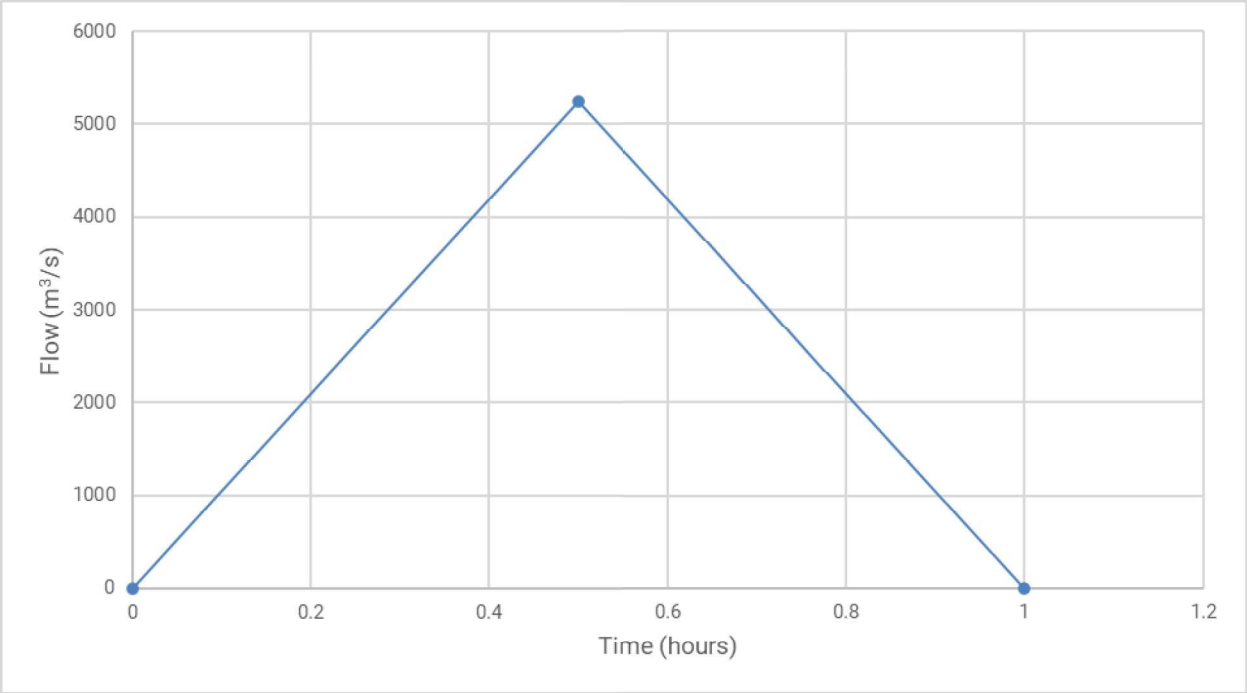
For the failure time of the Sunny Day Scenario, a total outflow time of 1 hour was estimated. Given the relatively high viscosity and volume of the released tailings to be modelled, a shorter breach formation time (i.e. rapid exit from the reservoir through the breach in the dam) was deemed to be unlikely.

In the case of the flood induced scenario, given that the tailings deposit does not have the capacity to impound the design storm event, 2/3 between the 1:1000 event and the PMF, Ausenco (2024b). It was assumed that the duration of the breach hydrograph corresponds to the duration of the development of the flood over the tailing's impoundment, and that it is during this process, when the water level is overtopping the crest, therefore the erosive process and formation of the breach begins.

3.6 Dam Breach Hydrographs

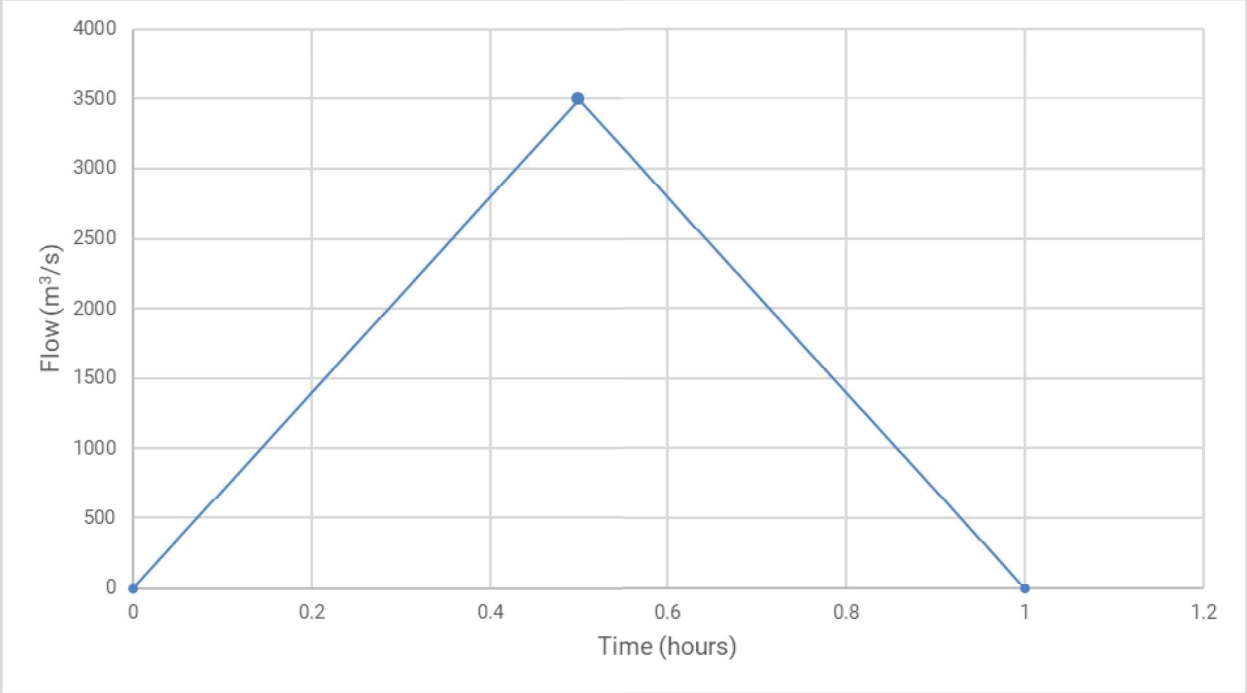
Symmetrical and triangular hydrographs were used in the analysis, where the base is equal to the failure time, defined in the previous paragraphs, and the peak flow was calculated based on the total volume of tailings and water discharged in each scenario (Sunny Day or Flood-induced Failure).

The estimated hydrographs for the sunny day and flood-induced scenarios used in the modelling are shown in the **Figure 3-6** to **Figure 3-13**. Note that the flow rates corresponding to the volume of water released are shown, as they are the ones that are entered into the Flo-2D program along with the value of solids concentration by weight (C_V).



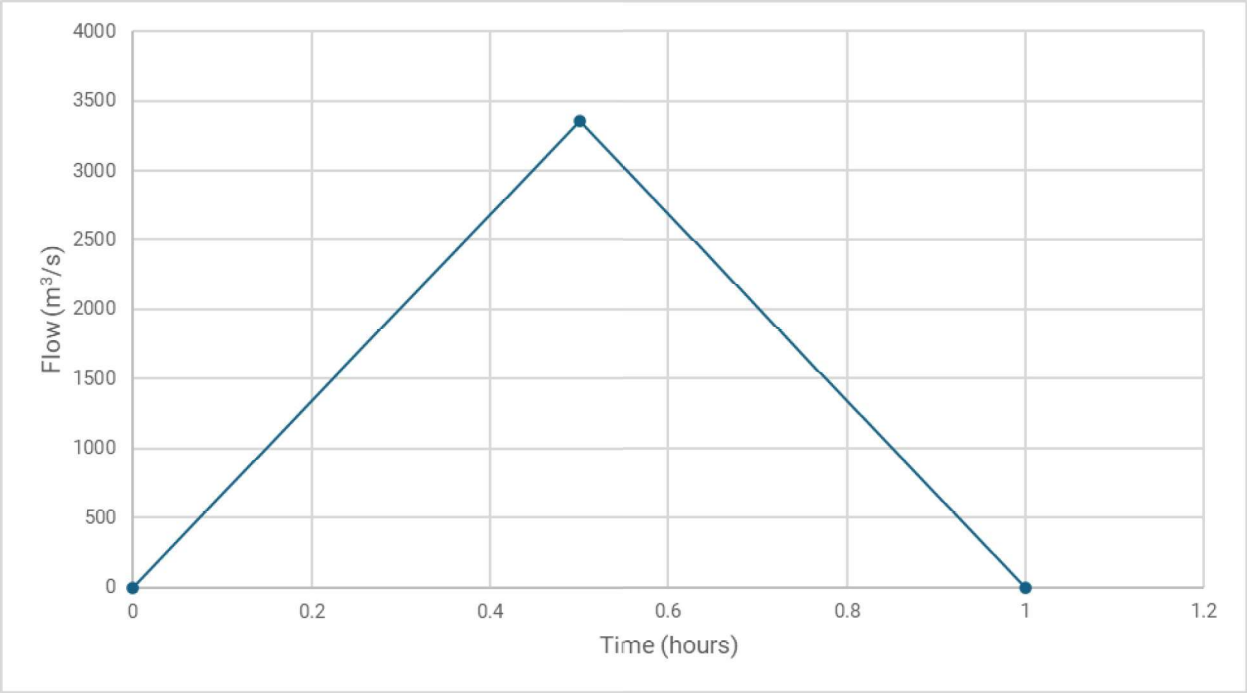
Source: Ausenco (2024).

Figure 3-6 Hydrograph for the Sunny day scenario (C_V=0.38) West Side



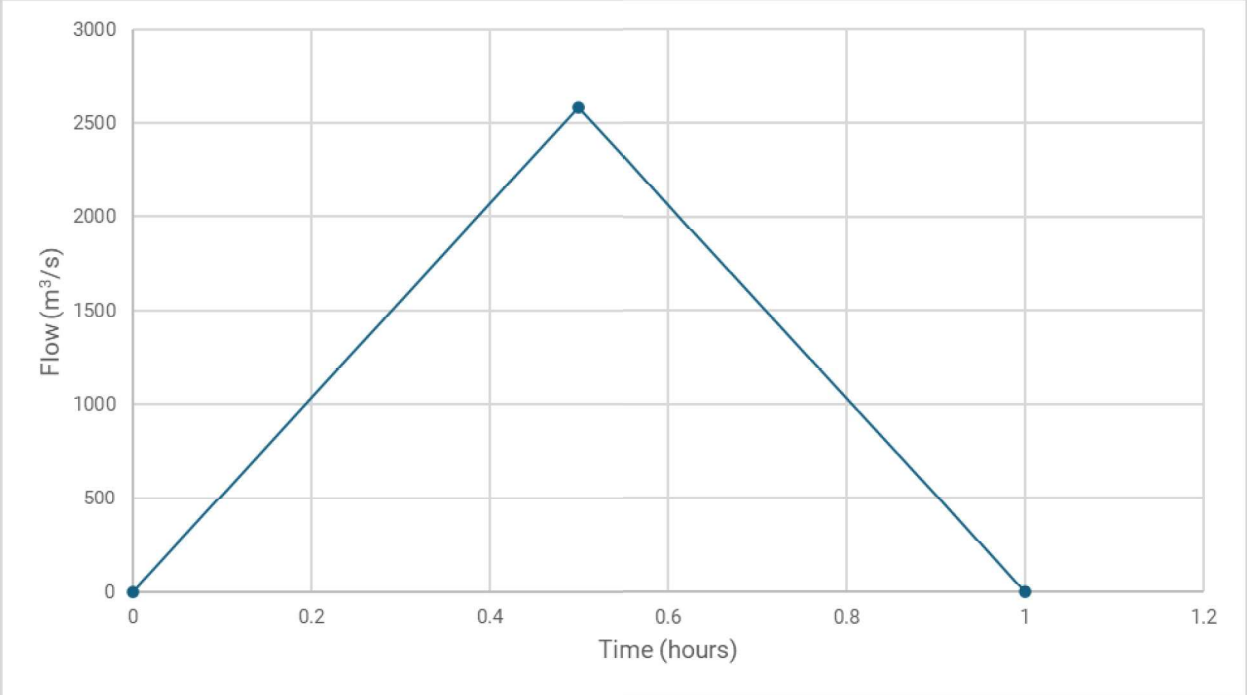
Source: Ausenco (2024).

Figure 3-7 Hydrograph for the Sunny day scenario (C_V=0.38) East Side



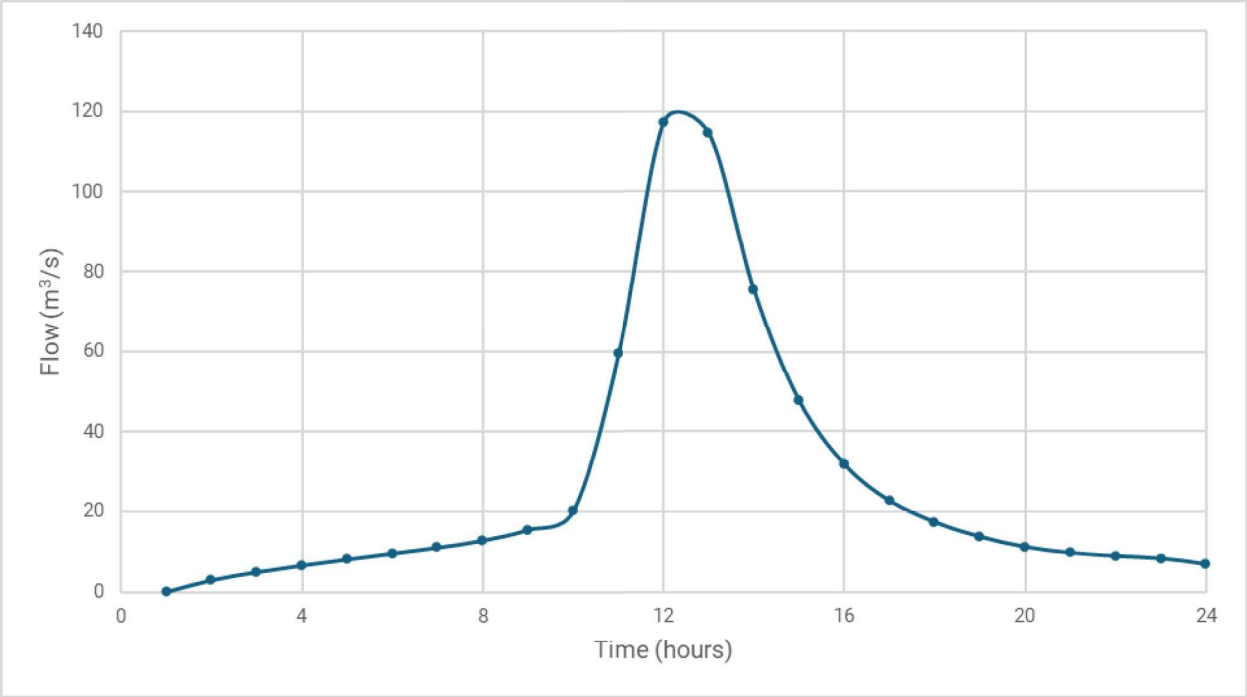
Source: Ausenco (2024).

Figure 3-8 Hydrograph for the Sunny day scenario (C_V=0.38) North End



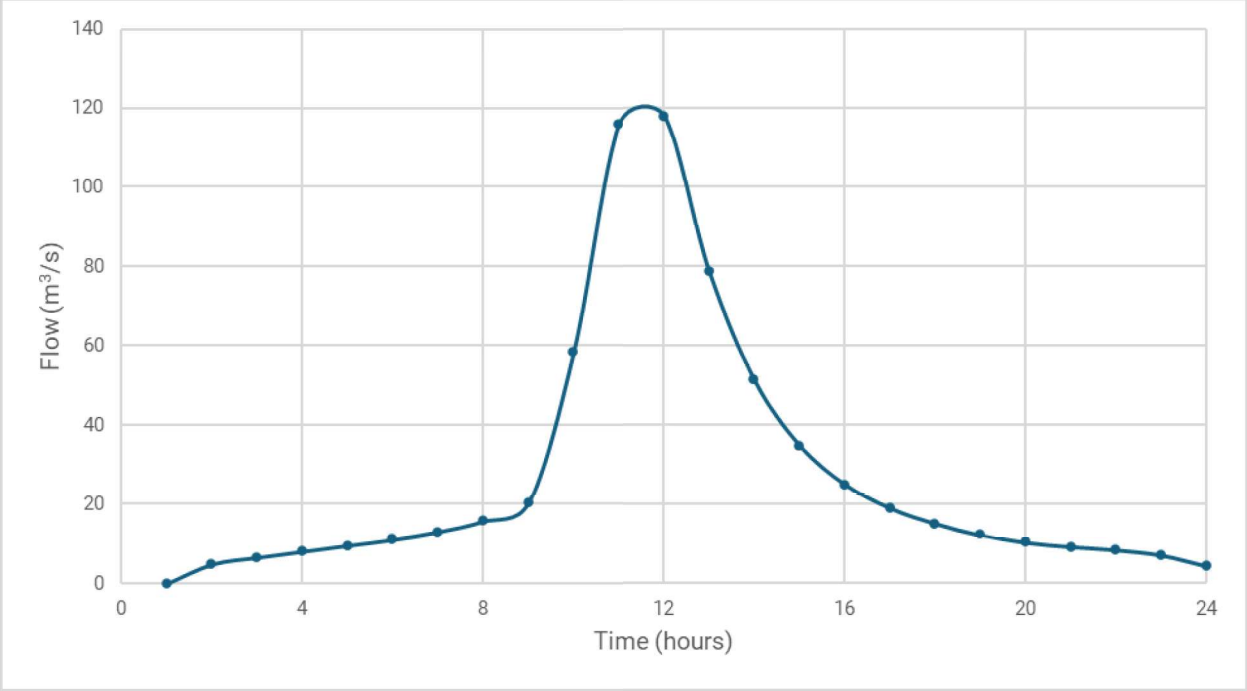
Source: Ausenco (2024).

Figure 3-9 Hydrograph for the Sunny day scenario (C_V=0.38) South End



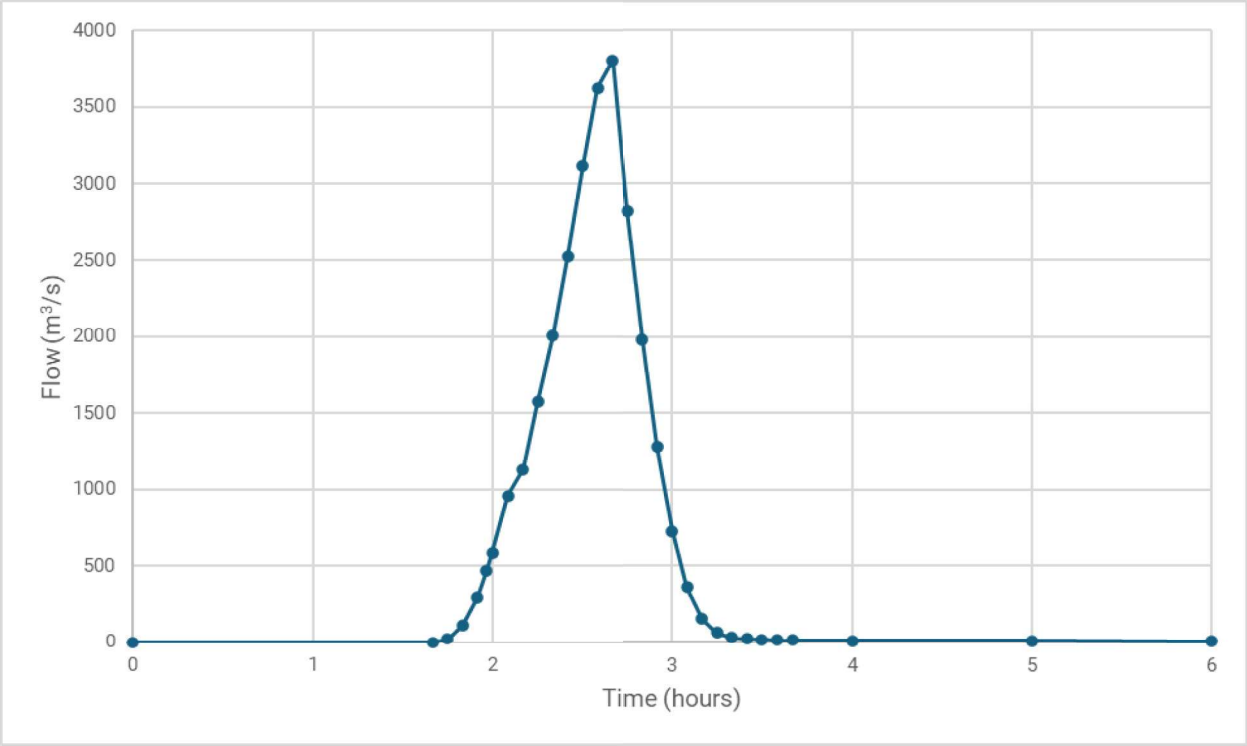
Source: Ausenco (2024).

Figure 3-10 Hydrograph for the Flood Induced scenario (C_V=0.02) West Side



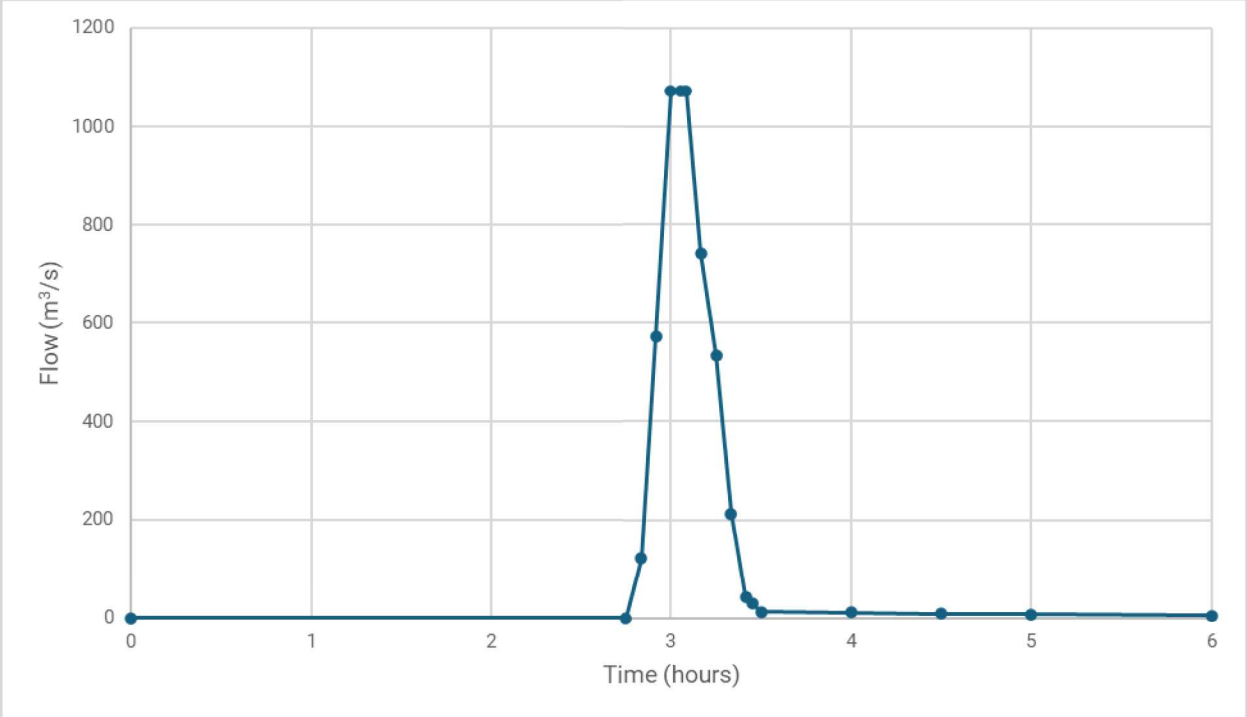
Source: Ausenco (2024).

Figure 3-11 Hydrograph for the Flood Induced scenario (C_V=0.02) East Side



Source: Ausenco (2024).

Figure 3-12 Hydrograph for the Flood Induced scenario (C_V=variable) North End



Source: Ausenco (2024).

Figure 3-13 Hydrograph for the Flood Induced scenario (C_V=variable) South End

4.0 Numerical Model FLO2D PRO

Based on the characteristics of the study area, the use of two-dimensional software is considered. Numerical modelling was performed using FLO2D PRO.

FLO2D PRO has been approved by the CDA (2021) and FEMA (Federal Emergency Management Agency) for the evaluation of flood studies and non-Newtonian fluid flows (hyper-concentrated flows).

FLO2D PRO is a two-dimensional finite difference model, it was developed to model surface flows. The software is suitable for modelling both Newtonian fluid flows (water or water with low concentration sediments) and non-Newtonian fluid flows (sludge, hyper-concentrated flows).

FLO2D PRO is based on the equations of continuity (preserves volume) and momentum (physical relationships that describe movement), and on the principle of volume conservation.

Hyper-concentrated flows (non-Newtonian fluid) involve a complex interaction between processes in water and sediment such as turbulence, viscous shear, fluid-sediment particle momentum exchange, and sediment particle collision. FLO-2D uses the Bingham rheological model that combines the components of viscous stress and flow limit.

O'Brien & Julien (1988), Julien & Lan (1991), y Major & Pierson (1992) investigated hyper-concentrated flows with high concentrations of fine sediments in the fluid matrix. These studies indicated that sludge behaves like Bingham fluids.

Likewise, FLO2D proposes the following empirical relationships to estimate the viscosity and fluidity limit:

$$\eta = \alpha_1 e^{\beta_1 C_V}$$

$$\tau_y = \alpha_2 e^{\beta_2 C_V}$$

Where:

η is the dynamic viscosity, τ_y the flow limit, α and β are empirical coefficients defined in laboratory tests and C_V is the volume solids content.

FLO2D PRO requires meshing of the modelling area, which consists of discretising the area using a mesh of cells of homogeneous size. Each grid element is represented by a single elevation, Manning coefficient value, and the entry hydrograph and exit points are entered with the grid numbering.

Finally, to determine the flood route, the software analyses the four cardinal directions (N, E, S, W) and the four lateral directions (NE, SE, SW, NW). As a final product, the software provides the hydraulic parameters (depth and speed).

4.1 Extension of the computational domain

To determine the extension of the computational domain, in this analysis, the CDA (2021) criterion was considered, which recommends considering 24 hours of modelling.

4.2 Computational Domain Mesh

A structured mesh with 20 m x 20 m square-shaped cells was assigned. The elevation values were obtained based on the topographic information described in Tailings Dam Breach Analysis – Analysis Criteria Rev. B (Ausenco, 2024). In addition, the Manning coefficient values were assigned for each cell based on the characterization shown in **Item 2.2**.

4.3 Boundary Conditions

Input conditions were assigned to cells located on the breach axis of the hypothetical failure. For the Sunny Day and Flood Induced scenarios, the hydrographs presented in **item 3.6** were assigned. No output elements were assigned because flow was modelled over 24 hours.

4.4 Rheological Parameters

The empirical coefficients α and β to express the yield stress and viscosity as a function of the concentration of solids in volume were obtained from the equations presented in **item 2.1**.

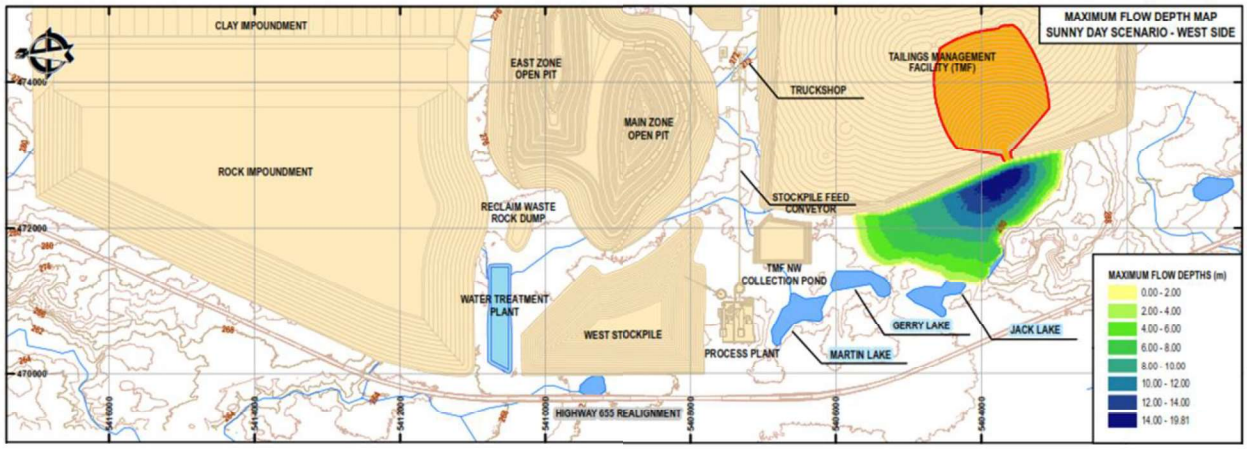
5.0 Results

5.1 Inundation Analysis

In **Figure 5-1** the results of maximum flow depths for the Sunny Day Scenario are shown. The location of the breach considered on the west side of the TMF, where the dam has greater height, and the geometry of the stacked tailings allows the volume of discharge to be greater with respect to other locations that discharge to the west.

The inundation footprint encompasses large areas west of the tailing's impoundment and its surroundings. The discharged tailings would not reach the contact water collection pond or the process plant and auxiliary structures.

Map A01-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A01-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



Source: Ausenco (2024)

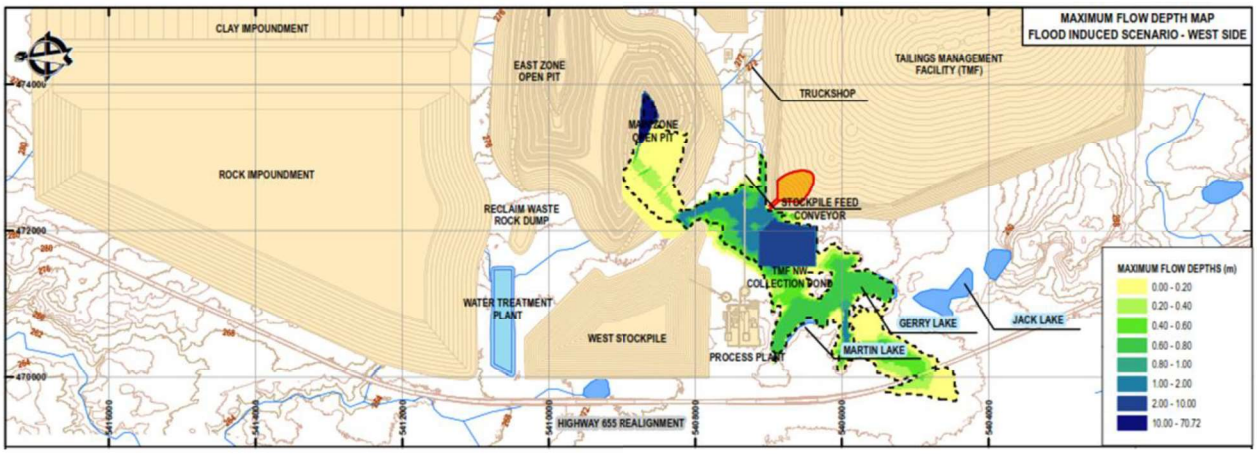
Figure 5-1 Sunny Day Scenario West Side– Maximum Flow Depths

In the **Figure 5-2**, the maximum flow depths for the Flood-induced Scenario are shown (which including flow from IDF upstream catchment areas), and flooding area only by IDF is also shown (dashed black lines); the location of the breach considered in the northwest corner of the reservoir can be appreciated, where the flow of the flood would leave the basin area of the tailings facility, exceeding the level of the dam.

The impacted area is the area close to the discharge of the flow, the TMF NW collection pond and the area between the TMF and the pond. The flow is expected to quickly enter the open pit. The Flo-2D model does not predict the representative inundation area within the pit due to the complexity of the steep slopes and internal ramps.

The model considers the flow from the west side basins whose water courses for the IDF (2/3 between the 1:1000 event and the PMF), would mix with the tailings discharged from the TMF.

Map A02-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A02-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



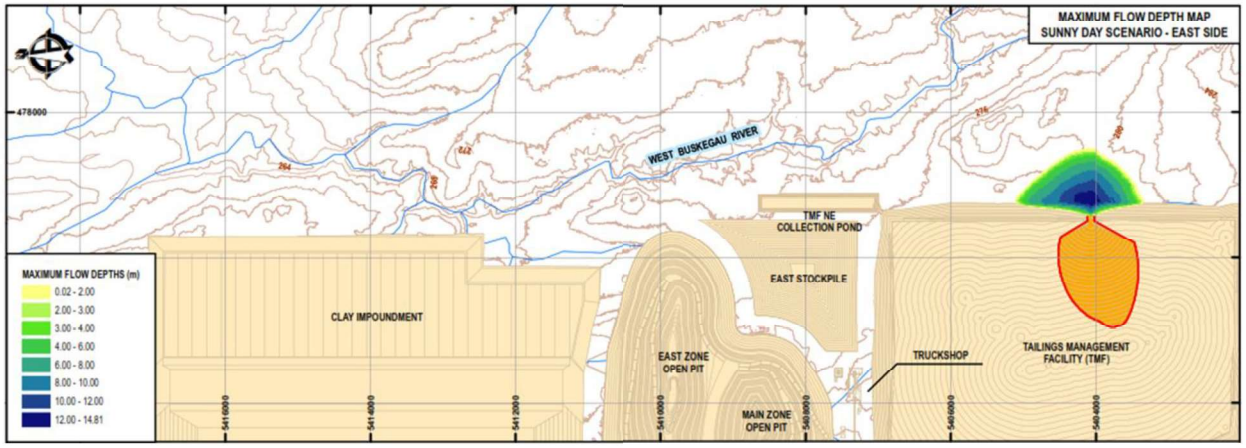
Source: Ausenco (2024)

Figure 5-2 Flood induced scenario West Side– Maximum Flow Depths

On the Map A02-3 (Appendix 1), the results shown corresponds to the dam breach flood footprint whose maximum volumetric solids content is greater or equal to 20% for the west side of the TMF. Nevertheless, for this scenario, the entire dam breach flood footprint has a maximum volumetric solids content less than 20%, for this reason, the symbology of maximum flow depths, maximum velocities, time until flow reaches 30 centimeters depth, maximum volumetric solids content, flood wave arrival time and time to maximum depth are not presented.

Figure 5-3 shows the maximum flow depths for the Sunny Day Scenario on the east side of the TMF, including the location of the breach considered. The inundation footprint would not reach the TMF Northeast Collection Pond and the West Buskegau river.

Map A03-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A03-2 (**Appendix 1**) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



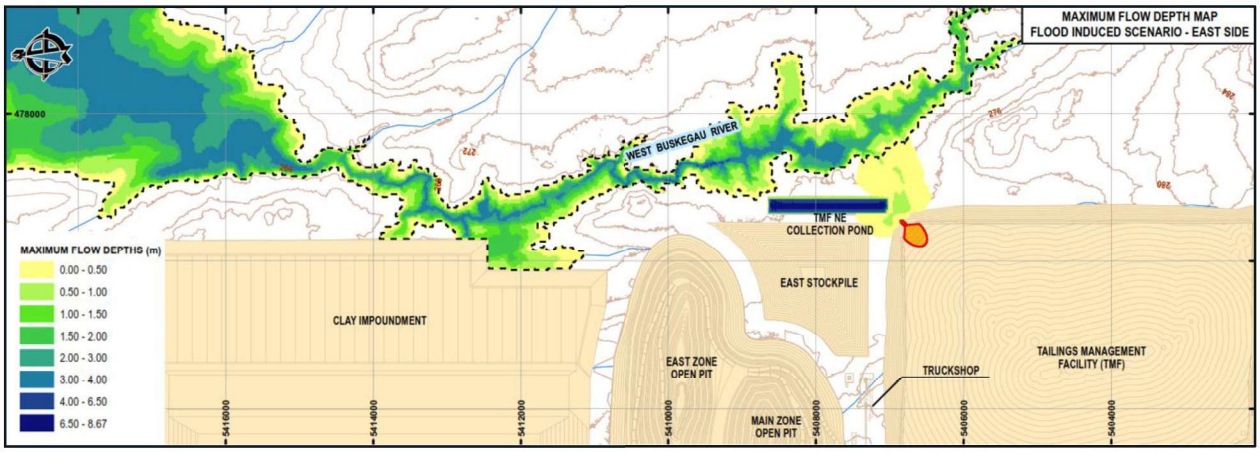
Source: Ausenco (2024)

Figure 5-3 Sunny Day Scenario East Side– Maximum Flow Depths

In **Figure 5-4,** maximum flow depths for the flood-induced scenario east side are shown. The location of the breach considered in the northeast corner of the reservoir can be seen, where the flow of the flood would overtop the crest dam. The inundation reaches the West Buskegau river, travelling 8 km downstream in 24 hours.

The model considers a baseline flow from the West Buskegau River, whose water course for the design storm event, 2/3 between the 1:1000 event and the PMF, would mix with the tailings discharged from the TMF and transport the tailings sediments downstream. The "baseline" flows in the West Buskegau were also modelled at IDF-level at the time of the flood-induced breach.

Map A04-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A04-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



Source: Ausenco (2024)

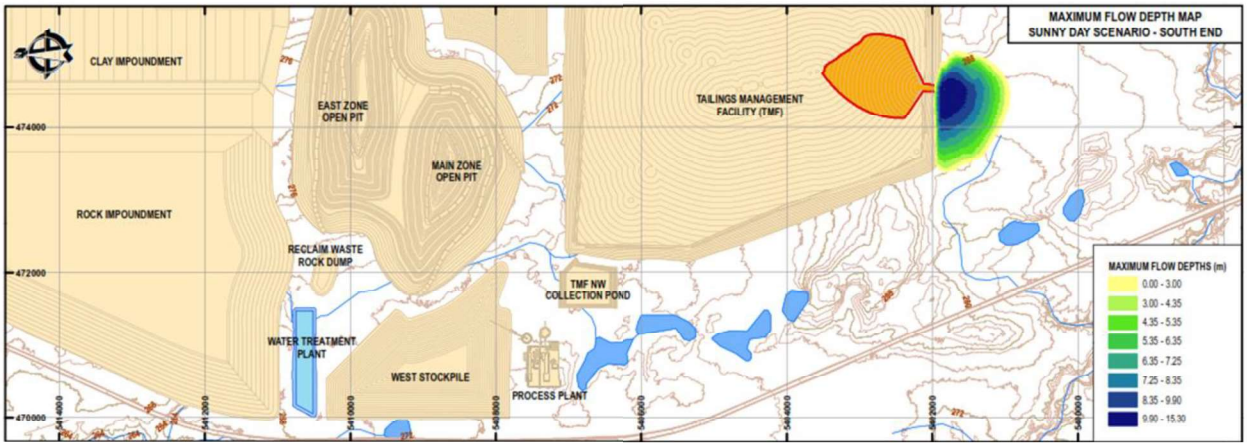
Figure 5-4 Flood induced scenario East Side– Maximum Flow Depths

On the Map A04-3 (Appendix 1), the results shown corresponds to the dam breach flood footprint whose maximum volumetric solids content is greater or equal to 20% for the east side. Nevertheless, for this scenario, the entire dam breach flood footprint has a maximum volumetric solids content less than 20%; for this reason, the symbology of maximum flow depths, maximum velocities, time until flow reaches 30 centimeters depth, maximum volumetric solids content, flood wave arrival time and time to maximum depth are not presented.

Figure 5-5 shows the maximum flow depths for the Sunny Day Scenario on the south end of the TMF, including the location of the breach considered.

The inundation footprint encompasses large areas south of the tailing's impoundment and its surroundings. The discharged tailings would not reach any structure or natural water course.

Map A05-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A05-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



Source: Ausenco (2024)

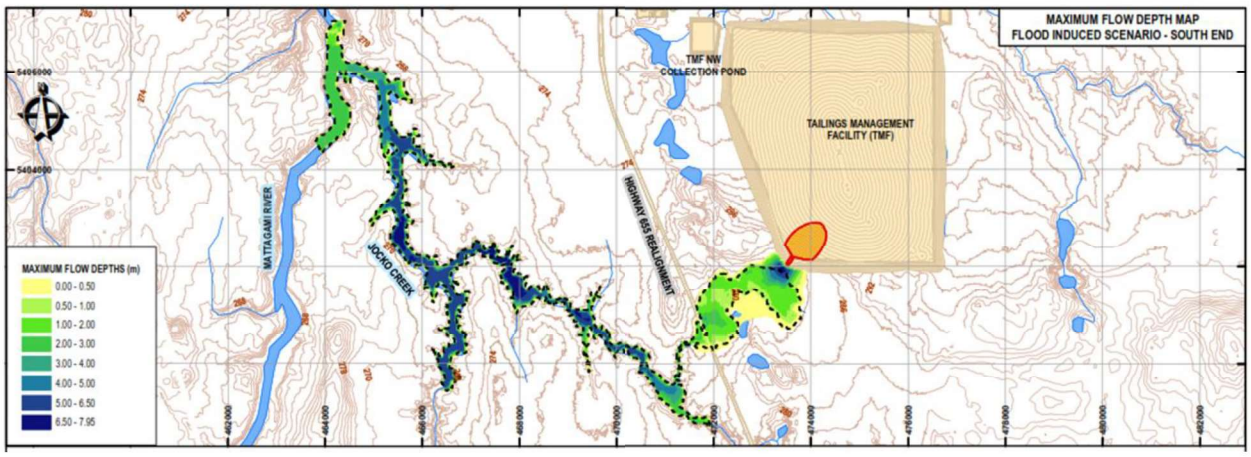
Figure 5-5 Sunny Day Scenario South End– Maximum Flow Depths

In **Figure 5-6**, the maximum flow depths for the Flood-induced Scenario are shown; the location of the breach considered in the southwest corner of the reservoir can be appreciated, where the flow of the flood would leave the basin area of the tailings facility, exceeding the level of the dam.

The inundation rapidly reaches Jocko Creek, crossing the Highway 655 Realignment and travelling approximately 10 km downstream in 24 hours, eventually reaching the Mattagami River.

The model considers the flow from the Jocko Creek and its tributaries whose water course for the design storm event, 2/3 between the 1:1000 event and the PMF, would mix with the tailings discharged from the TMF and transport the tailings sediments downstream.

Map A06-1 (**Appendix 1**) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A06-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.

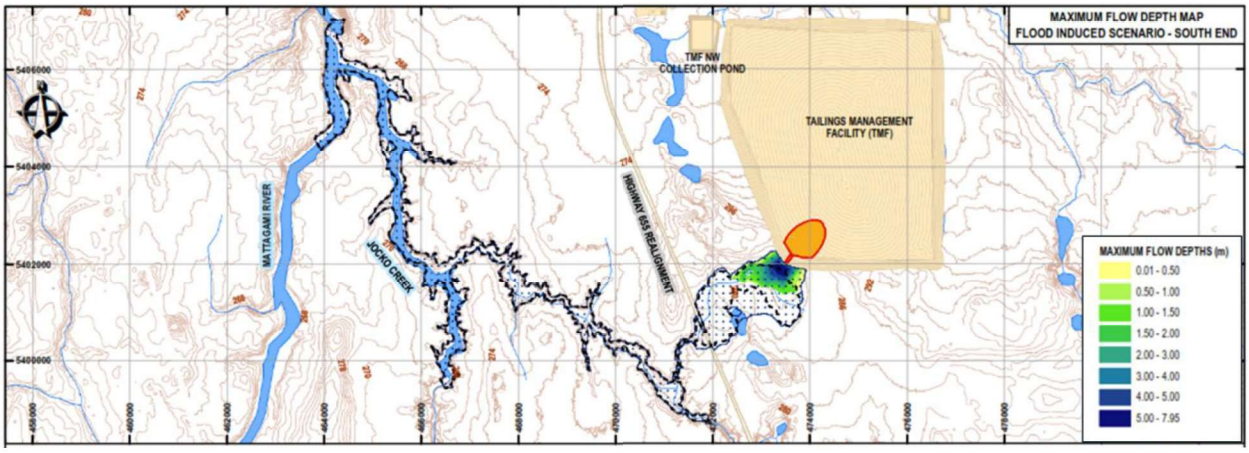


Source: Ausenco (2024)

Figure 5-6 Flood induced scenario South End – Maximum Flow Depths

In **Figure 5-7**, the maximum flow depths for breach materials with a volumetric solids content greater than or equal to 20% for the Flood-induced Scenario are shown; the location of the breach considered in the southwest corner of the reservoir can be seen, where the flow of the flood would leave the basin area of the tailings facility, exceeding the level of the dam.

In Maps A06-3 and Map A06-4 (Appendix 1), the results shown corresponds to the dam breach flood footprint whose maximum volumetric solids content is greater or equal to 20% for the south end.



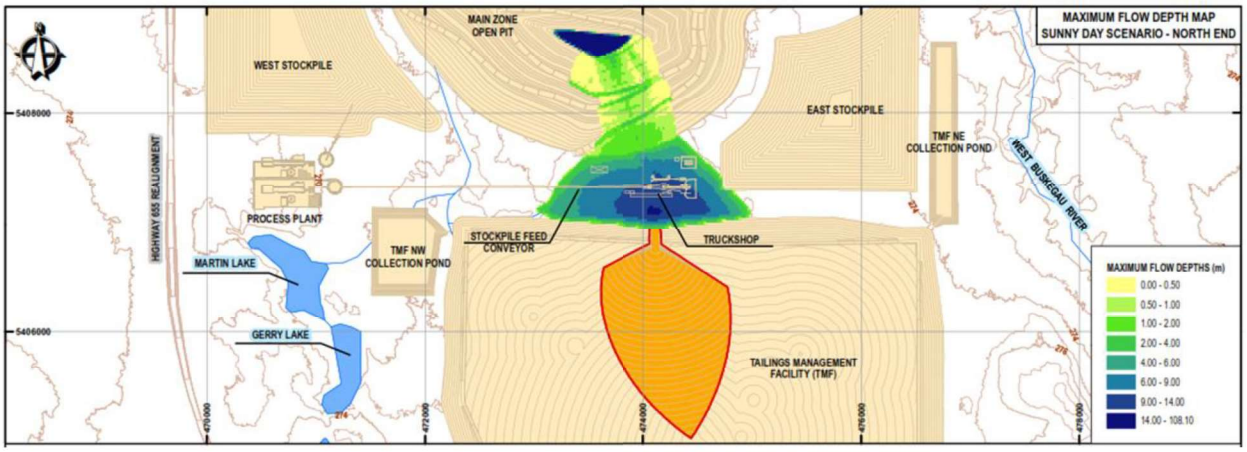
Source: Ausenco (2024)

Figure 5-7 Flood induced scenario South End – Maximum Flow Depths ($C_v \geq 20\%$)

Figure 5-8 shows the maximum flow depths for the Sunny Day Scenario on the north end of the TMF, including the location of the breach considered.

The inundation footprint encompasses large areas on the north of the tailing's impoundment, the truck shop, and the crusher. The maximum flow depths around the truck shop reach values of 14 meters and a large volume of discharged tailings would enter the open pit within the 24 hours of modelling.

Map A07-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A07-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



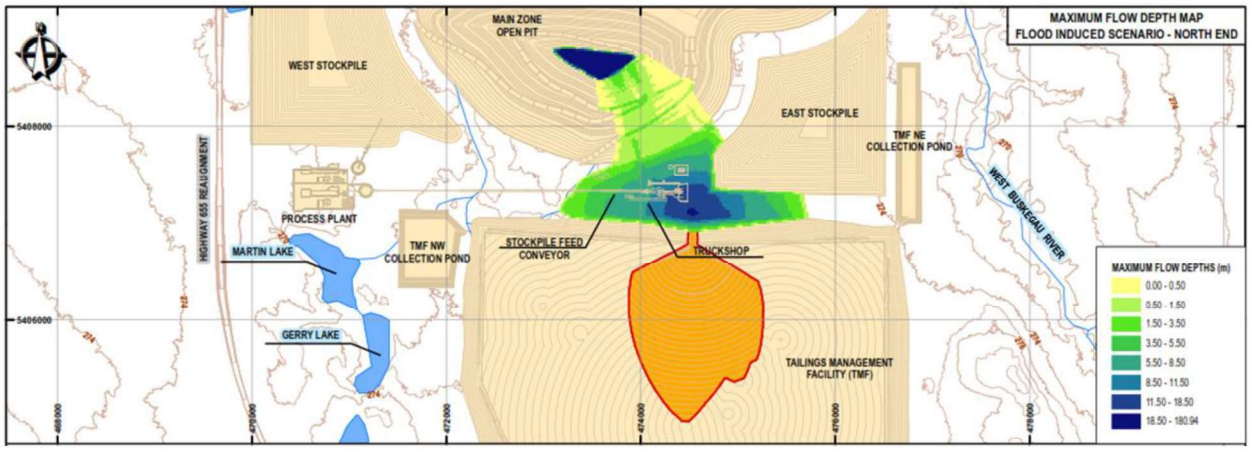
Source: Ausenco (2024)

Figure 5-8 Sunny Day Scenario North End– Maximum Flow Depths

In the **Figure 5-9**, the maximum flow depths for the Flood-induced Scenario are shown; the location of the breach considered in the north sector of the reservoir can be appreciated, where the flow of the flood would leave the basin area of the tailings facility, exceeding the level of the dam.

The inundation footprint encompasses large areas on the north of the tailing's impoundment, the truck shop, and the crusher. The maximum flow depths around the truck shop reach values of 18.5 meters and a large volume of discharged tailings would enter the open pit within the 24 hours of modelling.

Map A08-1 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth. Likewise, Map A08-2 (Appendix 1) shows the results for the maximum volumetric solids content, the flood wave arrival time, and the time to maximum depth.



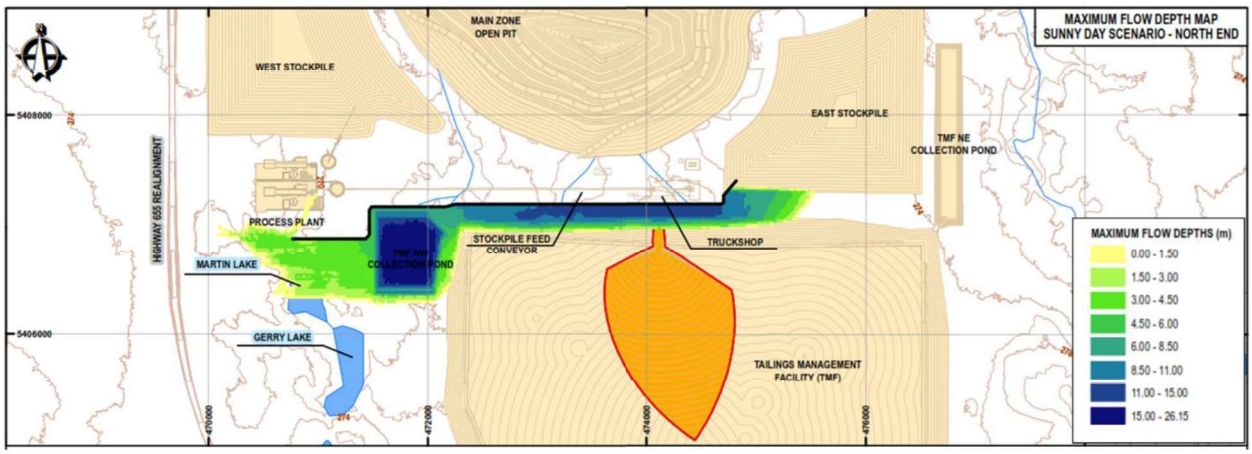
Source: Ausenco (2024)

Figure 5-9 Flood induced scenario North End – Maximum Flow Depths

Figure 5-10 shows the maximum flow depths for the Sunny Day Scenario on the north end of the TMF considering a projected deflector berm and including the location of the breach considered.

In this scenario, the use of a deflector berm is modelled in order to show a way to mitigate the risk of loss of life. According to the results, in the sunny day scenario, the maximum flow depths reach values of 15 meters against the deflector berm, which should be considered for its design. Likewise, for this scenario, the flow wouldn't reach the process plant and the mine infrastructure buildings.

Map A07-3 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth.



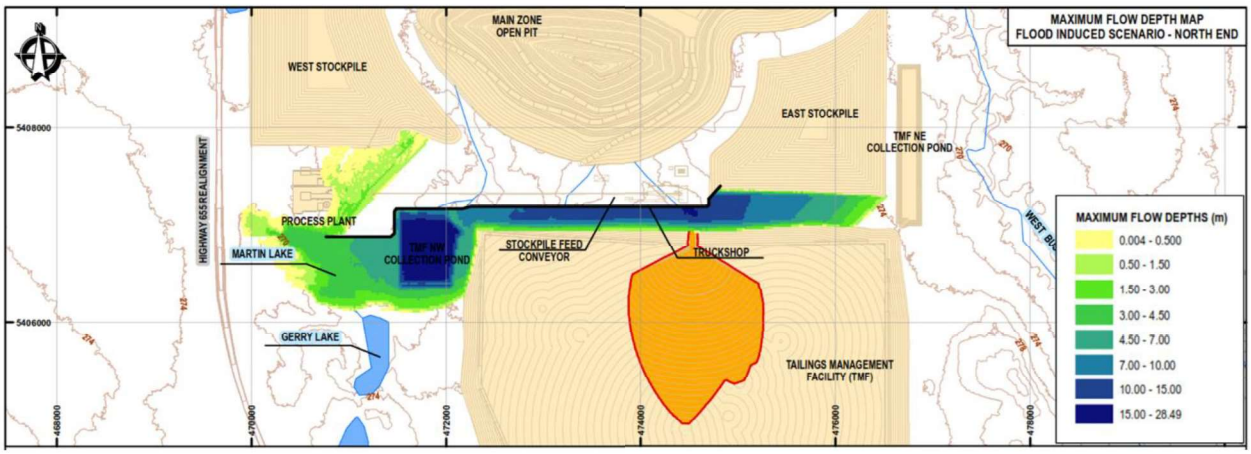
Source: Ausenco (2024)

Figure 5-10 Sunny Day Scenario with Berm North End – Maximum Flow Depths

In **Figure 5-11**, the maximum flow depths for the Flood-induced Scenario with a deflector berm are shown; the location of the breach considered in the north sector of the reservoir can be appreciated, where the flow of the flood would leave the basin area of the tailings facility, exceeding the level of the dam.

In this scenario, the use of a deflector berm is modelled in order to show a way to mitigate the risk of loss of life. According to the results, in the flood induced scenario, the maximum flow depths reach values of 15 meters in the deflector berm, which should be considered for its design.

Map A08-3 (Appendix 1) shows the results for maximum flow depths, maximum velocities, and time until flow reaches 30 centimeters depth.



Source: Ausenco (2024)

Figure 5-11 Flood induced scenario with berm North End – Maximum Flow Depths

6.0 Conclusions

Credible failure modes for potential dam breaches were determined for sunny day and flood induced scenarios.

- For the sunny day scenario, it is estimated that approximately 15.2 Mm^3 (west side), 6.3 Mm^3 (east side), 9.8 Mm^3 (north end) and 7.5 Mm^3 (south end) of tailings and water would be released, while in the case of the flood-induced failure it is estimated that approximately 1.9 Mm^3 (for either west side or each side breaches), 13.5 Mm^3 (north end) and 2.1 Mm^3 (south end) of material would be released.
- The volumetric content of solids (C_V), i.e. the volume of the solids divided by the total volume, for the sunny day scenario is 38% for the east side, west side, north end and south end. Furthermore, for the flood-induced scenario, the C_V is 2% for the west side and east side and is variable for the north end and south end.
- For the sunny day scenario, it was estimated that the tailings discharge time through the breach is approximately 1 hour with a peak flow of approximately 5,100 m^3/s for the west side case, 3,500 m^3/s for the east side, 3,300 m^3/s for the north end and 2,600 m^3/s for the south end.
- For the flood-induced scenario, the duration of the breach hydrograph coincides with the duration of the design storm event (2/3 between the 1:1000 event and the PMF) given the absence of retention capacity within the TMF footprint, with a peak flow of approximately 117.2 m^3/s for the west side case, 115.7 m^3/s for the east side, 3,807.5 m^3/s for the north end and 1,072.5 m^3/s for the south end.
- On the east side, west side, north end and south end, the inundation footprint of the Sunny Day Scenarios would have a smaller area than the Flood-induced Scenarios, due to the higher viscosity of its flow.
- On the north end, the Sunny Day Scenario and Flood-induced scenario would have greater downstream impacts on the project's operating facilities (mine workshop, crusher etc.), with the north end of the tailing facility having the greatest impacts.
- On the east side for the Flood-Induced scenario would have similar impacts on the mine infrastructure (affecting the TMF Northeast collection pond) and would both reach the West Buskegau river, which would generate environmental impacts downstream portion of the river.
- On the west side, for the Flood-Induced scenario, the impacted area is the area close to the discharge of the flow, the TMF NW collection pond and the area between the TMF and the pond. The flow is expected to quickly enter the open pit.

7.0 Recommendations

- It is recommended to update the breach analysis once tailings samples from the facility are available. Rheological properties should be verified using samples from consolidated tailings during operational stages of the facility.
- It is recommended that inundation maps be updated if the layout of site facilities is modified, i.e. layout of TMF, open pit, stockpiles or process plant, truck shop, and other infrastructure to reevaluate impacts on these facilities.
- It is recommended that the project evaluate the construction of a deflection berm or structure between the mine infrastructure and crushing buildings and the TMF, to protect people and reduce the hazard classification in case of a failure in the north sector.
- It is recommended to update the dam breach analysis using topographic information with higher resolution (surfaces with 1 m x 1 m DTM grid).

8.0 Closure

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

Report reviewed by:
Ausenco Sustainability ULC

<Original signed by>

Scott Cameron Elfen, PE
Global Lead Geotechnical Service

9.0 References

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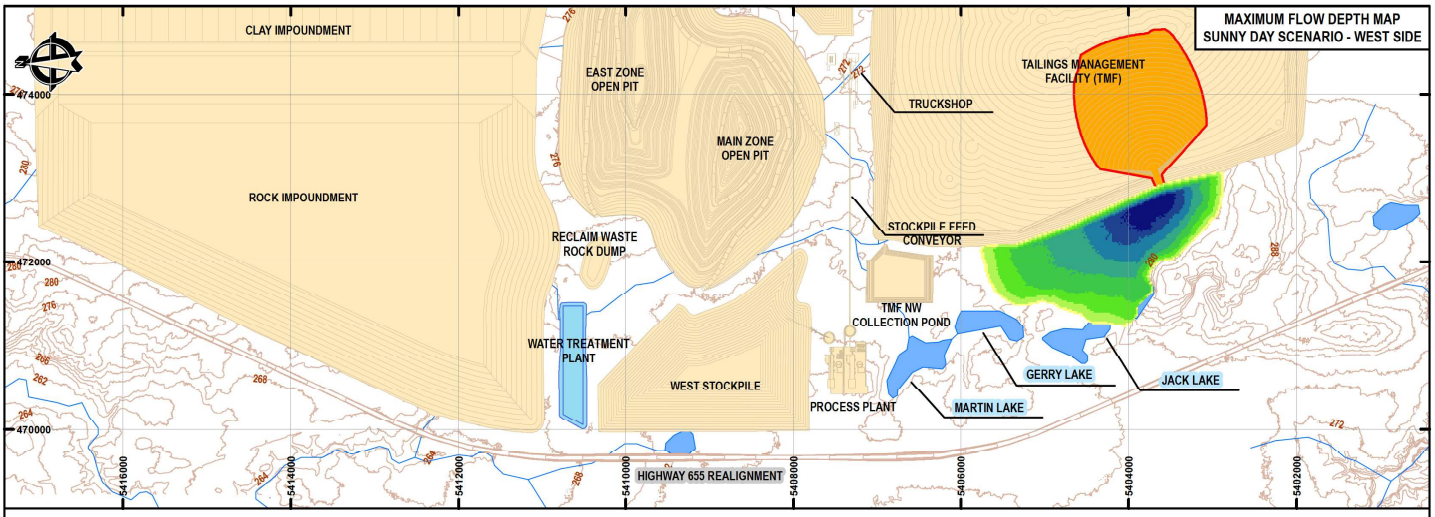
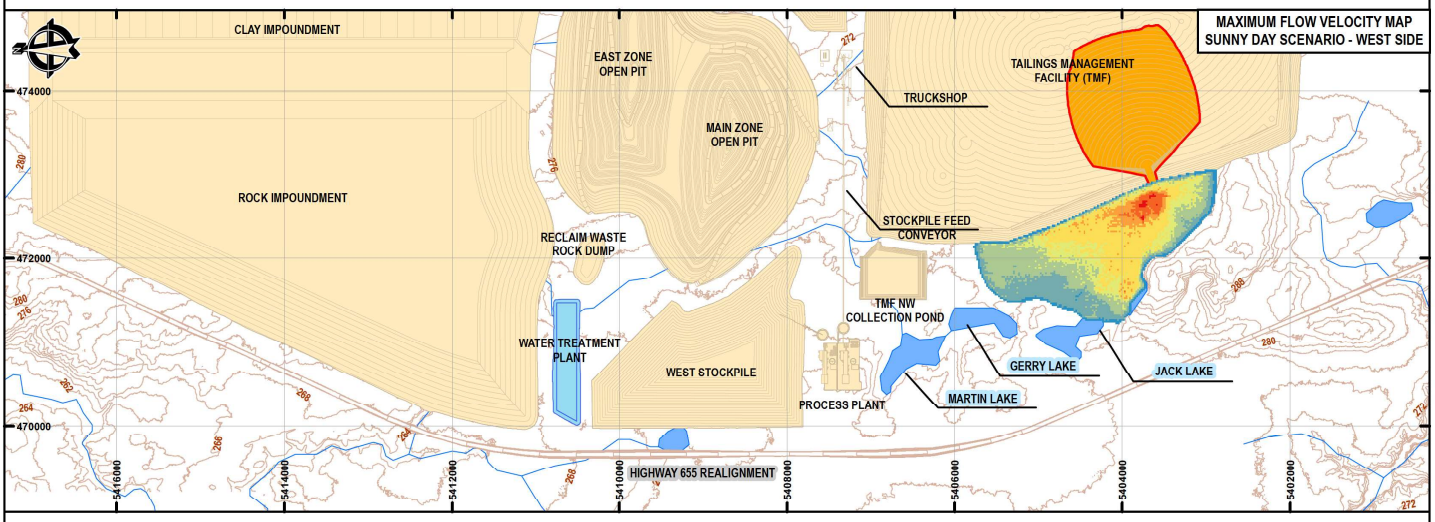
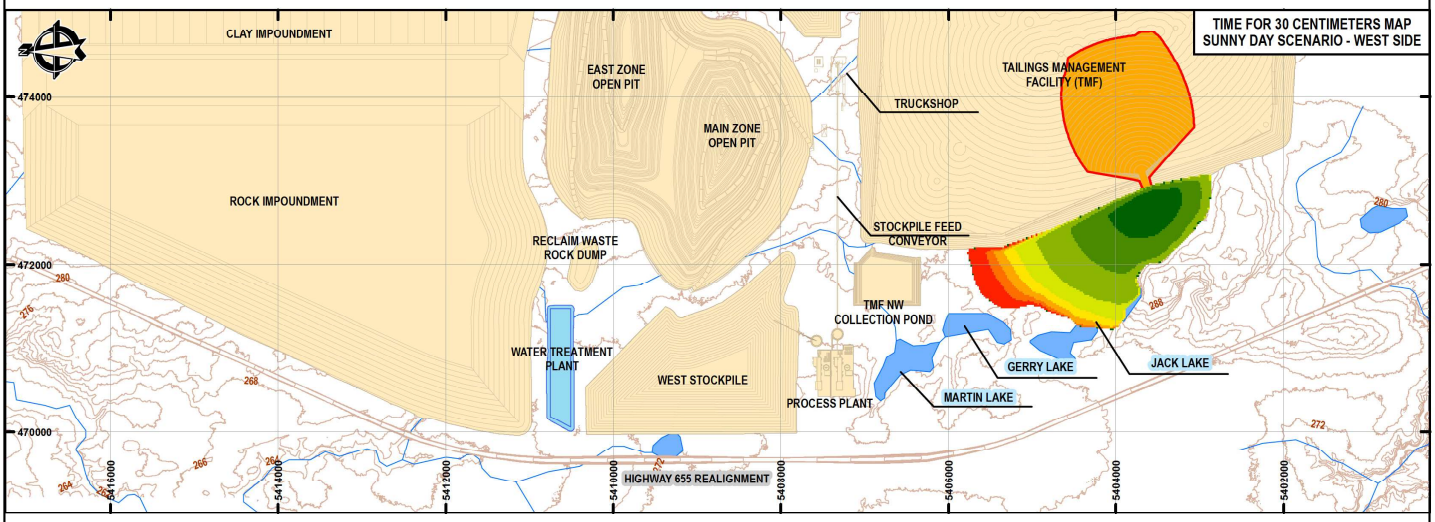
Appendix A
Inundation Maps







SCALE: 1:60,000

SIMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 2.00	0.00 - 0.50	0.00 - 0.25
2.00 - 4.00	0.50 - 1.00	0.25 - 0.50
4.00 - 6.00	1.00 - 1.50	0.50 - 0.75
6.00 - 8.00	1.50 - 2.00	0.75 - 1.00
8.00 - 10.00	2.00 - 3.00	1.00 - 1.25
10.00 - 12.00	3.00 - 4.00	1.25 - 1.50
12.00 - 14.00	4.00 - 6.00	1.50 - 1.75
14.00 - 19.81	6.00 - 8.03	1.75 - 2.40

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

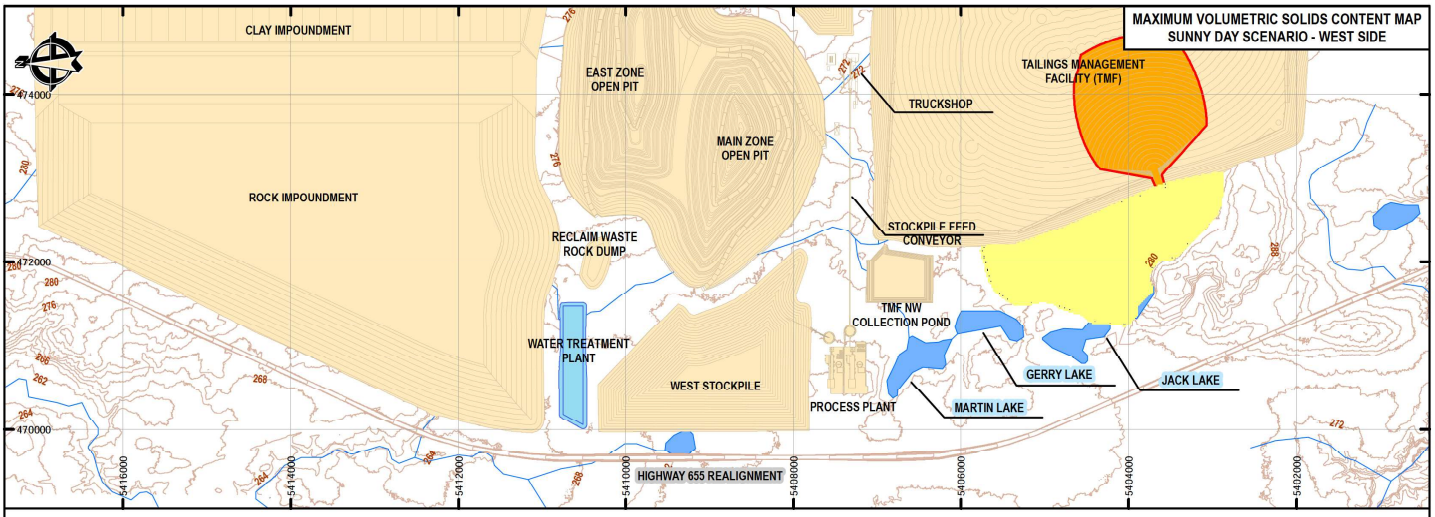
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

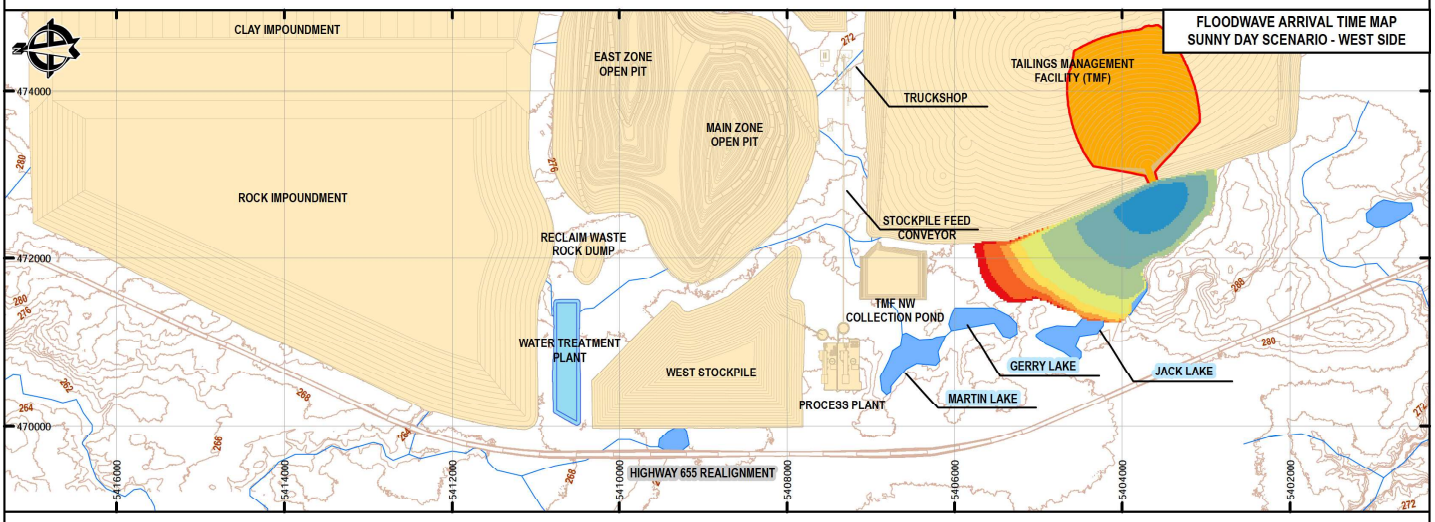
TITLE:

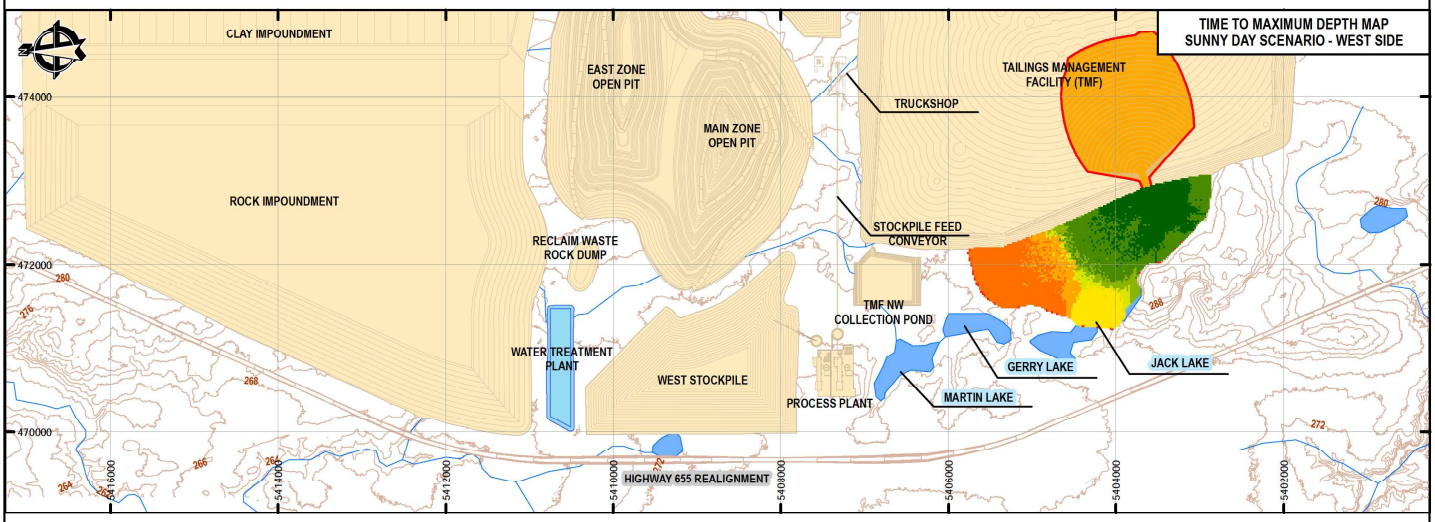
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - WEST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A01-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SIMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
37.0%	0.01 - 0.25	0.45 - 0.75
37.0% - 37.1%	0.25 - 0.500	0.71 - 1.00
	0.50 - 0.75	1.00 - 1.25
	0.75 - 1.00	1.25 - 1.50
	1.00 - 1.25	1.50 - 1.75
	1.25 - 1.50	1.75 - 2.00
	1.50 - 2.00	2.00 - 2.50
	2.00 - 2.30	2.50 - 24.00

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

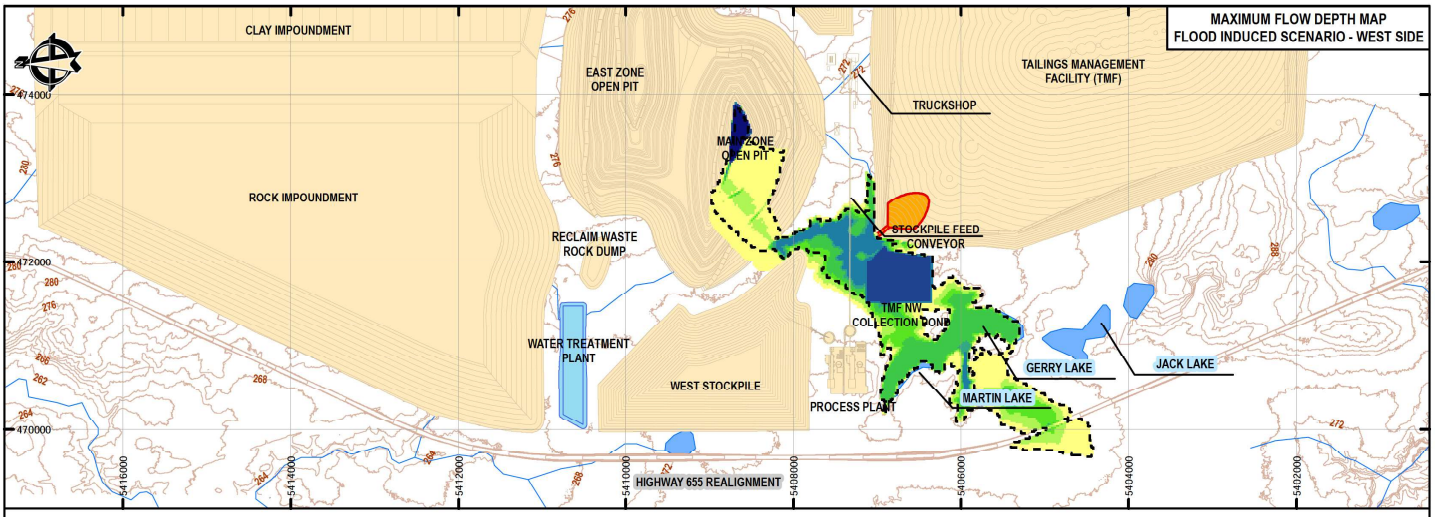
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

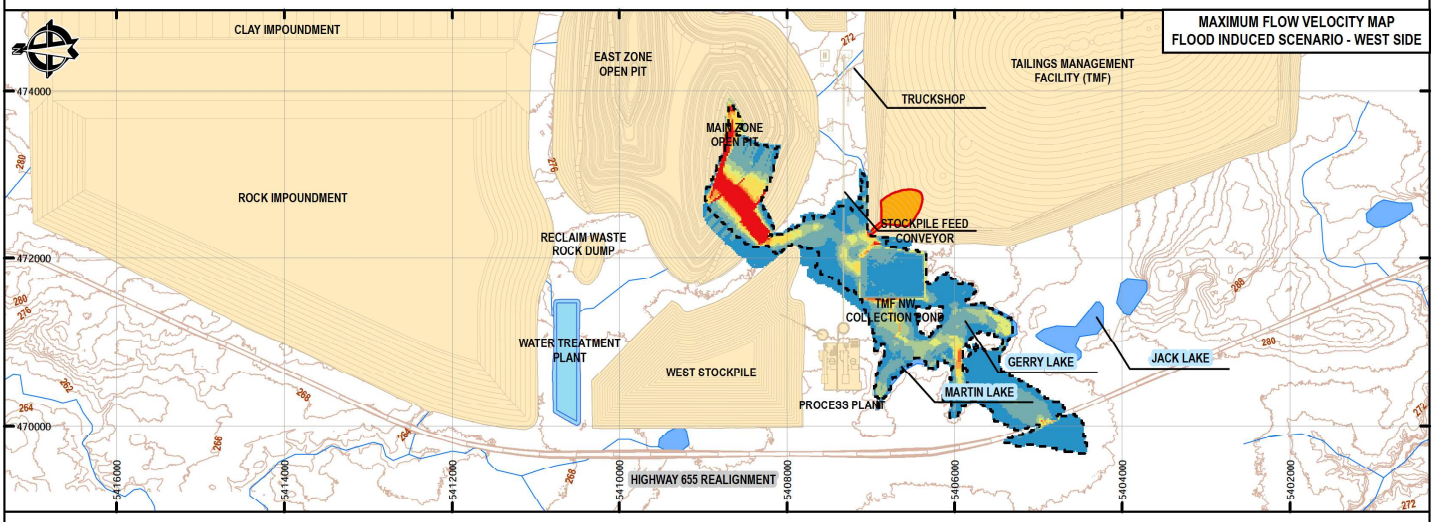
TITLE:

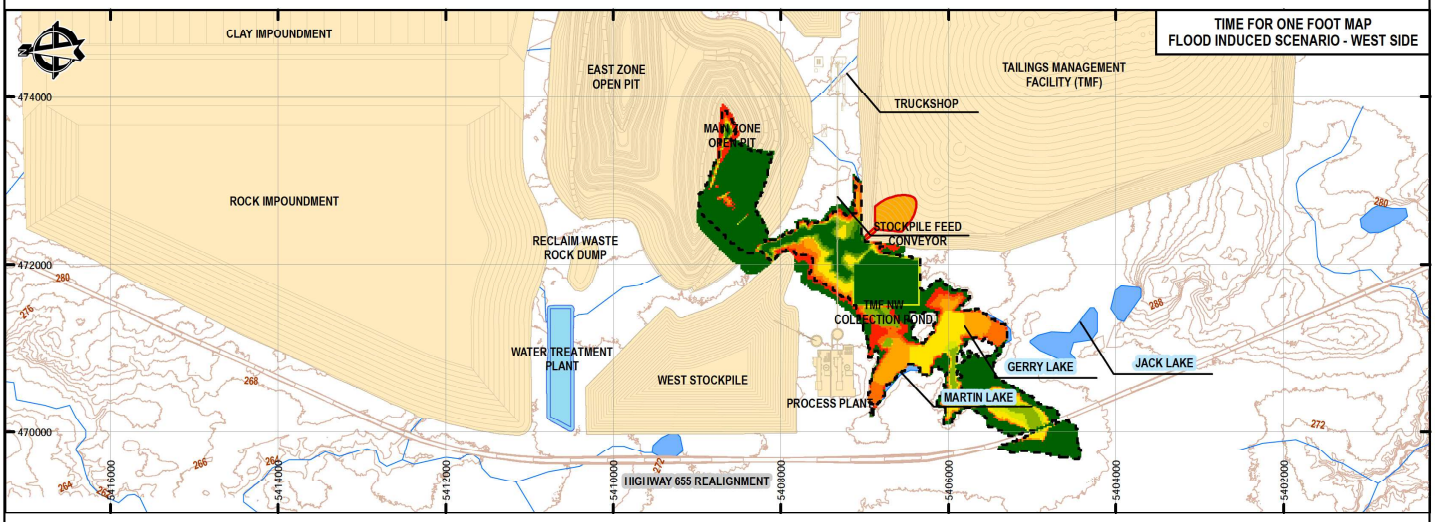
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - WEST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A01-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 0.20	0.00 - 0.10	0.00 - 10.00
0.20 - 0.40	0.10 - 0.20	10.00 - 12.00
0.40 - 0.60	0.20 - 0.30	12.00 - 13.50
0.60 - 0.80	0.30 - 0.40	13.50 - 14.00
0.80 - 1.00	0.40 - 0.60	14.00 - 15.00
1.00 - 2.00	0.60 - 0.80	15.00 - 15.50
2.00 - 10.00	0.80 - 1.00	15.50 - 16.50
10.00 - 70.72	1.00 - 11.15	16.50 - 47.32

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

LEGEND

- IDF FOOTPRINT
- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

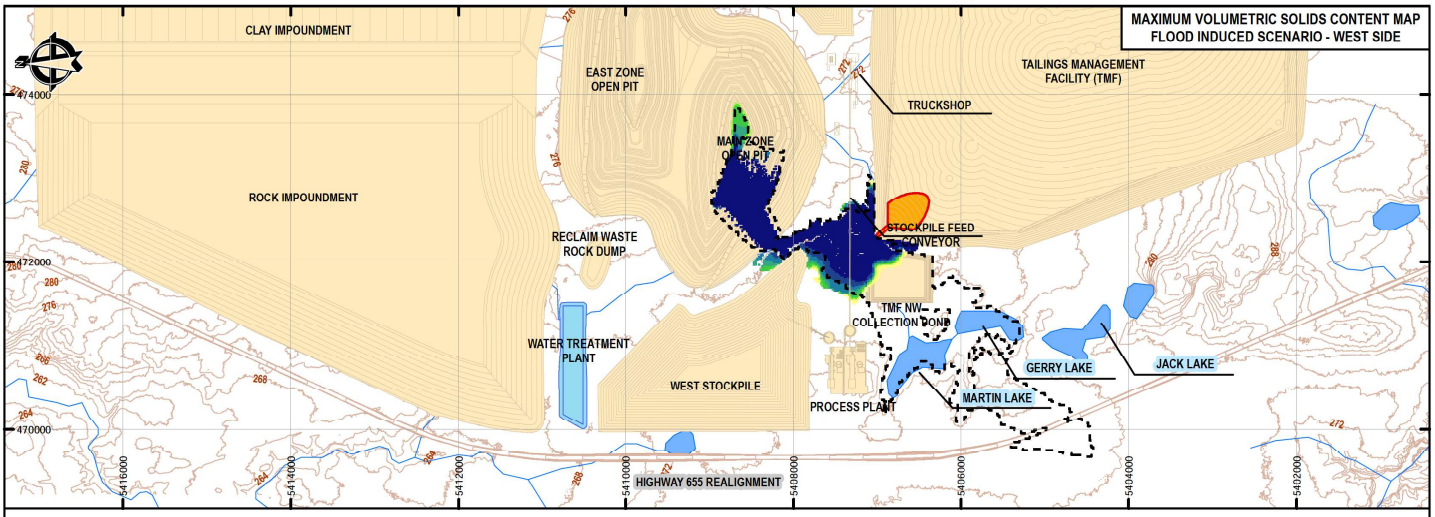
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

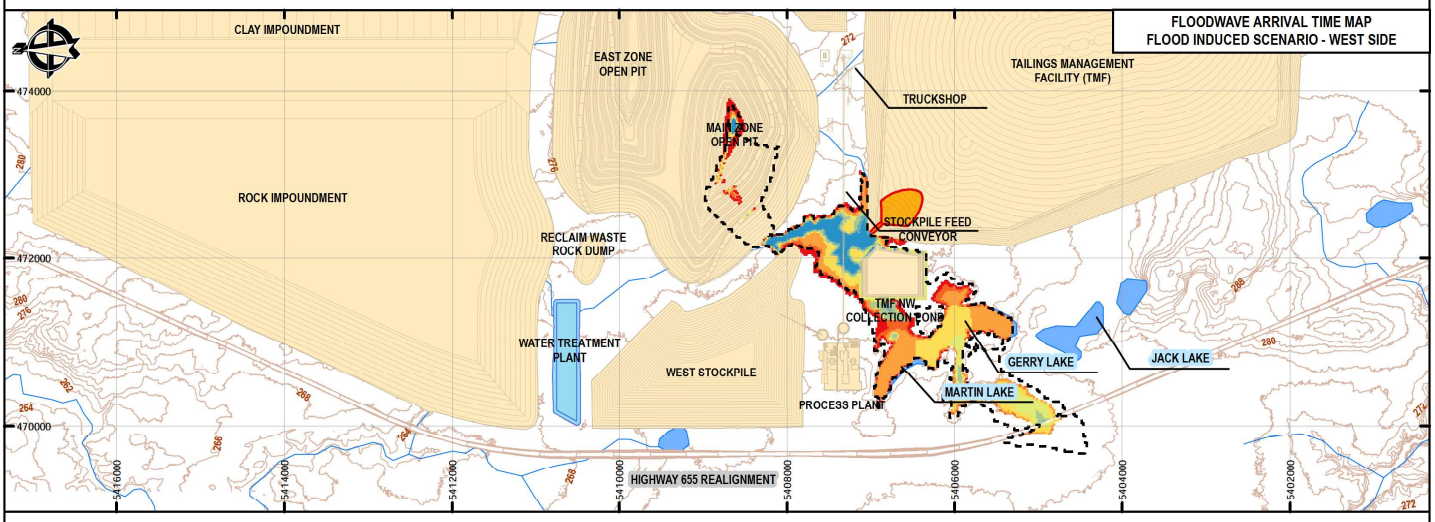
TITLE:

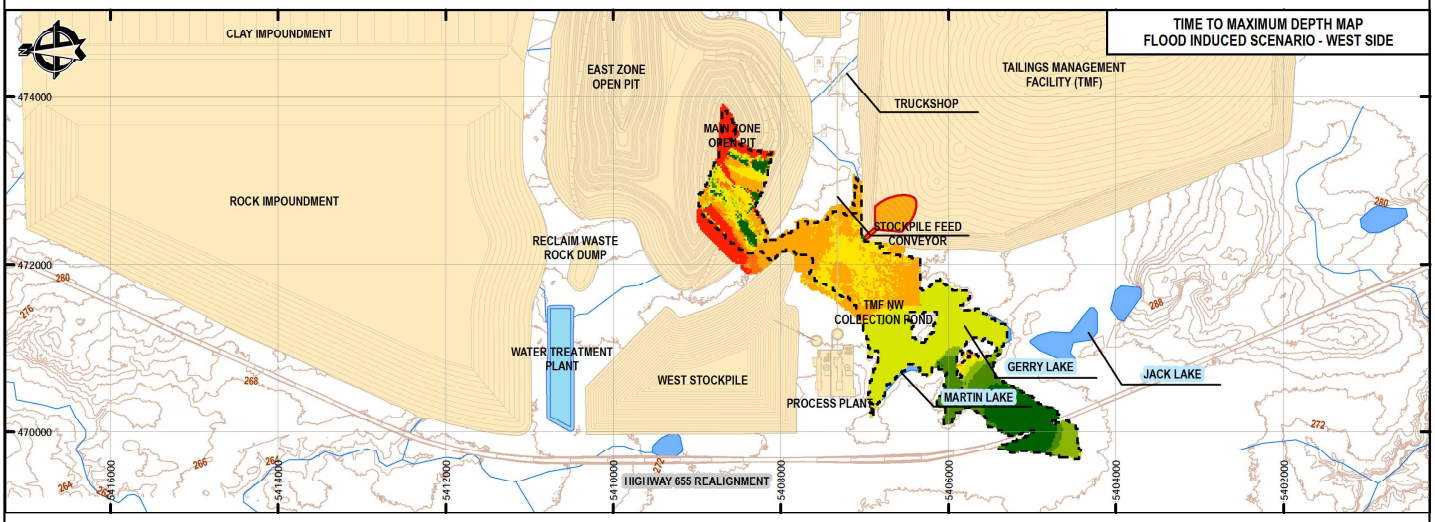
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - WEST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A02-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SYMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
0.1% - 1.0%	2.82 - 11.00	12.17 - 17.00
1.0% - 1.2%	11.00 - 12.00	17.00 - 18.00
1.2% - 1.4%	12.00 - 13.00	18.00 - 19.00
1.4% - 1.6%	13.00 - 14.00	19.00 - 20.00
1.6% - 1.8%	14.00 - 15.00	20.00 - 21.00
1.8% - 2.0%	15.00 - 16.00	21.00 - 22.00
2.0% - 2.2%	16.00 - 17.00	22.00 - 23.00
2.2% - 2.3%	17.00 - 47.32	23.00 - 48.00

LEGEND

- IDF FOOTPRINT
- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

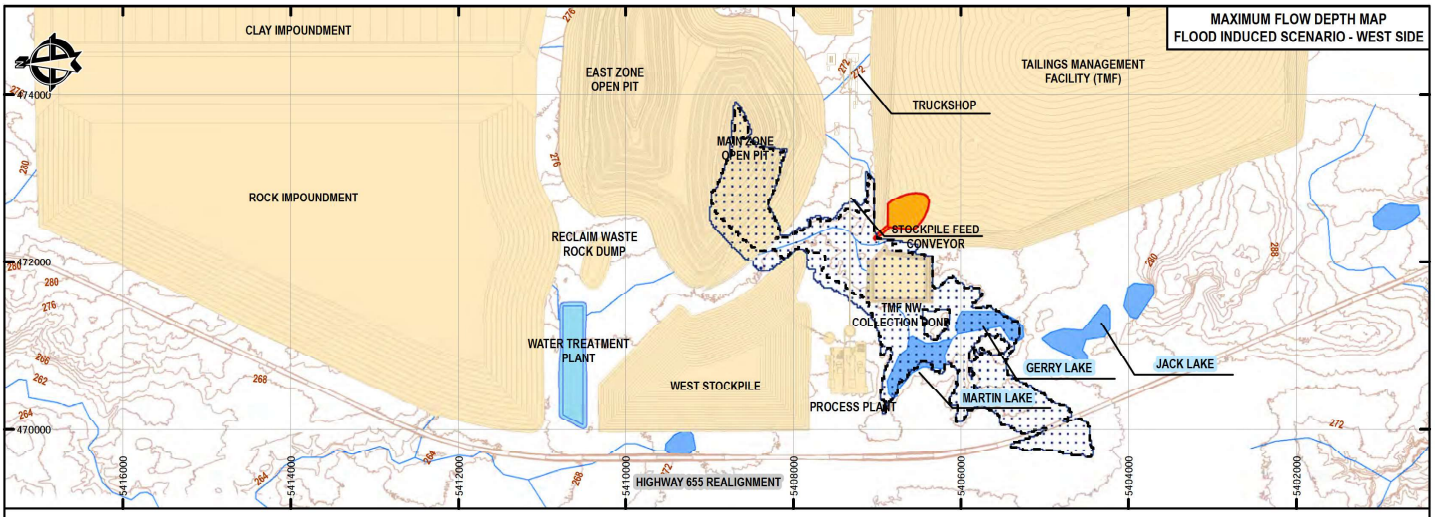
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

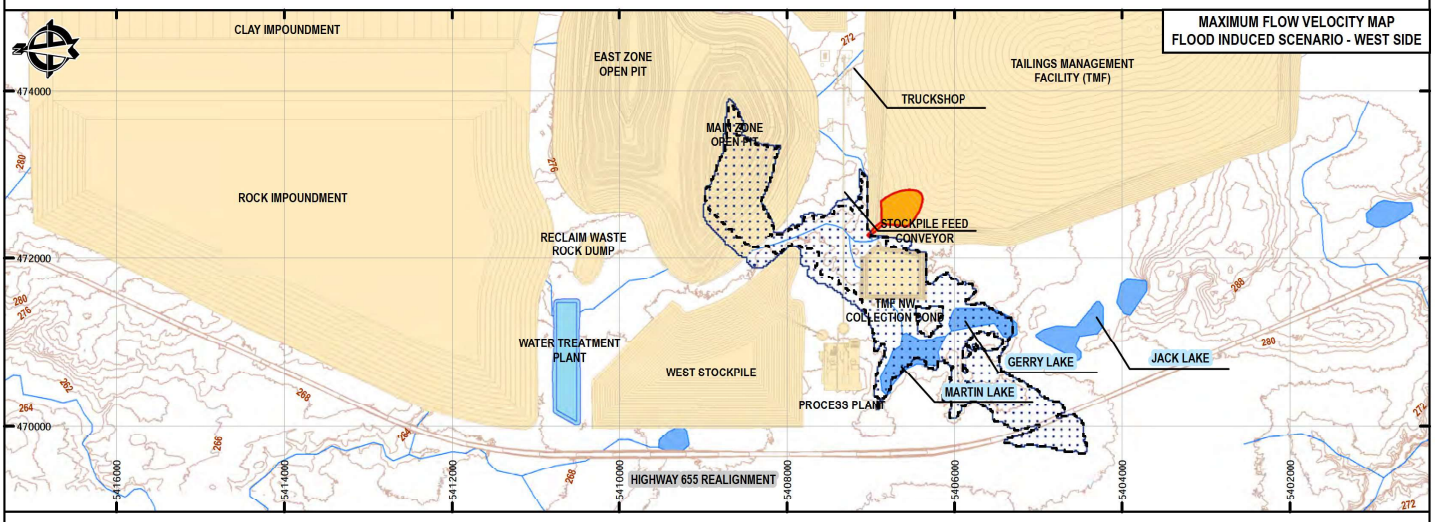
TITLE:

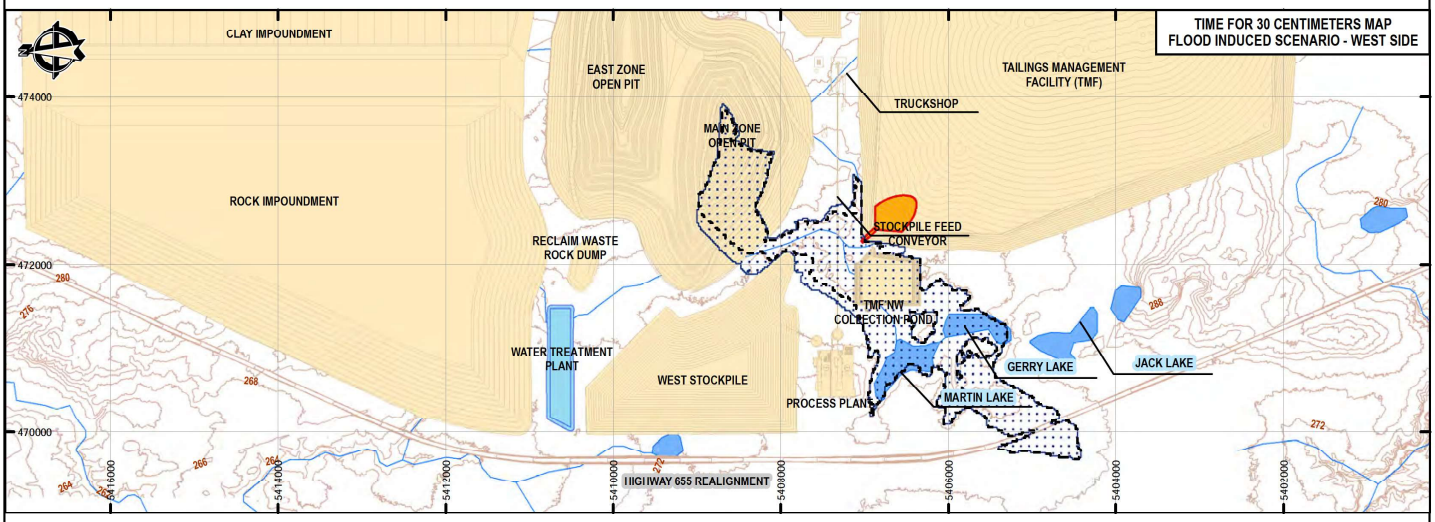
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - WEST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A02-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP
4. FOR THIS SCENARIO, THE ENTIRE DAM BREACH FLOOD FOOTPRINT HAS A MAXIMUM VOLUMETRIC SOLIDS CONTENT LESS THAN 20%, FOR THIS REASON, THE SIMBOLOGY OF MAXIMUM FLOW DEPTHS, MAXIMUM VELOCITIES, TIME FOR ONE FOOT, MAXIMUM VOLUMETRIC SOLIDS CONTENT, FLOODWAVE ARRIVAL TIME AND TIME TO MAXIMUM DEPTH ARE NOT PRESENTED.

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- DAM BREACH FLOOD FOOTPRINT
- IDF FOOTPRINT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

PROJECT:

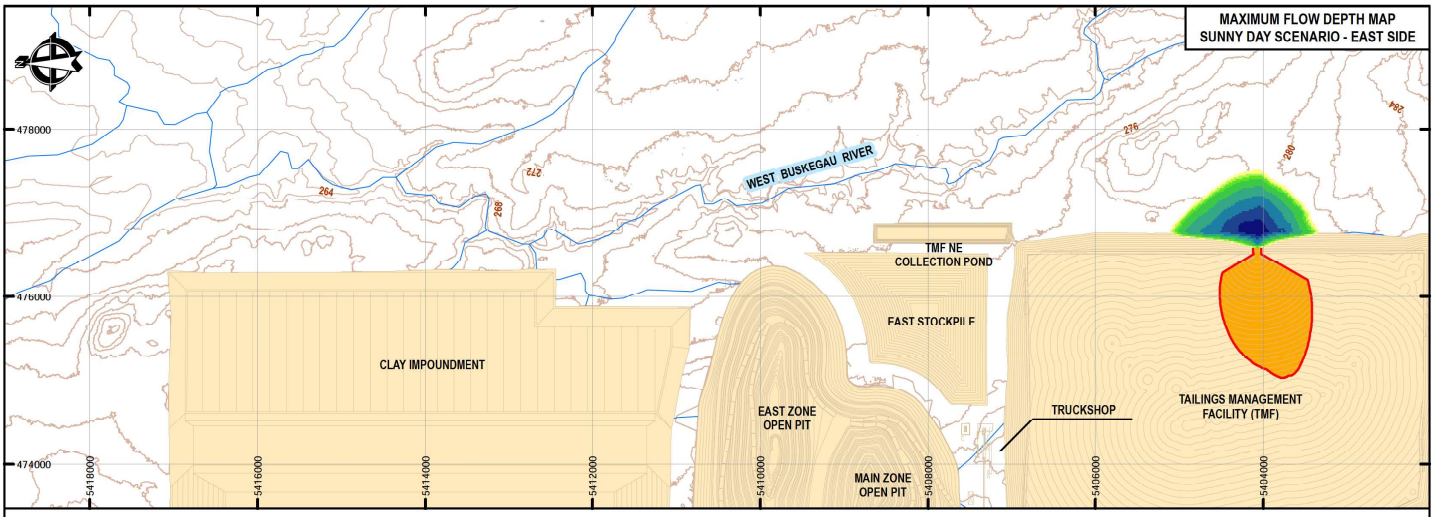
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

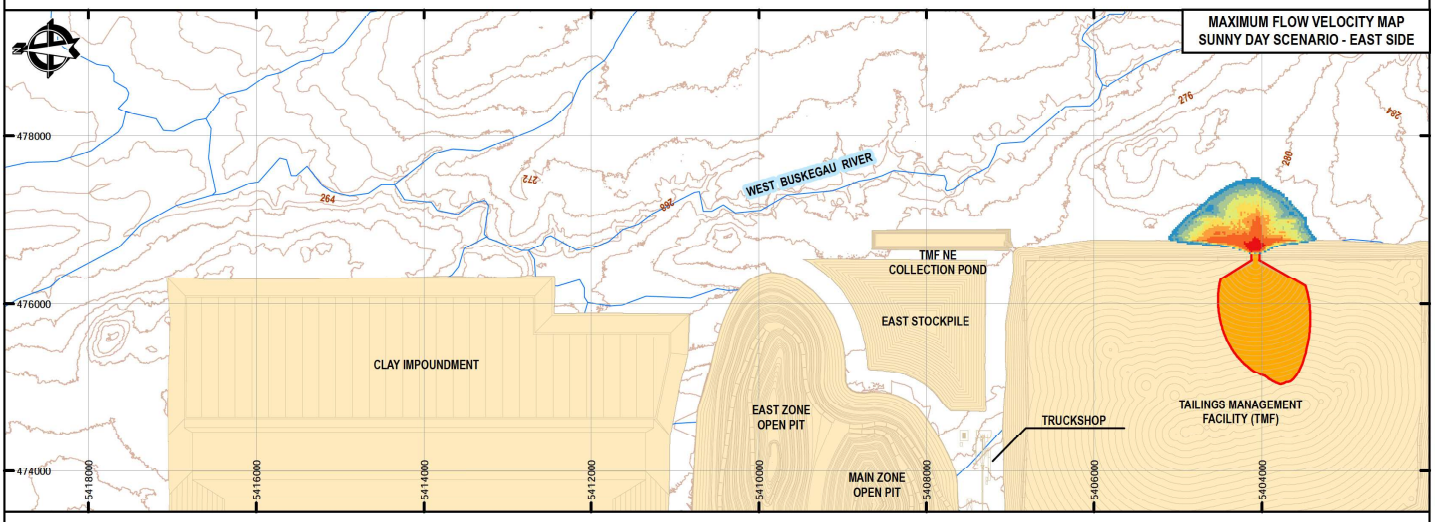
TITLE:

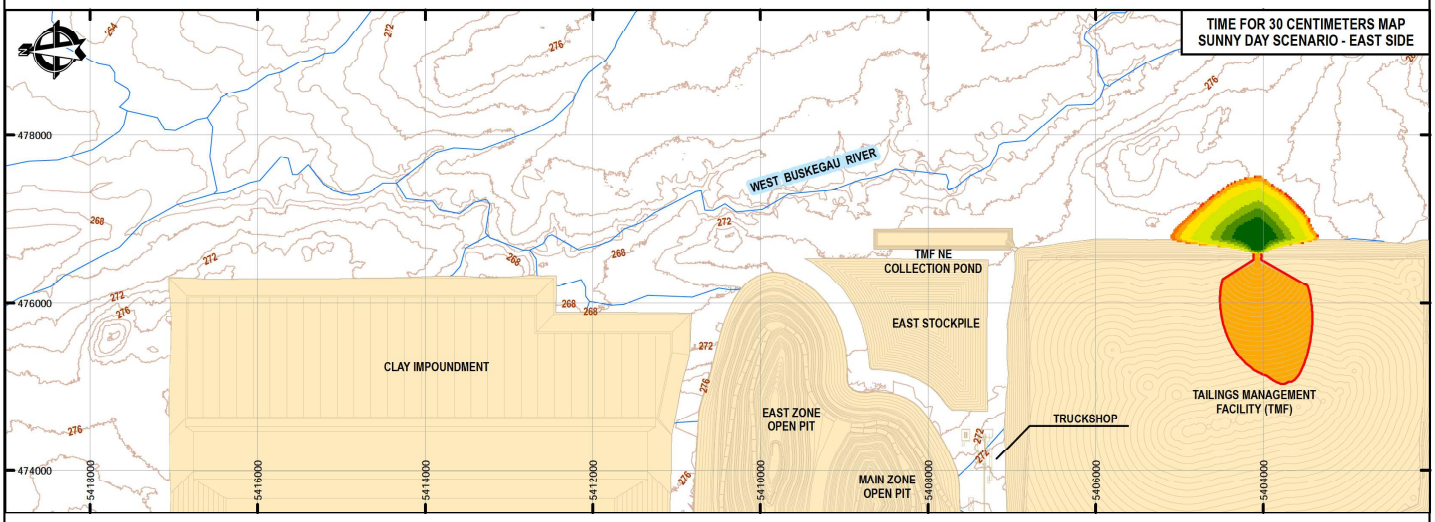
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - WEST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT Nº:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP Nº:	A02-3
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SIMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOT 30 CENTIMETERS (hr)
0.02 - 2.00	0.01 - 0.50	0.00 - 0.20
2.00 - 3.00	0.50 - 0.75	0.20 - 0.30
3.00 - 4.00	0.75 - 1.00	0.30 - 0.40
4.00 - 6.00	1.00 - 1.25	0.40 - 0.60
6.00 - 8.00	1.25 - 1.50	0.60 - 0.80
8.00 - 10.00	1.50 - 2.00	0.80 - 1.00
10.00 - 12.00	2.00 - 4.50	1.00 - 1.50
12.00 - 14.81	4.50 - 9.24	1.50 - 4.36

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

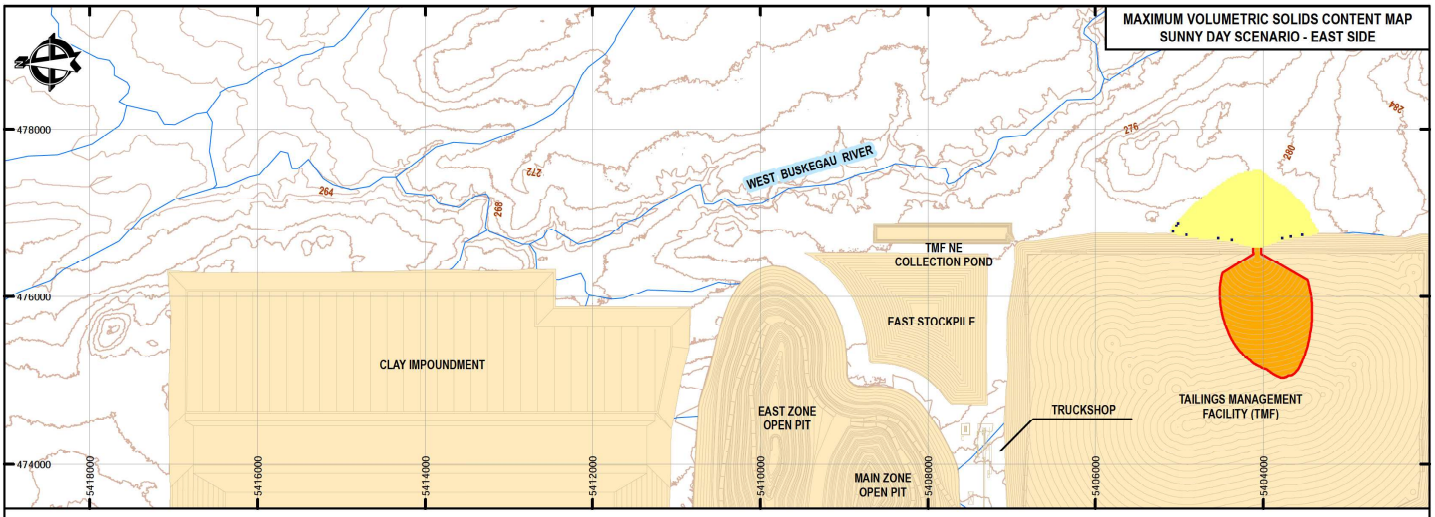
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

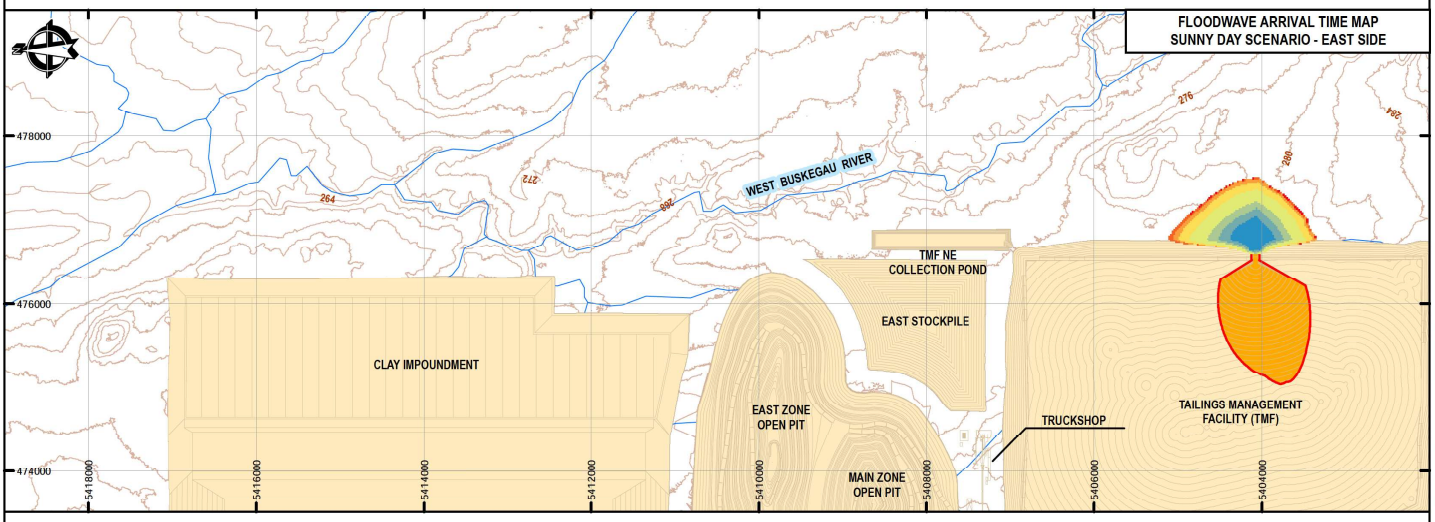
TITLE:

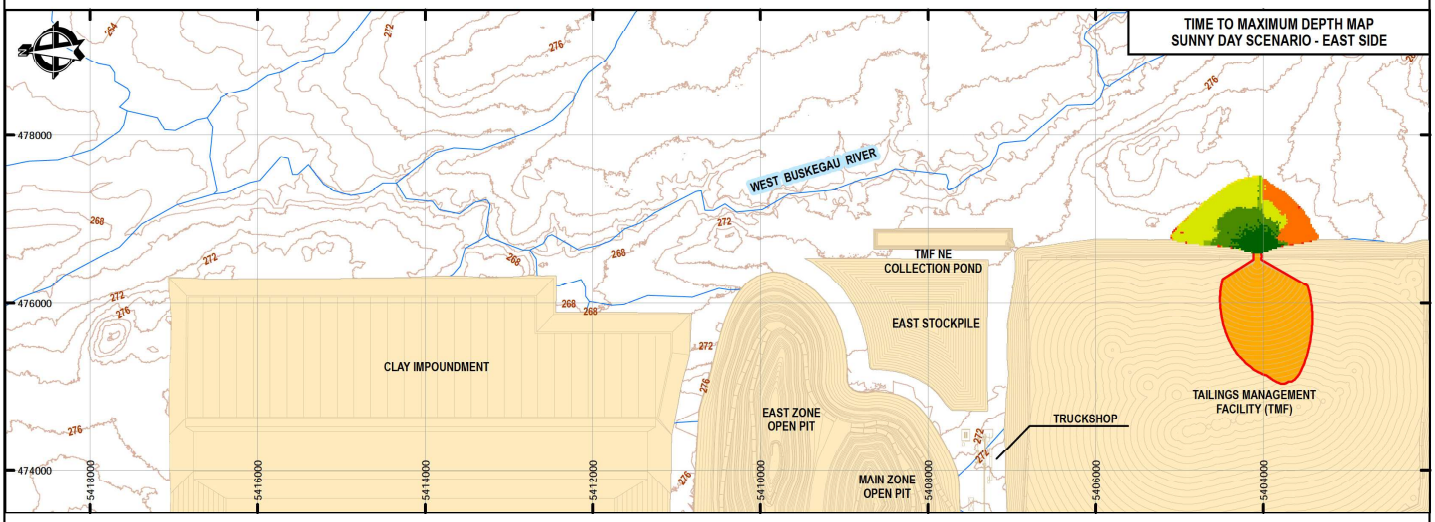
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - EAST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A03-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SIMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
38.40%	0.01 - 0.20	0.50 - 0.80
38.40% - 38.42%	0.20 - 0.30	0.80 - 1.00
	0.30 - 0.40	1.00 - 1.20
	0.40 - 0.60	1.20 - 1.60
	0.60 - 0.80	1.60 - 2.00
	0.80 - 1.00	2.00 - 3.00
	1.00 - 1.50	3.00 - 4.50
	1.50 - 4.36	4.50 - 24.00

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

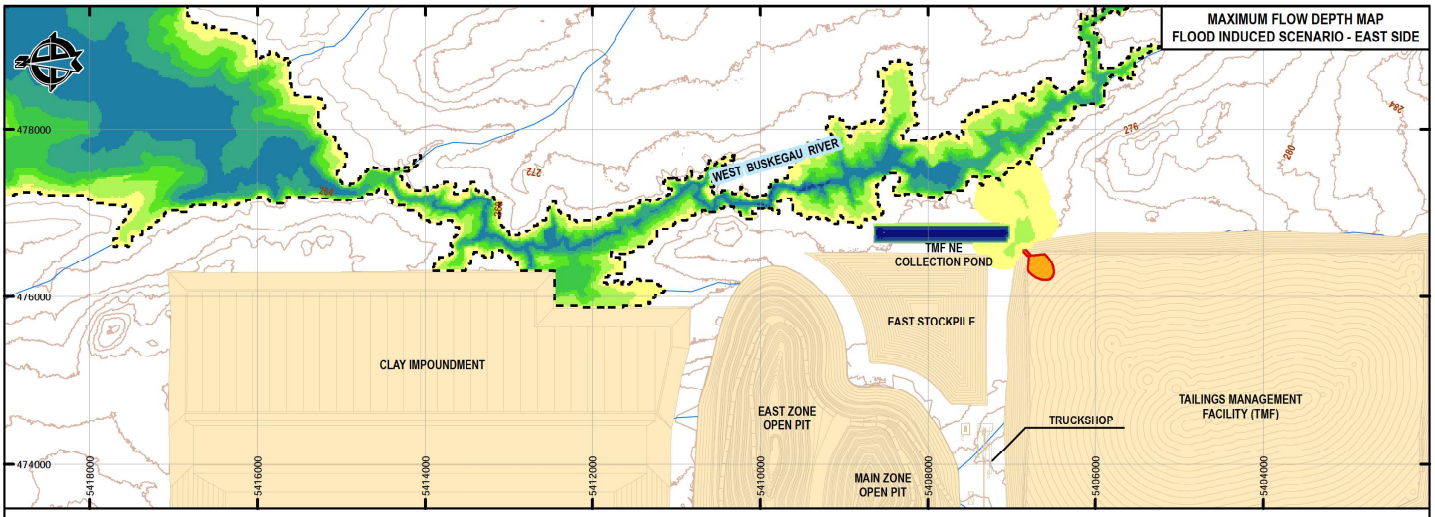
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

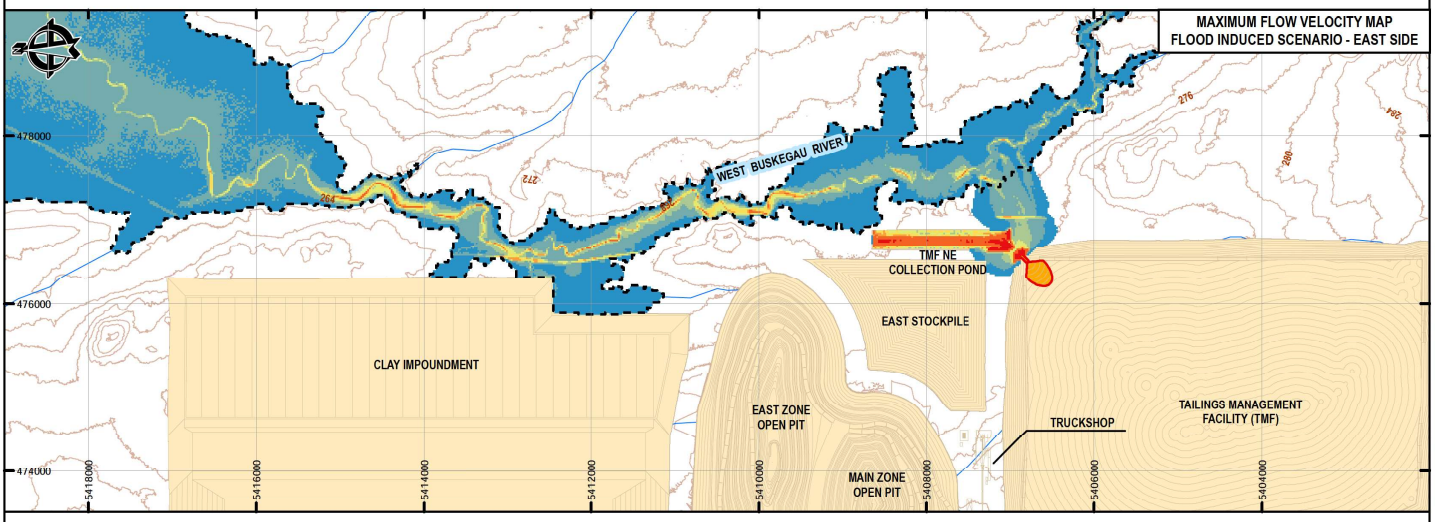
TITLE:

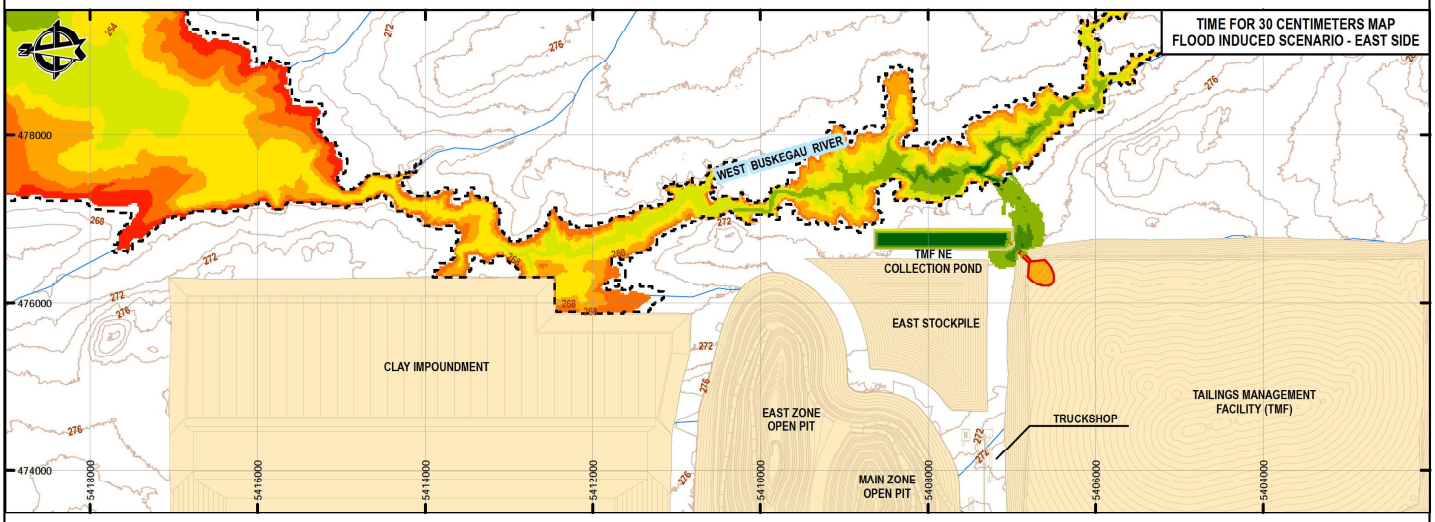
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - EAST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A03-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SIMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 0.50	0.01 - 0.15	0.00 - 8.00
0.50 - 1.00	0.15 - 0.30	8.00 - 12.00
1.00 - 1.50	0.30 - 0.45	12.00 - 16.00
1.50 - 2.00	0.45 - 0.60	16.00 - 20.00
2.00 - 3.00	0.60 - 0.75	20.00 - 24.00
3.00 - 4.00	0.75 - 1.00	24.00 - 28.00
4.00 - 6.50	1.00 - 3.00	28.00 - 40.00
6.50 - 8.67	3.00 - 5.62	40.00 - 59.98

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

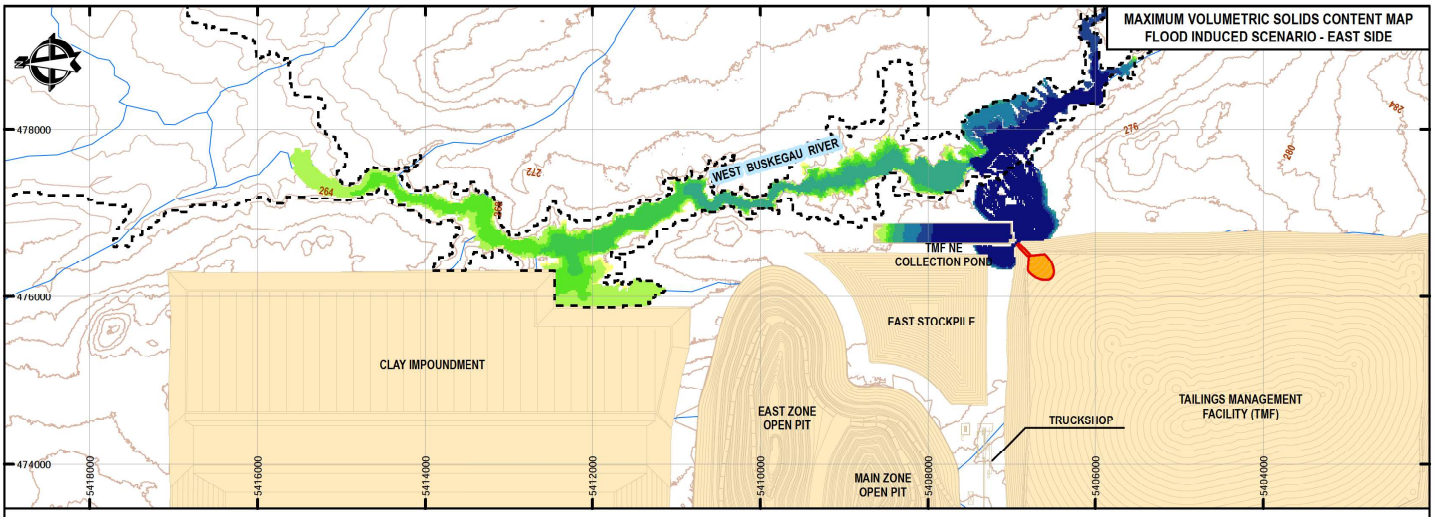
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

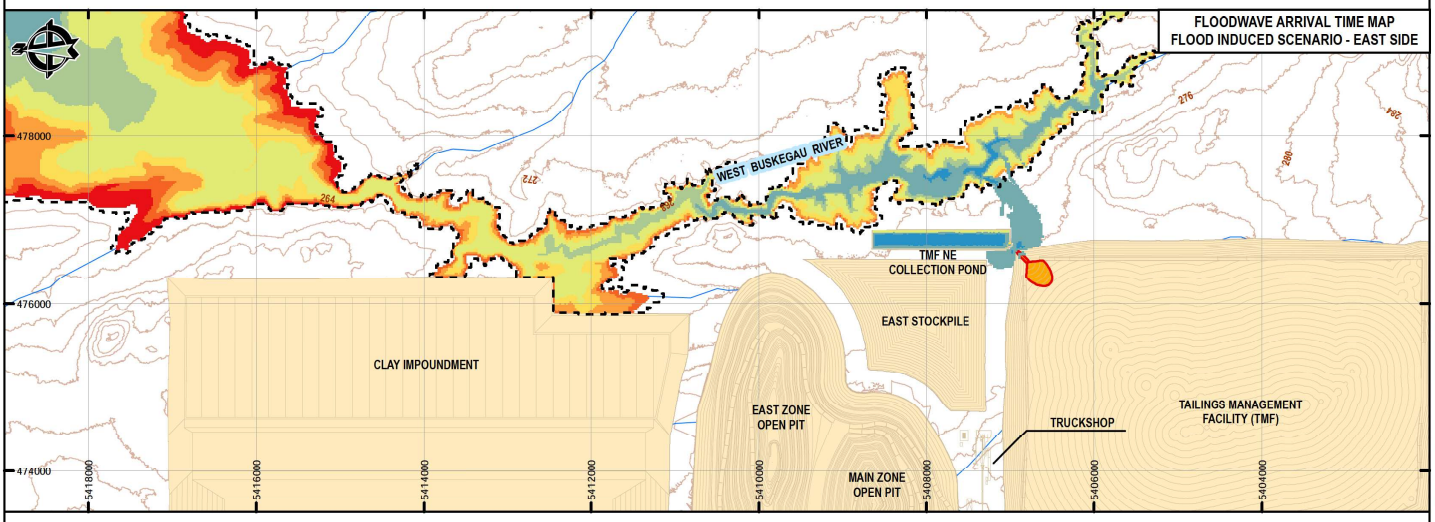
TITLE:

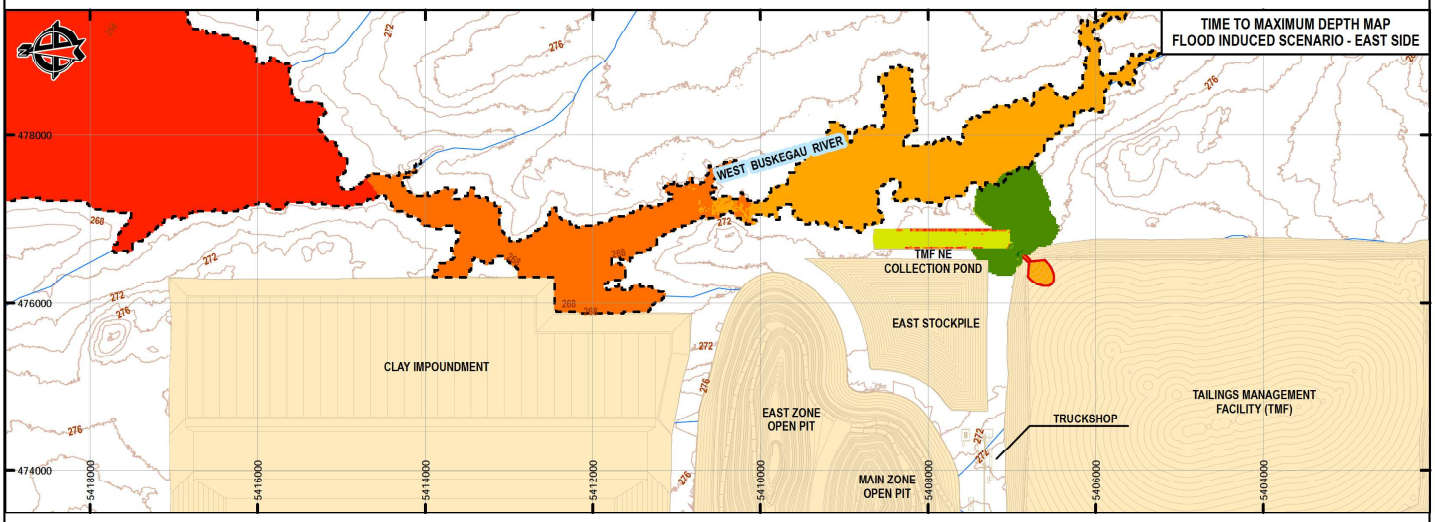
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - EAST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A04-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SIMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
0.0% - 0.1%	6.30 - 10.00	8.85 - 10.00
0.1% - 0.3%	10.00 - 16.60	10.00 - 15.00
0.3% - 0.4%	16.60 - 19.25	15.00 - 20.00
0.4% - 0.5%	19.25 - 23.90	20.00 - 25.00
0.5% - 0.8%	23.90 - 26.90	25.00 - 30.00
0.8% - 1.4%	26.90 - 30.80	30.00 - 35.00
1.4% - 1.8%	30.80 - 38.50	35.00 - 50.00
1.8% - 2.1%	38.50 - 60.00	50.00 - 60.00

LEGEND

- IDF FOOTPRINT
- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

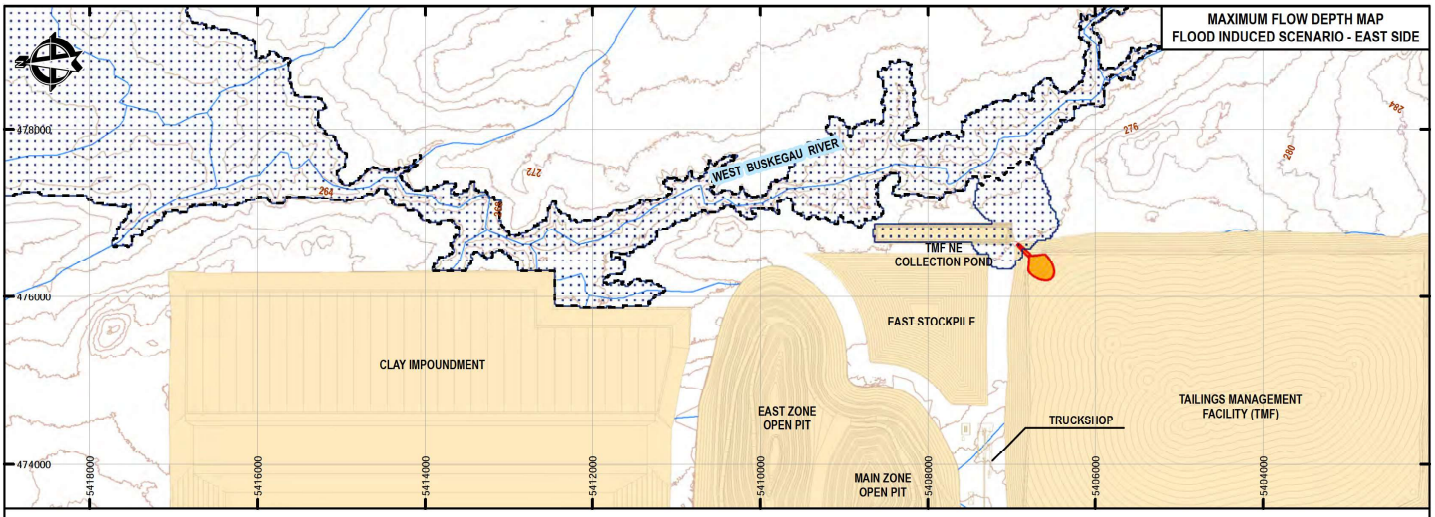
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

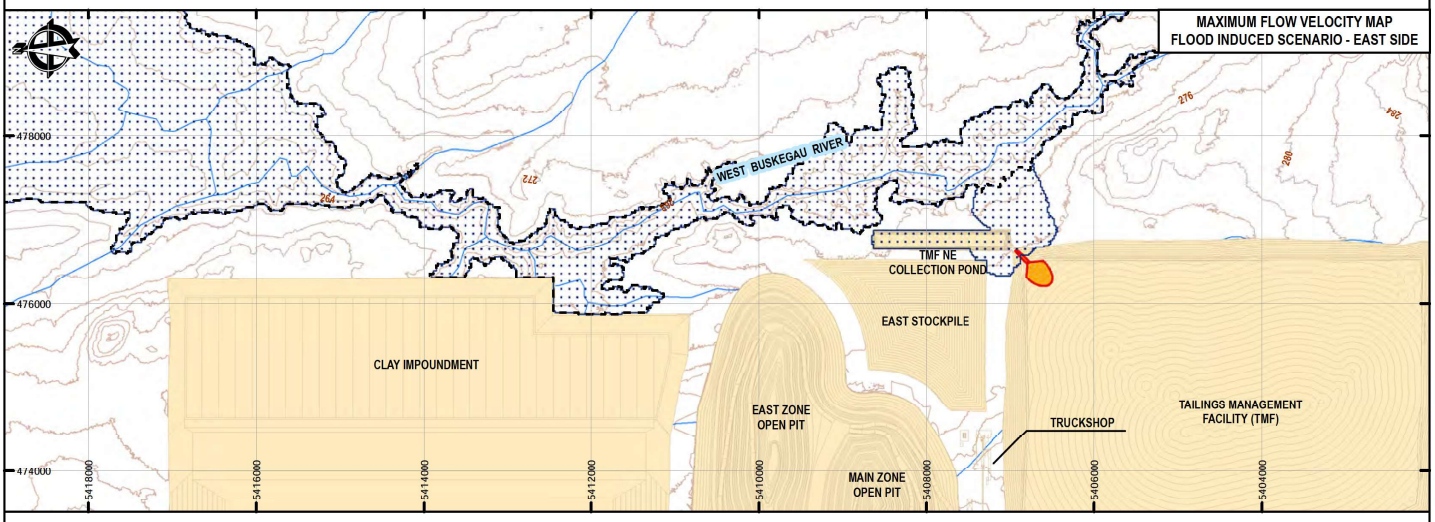
TITLE:

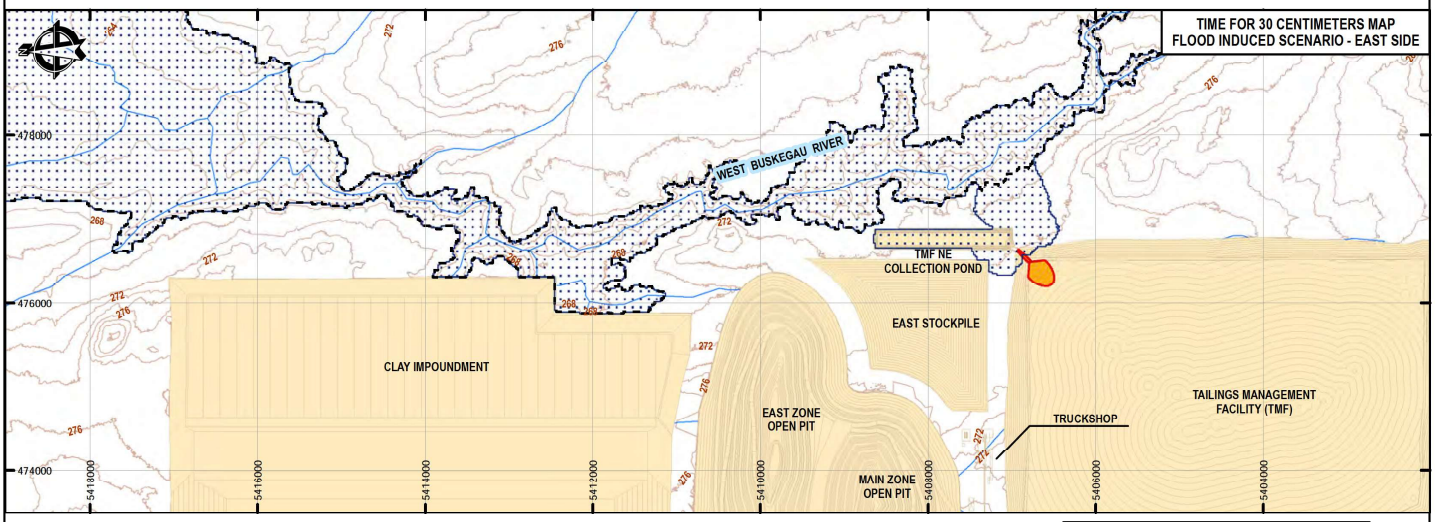
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - EAST SIDE

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A04-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

0 0.5 1 2 3 Kilometers

Scale: 1:60 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- DAM BREACH FLOOD FOORPRINT
- IDF FOOTPRINT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP
4. FOR THIS SCENARIO, THE ENTIRE DAM BREACH FLOOD FOOTPRINT HAS A MAXIMUM VOLUMETRIC SOLIDS CONTENT LESS THAN 20%, FOR THIS REASON, THE SIMBOLOGY OF MAXIMUM FLOW DEPTHS, MAXIMUM VELOCITIES, TIME FOR ONE FOOT, MAXIMUM VOLUMETRIC SOLIDS CONTENT, FLOODWAVE ARRIVALTIME AND TIME TO MAXIMUM DEPTH ARE NOT PRESENTED.

PROJECT:

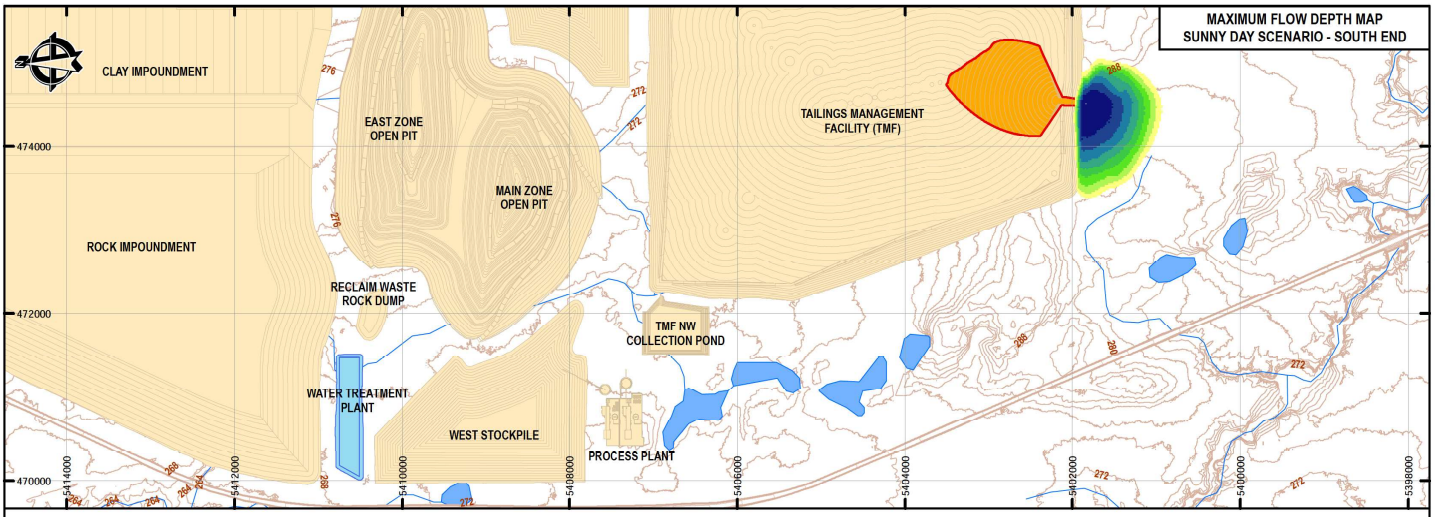
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

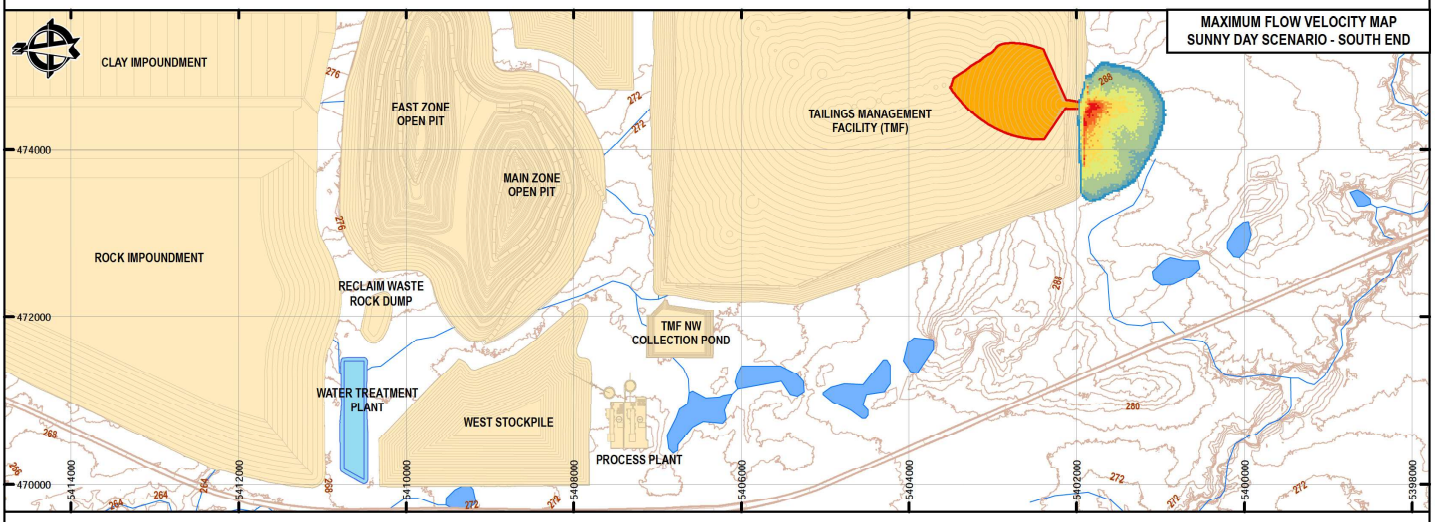
TITLE:

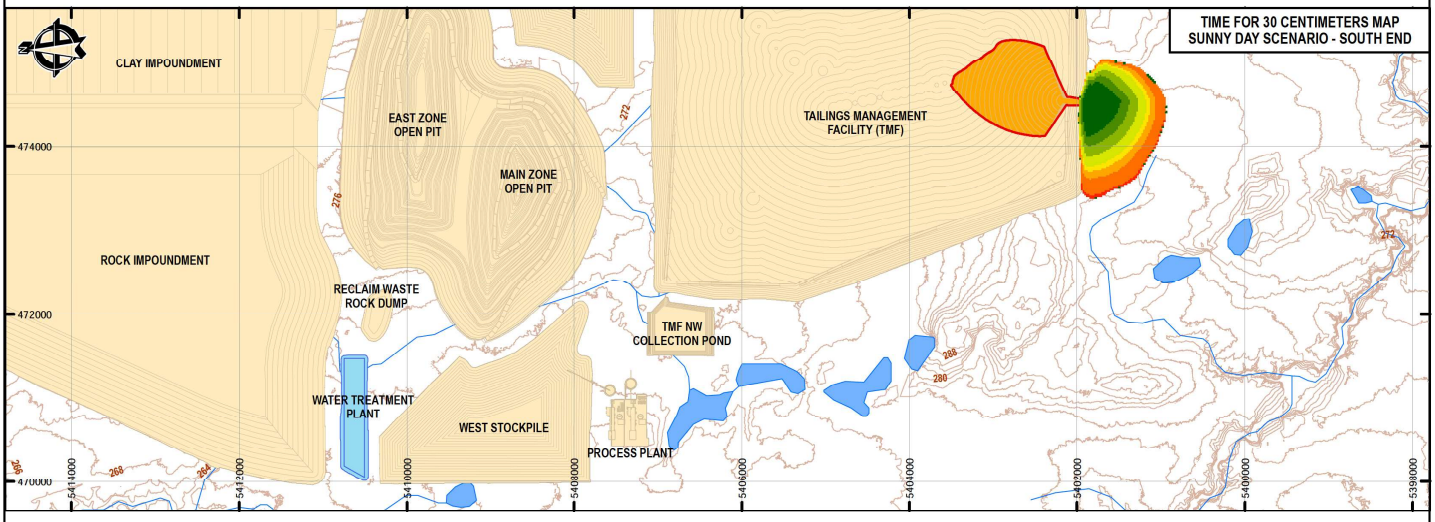
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - EAST SIDE

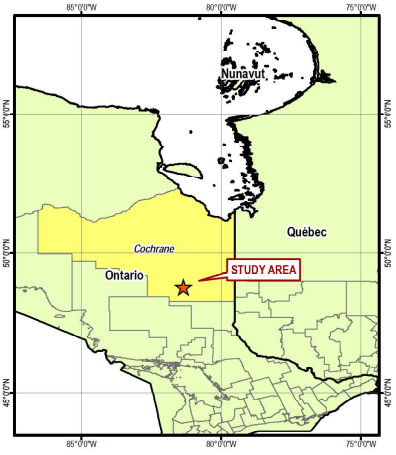
Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	1049455	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A04-3
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED









SCALE:1:60,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 3.00	0.00 - 0.50	0.00 - 0.25
3.00 - 4.35	0.50 - 1.00	0.25 - 0.35
4.35 - 5.35	1.00 - 1.50	0.35 - 0.45
5.35 - 6.35	1.50 - 2.00	0.45 - 0.55
6.35 - 7.25	2.00 - 2.50	0.55 - 0.60
7.25 - 8.35	2.50 - 3.00	0.60 - 0.70
8.35 - 9.90	3.00 - 4.00	0.70 - 1.00
9.90 - 15.30	4.00 - 5.20	1.00 - 13.30

1 0.5 0 1 2 Kilometers

Scale: 1:60 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

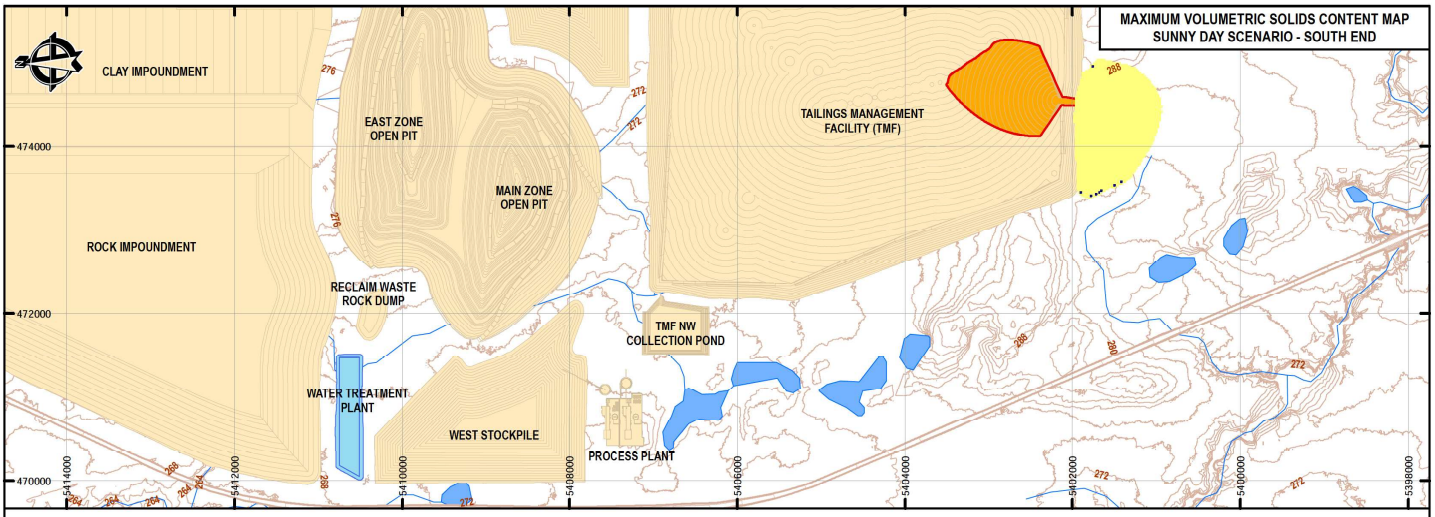
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

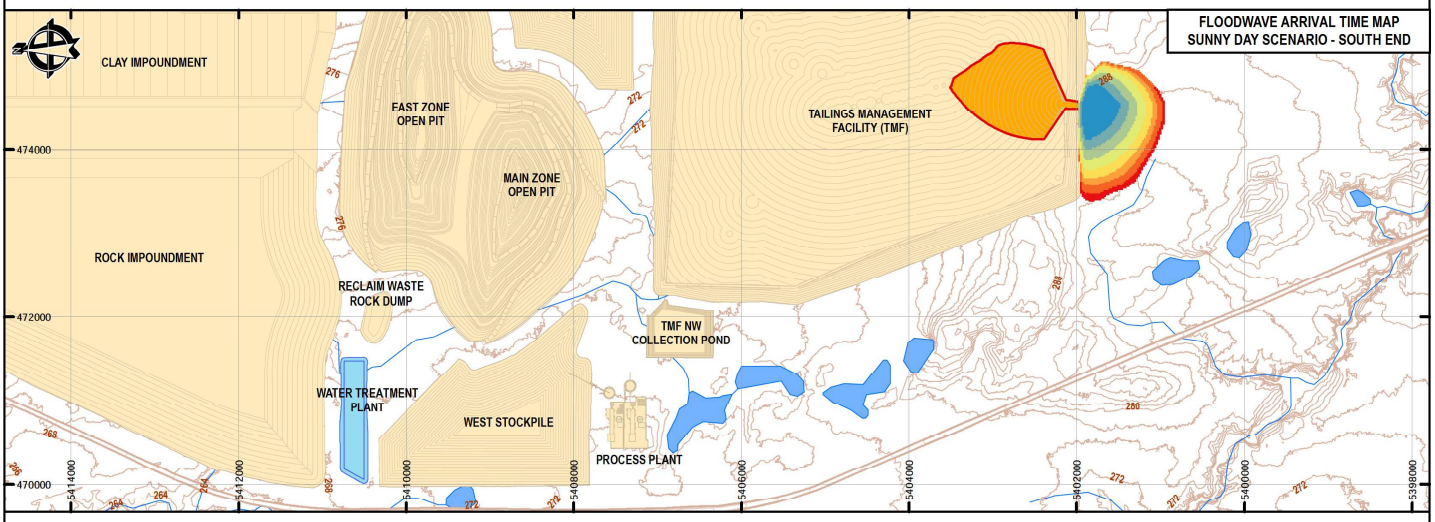
TITLE:

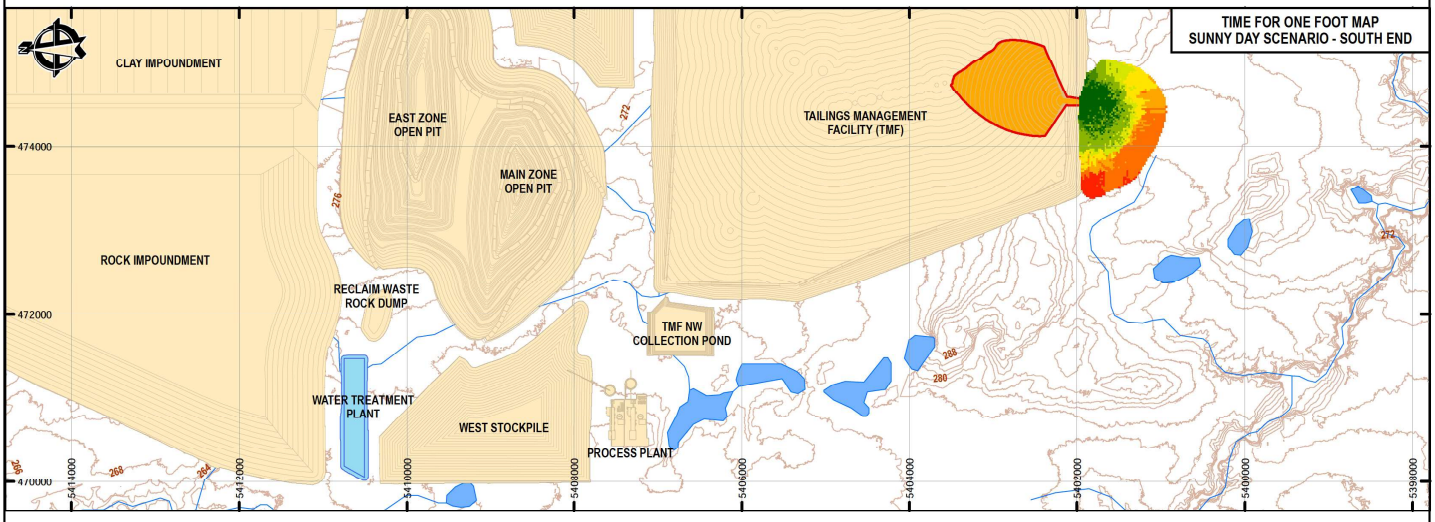
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - SOUTH END

Ausenco | Canada Nickel Company

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A05-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:60,000

SYMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
38.00%	0.00 - 0.25	0.00 - 0.70
38.00% - 38.02%	0.25 - 0.35	0.70 - 0.75
	0.35 - 0.45	0.75 - 0.85
	0.45 - 0.55	0.85 - 0.90
	0.55 - 0.65	0.90 - 0.95
	0.65 - 0.75	0.95 - 1.00
	0.75 - 0.90	1.00 - 1.10
	0.90 - 13.30	1.10 - 24.00

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

1 0.5 0 1 2 Kilometers

Scale: 1:60 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

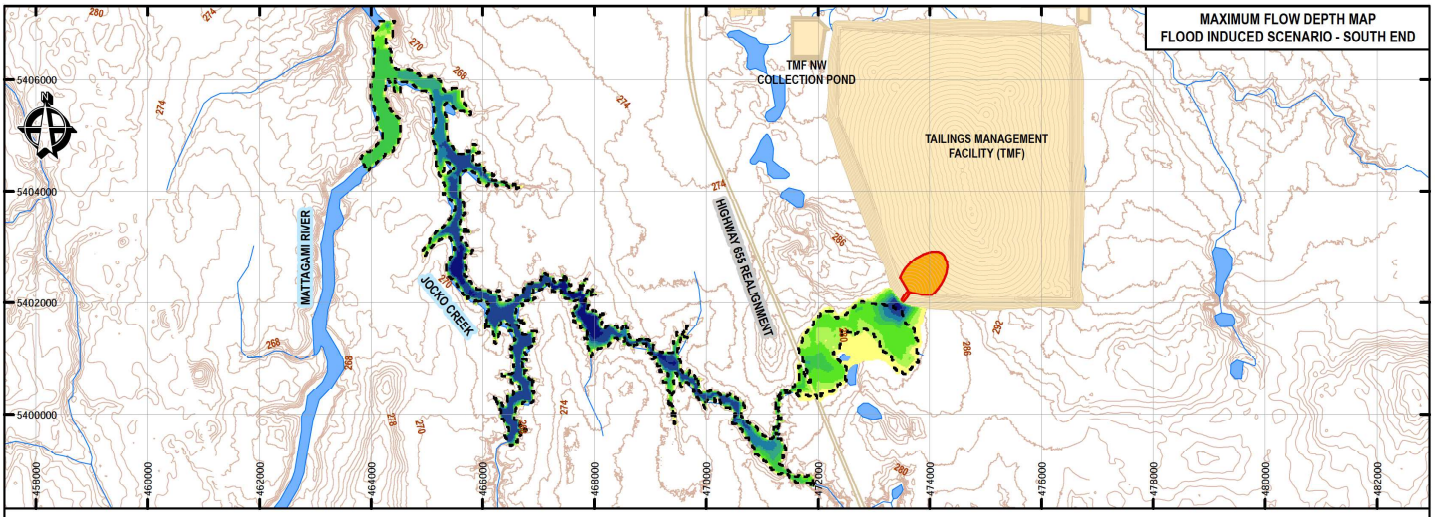
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

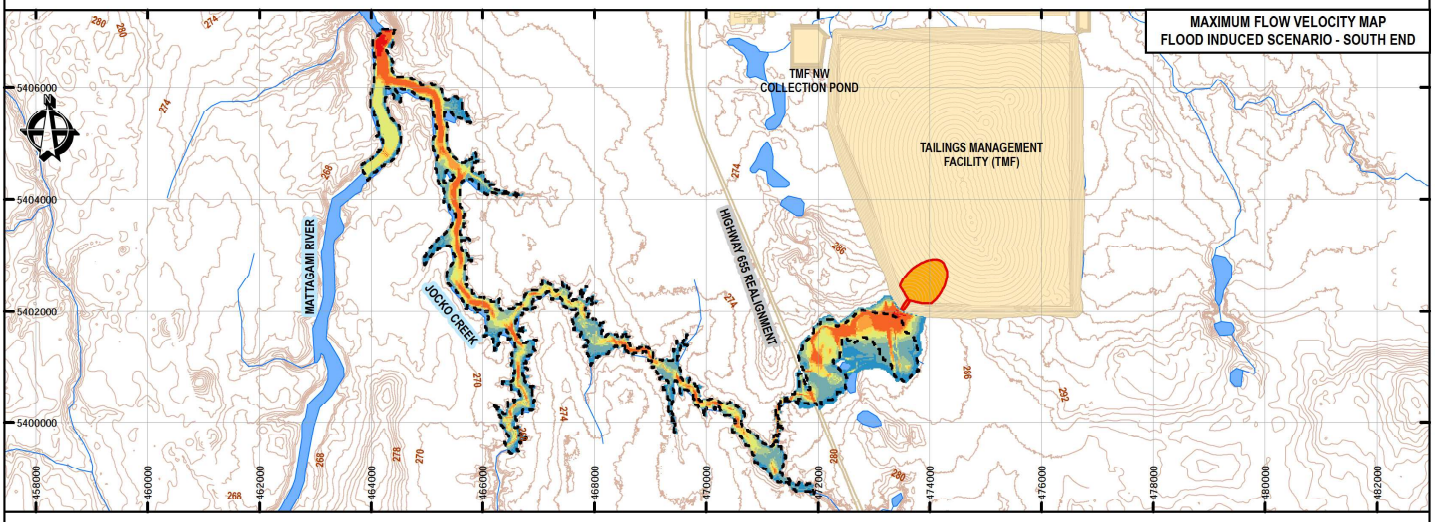
TITLE:

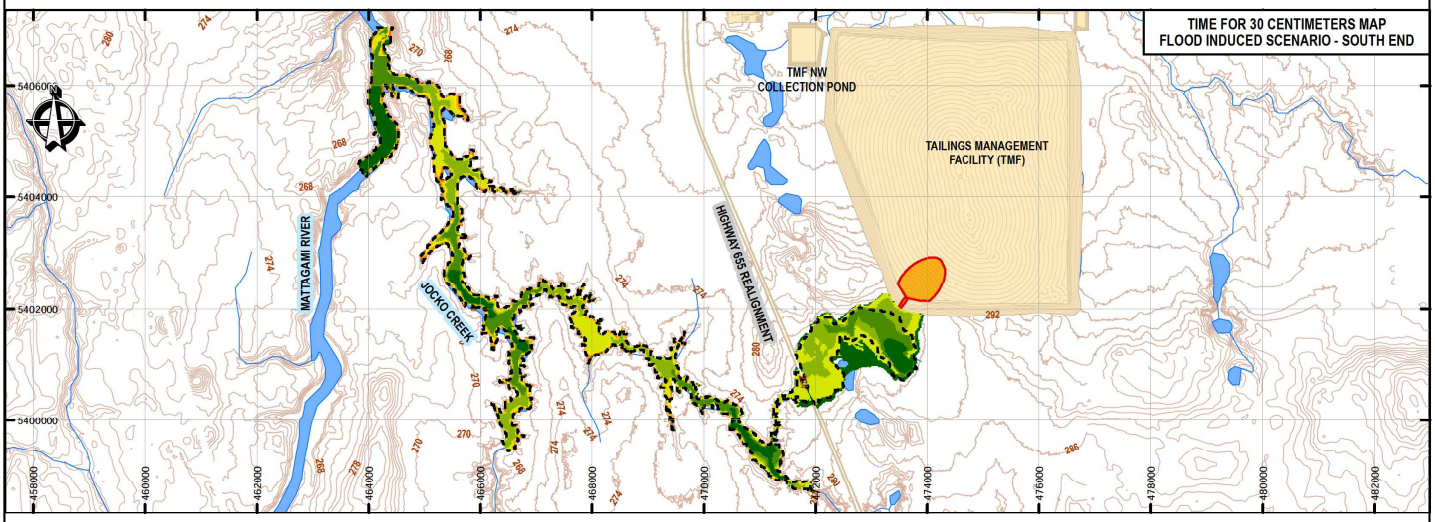
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - SOUTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	0
ISSUE DATE:	SEP 06, 2024	MAP N°:	A05-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:90,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 0.50	0.00 - 0.15	0.00 - 1.00
0.50 - 1.00	0.15 - 0.30	1.00 - 2.00
1.00 - 2.00	0.30 - 0.45	2.00 - 3.00
2.00 - 3.00	0.45 - 0.60	3.00 - 4.50
3.00 - 4.00	0.60 - 0.75	4.50 - 6.00
4.00 - 5.00	0.75 - 1.00	6.00 - 8.00
5.00 - 6.50	1.00 - 3.00	8.00 - 10.00
6.50 - 7.95	3.00 - 7.95	10.00 - 11.75

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- IDF FOOTPRINT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.75 1.5 3 4.5 Kilometers

Scale: 1:90 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

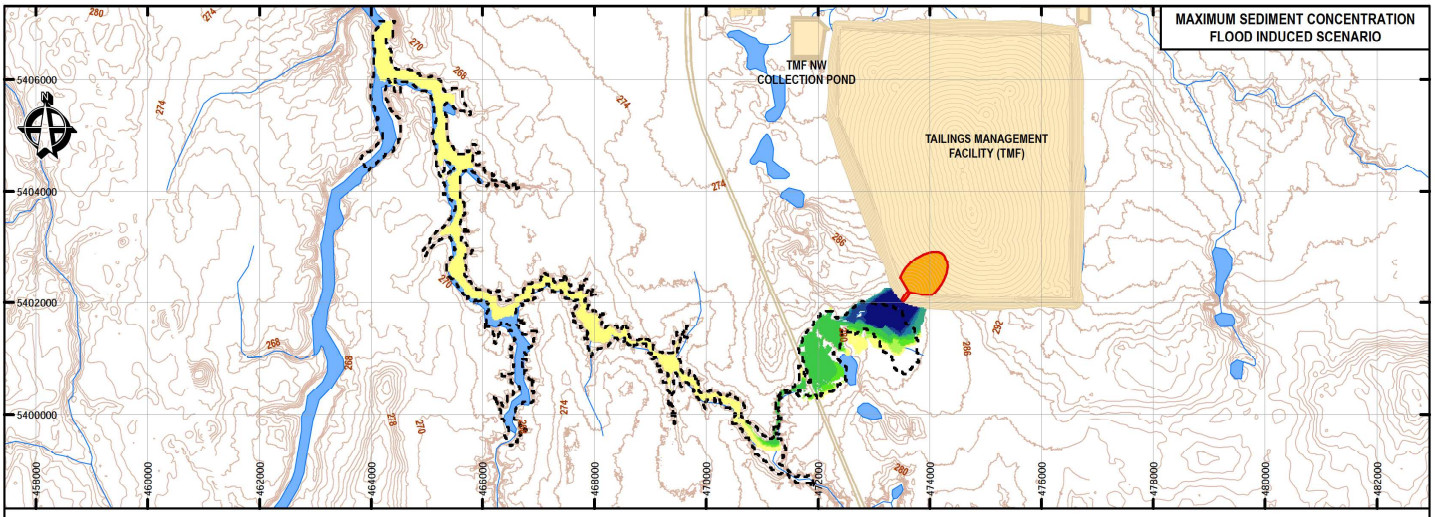
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

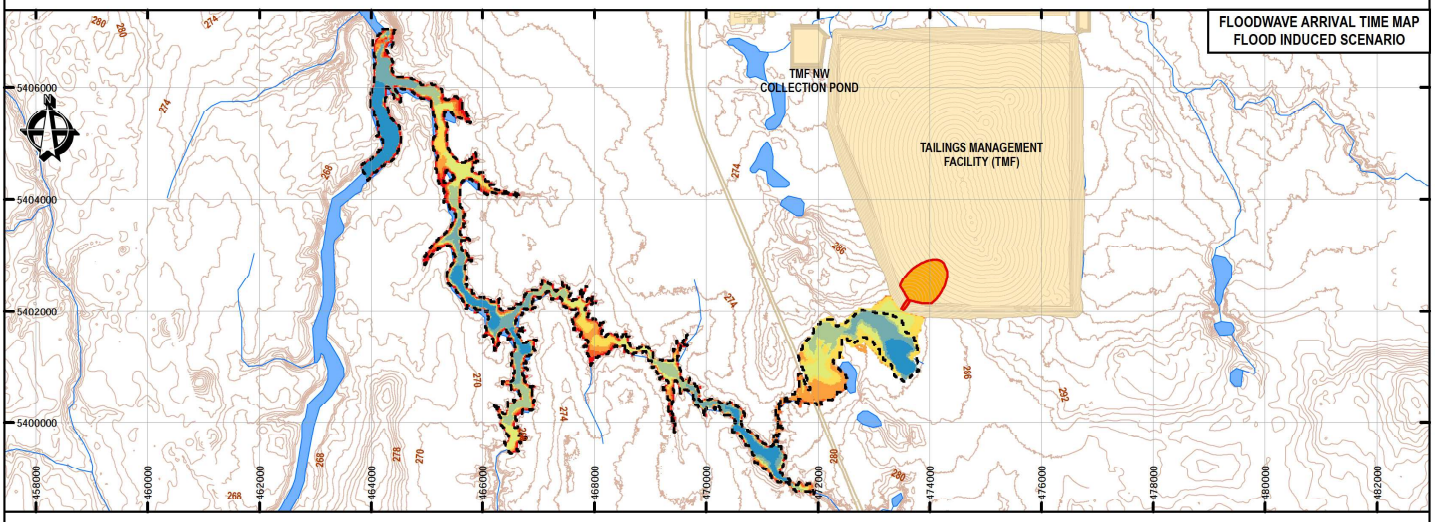
TITLE:

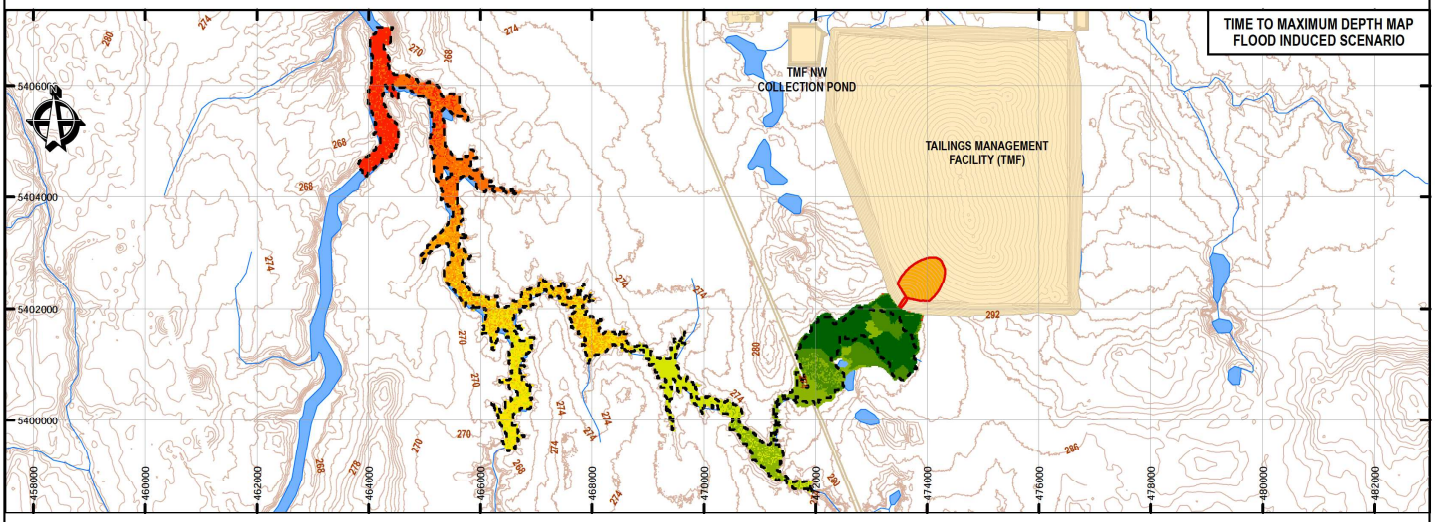
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - SOUTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A06-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE:1:90,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
0.001 - 0.050	0.00 - 1.10	2.00 - 3.40
0.050 - 0.075	1.100 - 1.80	3.40 - 4.50
0.075 - 0.115	1.80 - 2.45	4.50 - 8.30
0.115 - 0.190	2.45 - 3.00	8.30 - 10.45
0.190 - 0.225	3.00 - 3.30	10.45 - 10.70
0.225 - 0.265	3.30 - 4.10	10.70 - 11.10
0.265 - 0.300	4.10 - 5.80	11.10 - 11.70
0.300 - 0.400	5.80 - 11.75	11.70 - 48.00

1.5 0.75 0 1.5 3 Kilometers

Scale: 1:90 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- PMF FOOTPRINT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

PROJECT:

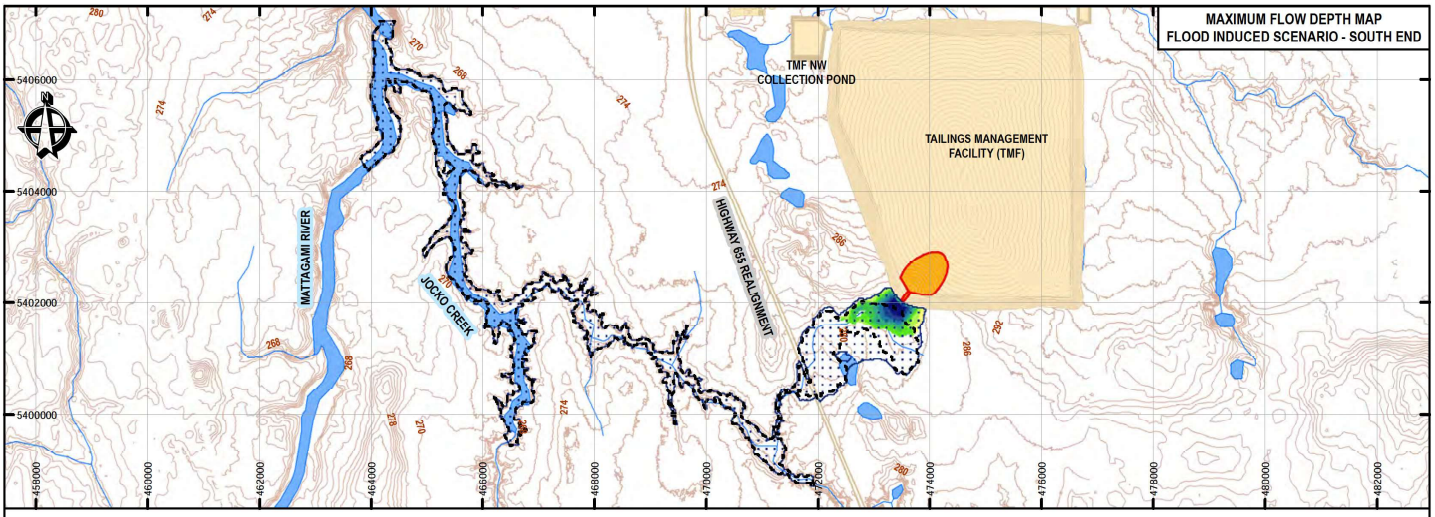
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

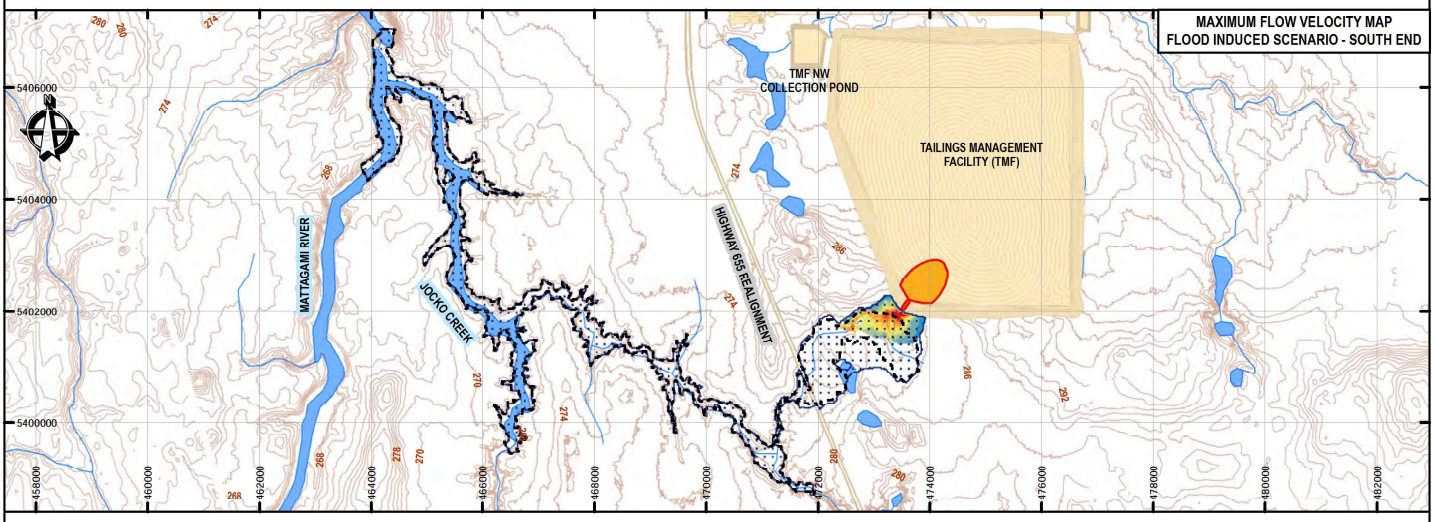
TITLE:

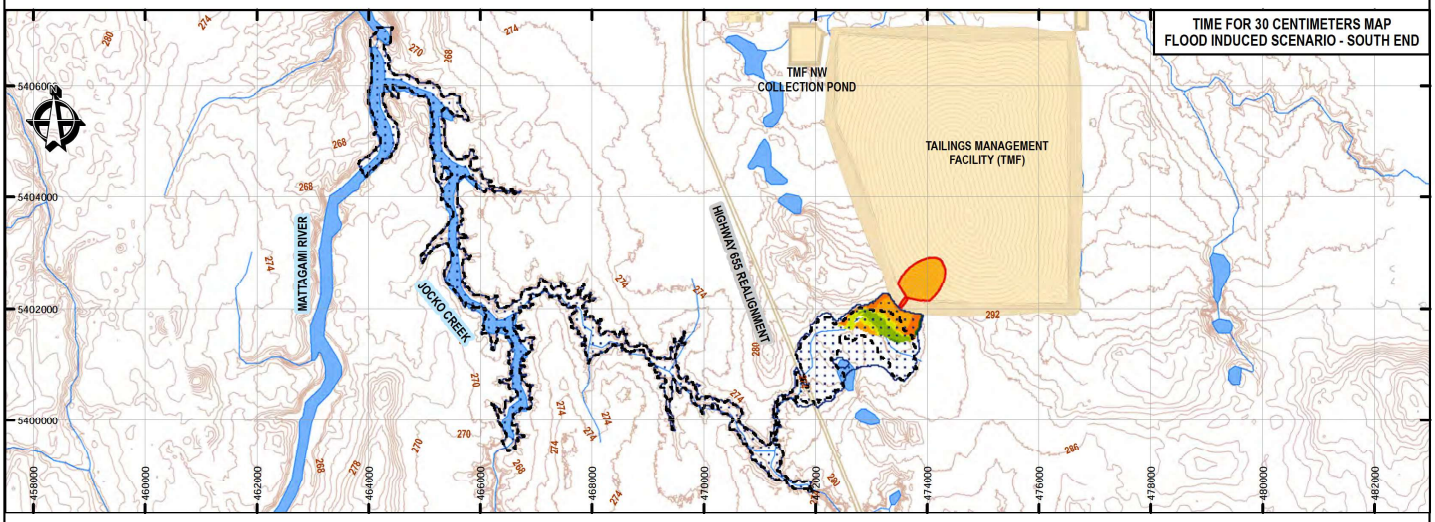
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A06-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE:1:90,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.01 - 0.50	0.00 - 0.25	0.00 - 0.50
0.50 - 1.00	0.25 - 0.50	0.50 - 1.00
1.00 - 1.50	0.50 - 0.75	1.00 - 1.50
1.50 - 2.00	0.75 - 1.00	1.50 - 2.00
2.00 - 3.00	1.00 - 1.50	2.00 - 2.50
3.00 - 4.00	1.50 - 2.00	2.50 - 3.00
4.00 - 5.00	2.00 - 2.50	3.00 - 3.50
5.00 - 7.95	2.50 - 3.88	3.50 - 5.00

0 0.75 1.5 3 4.5 Kilometers

Scale: 1:90 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- DAM BREACH FLOOD FOOTPRINT
- IDF FOOTPRINT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP
4. FOR THIS SCENARIO, THE SIMBOLOGY SHOWN CORRESPONDS TO THE DAM BREACH FLOOD FOOTPRINT WHOSE MAXIMUM VOLUMETRIC SOLIDS CONTENT IS GREATER OR EQUAL TO 20%.

PROJECT:

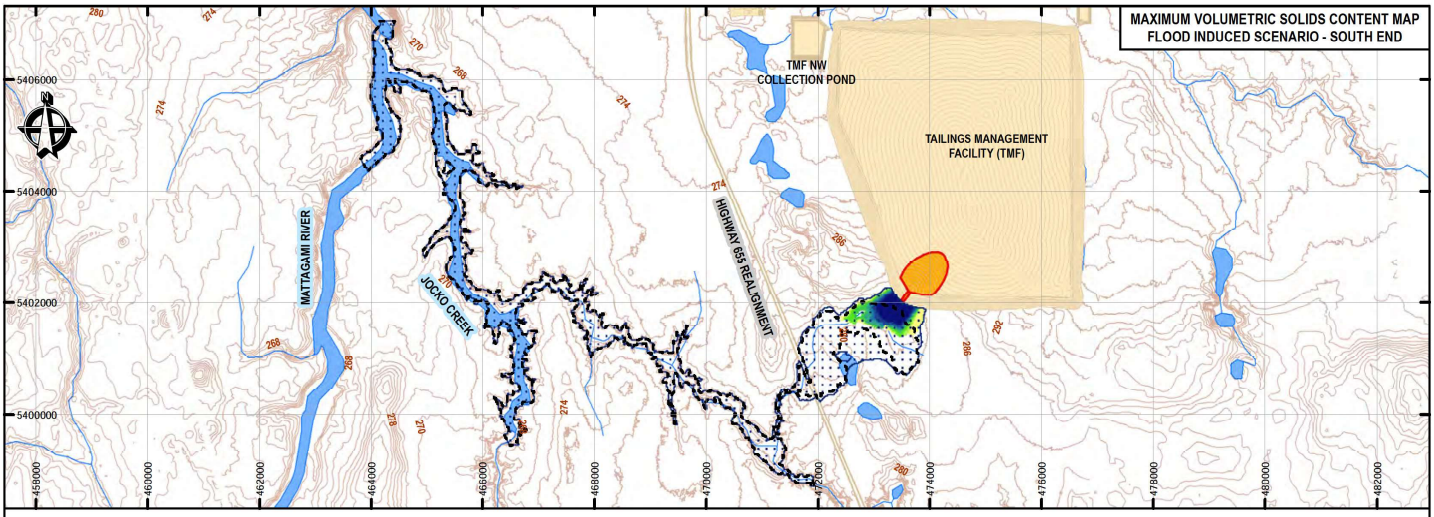
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

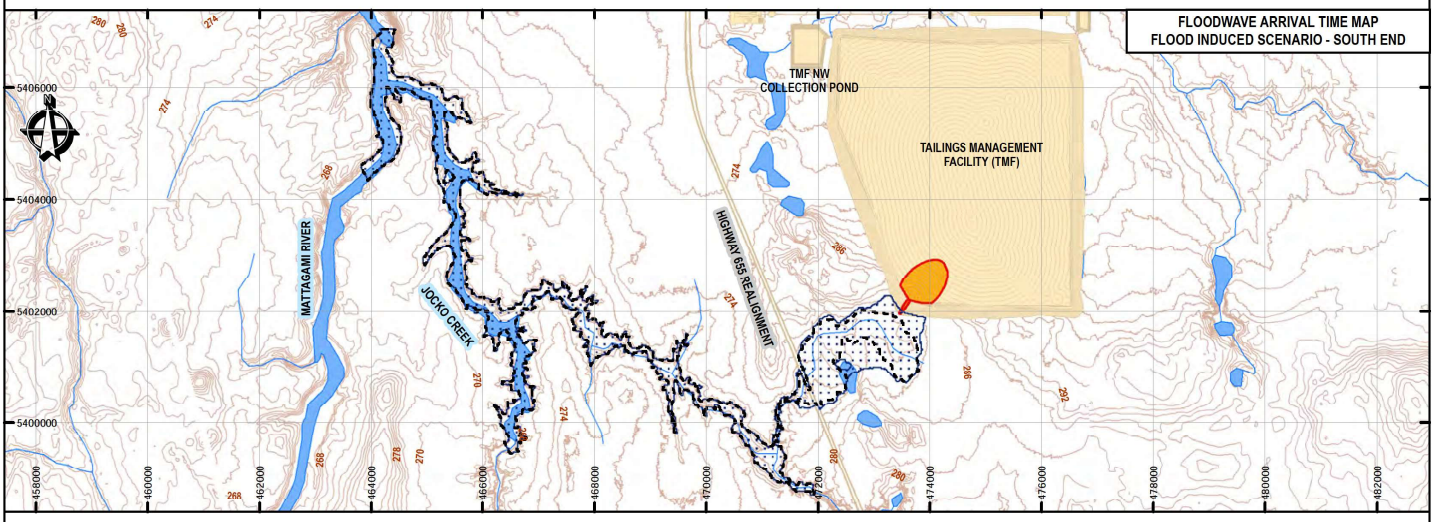
TITLE:

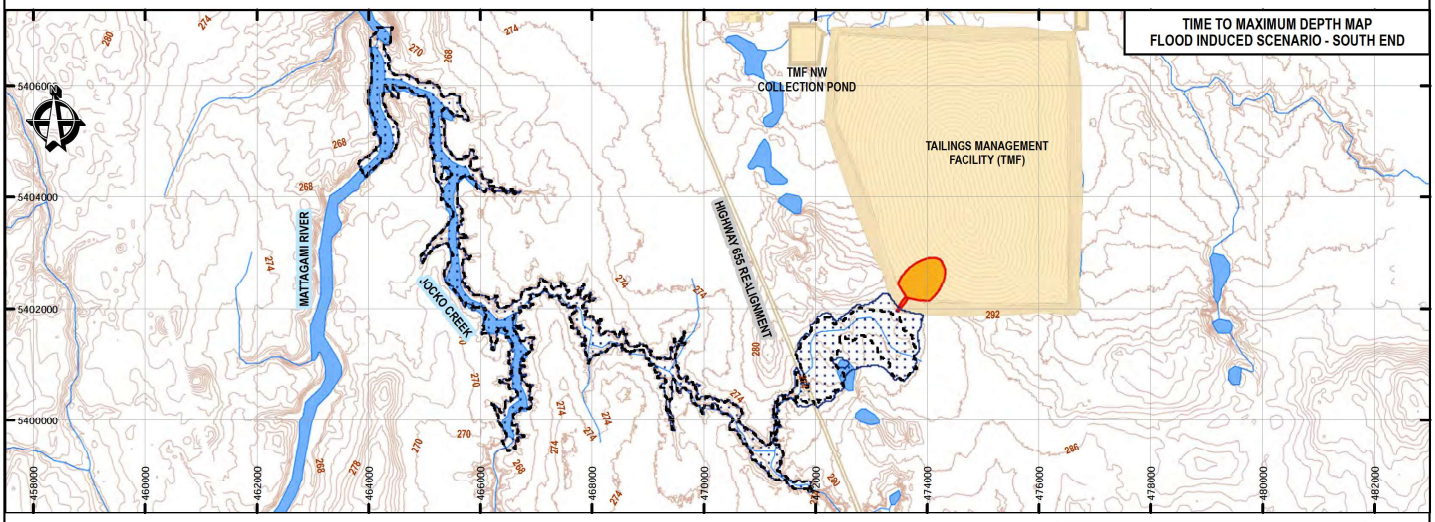
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - SOUTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A06-3
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE:1:90,000

SYMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
20% - 24%	0.95 - 1.20	3.06 - 3.10
24% - 26%	1.20 - 1.40	3.10 - 3.20
26% - 28%	1.40 - 1.60	3.20 - 3.30
28% - 30%	1.60 - 2.00	3.30 - 3.40
30% - 32%	2.00 - 2.50	3.40 - 3.60
32% - 34%	2.50 - 3.00	3.60 - 4.00
34% - 36%	3.00 - 3.50	4.00 - 5.00
36% - 38%	3.50 - 5.00	5.00 - 13.77

0 0.75 1.5 3 4.5 Kilometers

Scale: 1:90 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- DAM BREACH FLOOD FOOTPRINT
- IDF FOOTPRINT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP
4. FOR THIS SCENARIO, THE SIMBOLOGY SHOWN CORRESPONDS TO THE DAM BREACH FLOOD FOOTPRINT WHOSE MAXIMUM VOLUMETRIC SOLIDS CONTENT IS GREATER OR EQUAL TO 20%.

PROJECT:

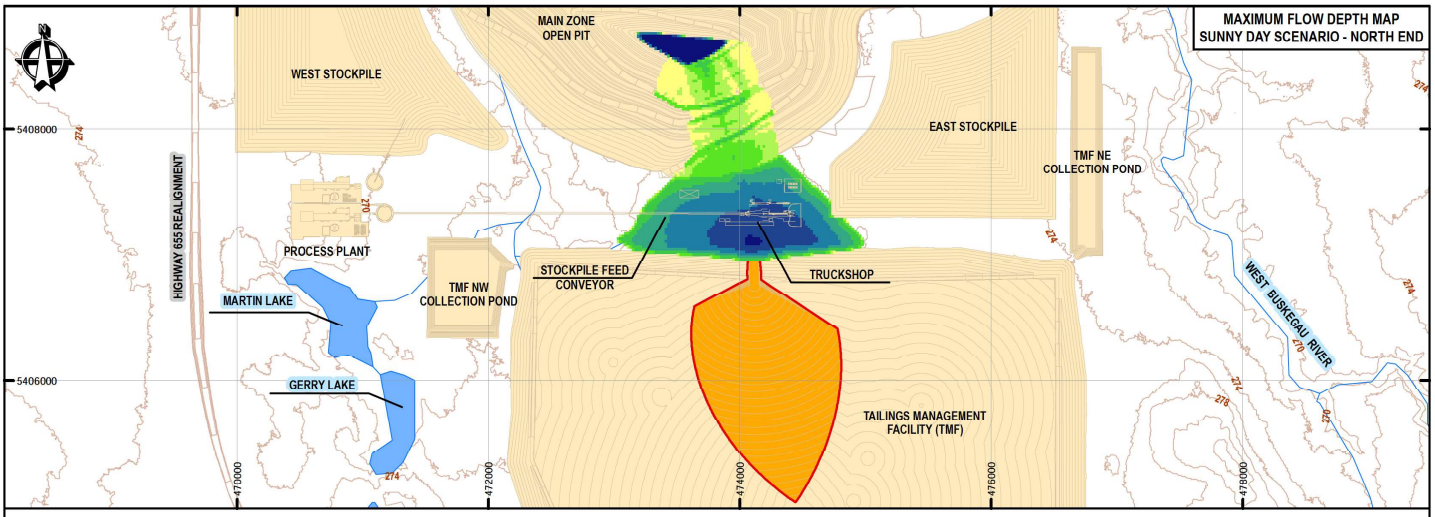
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

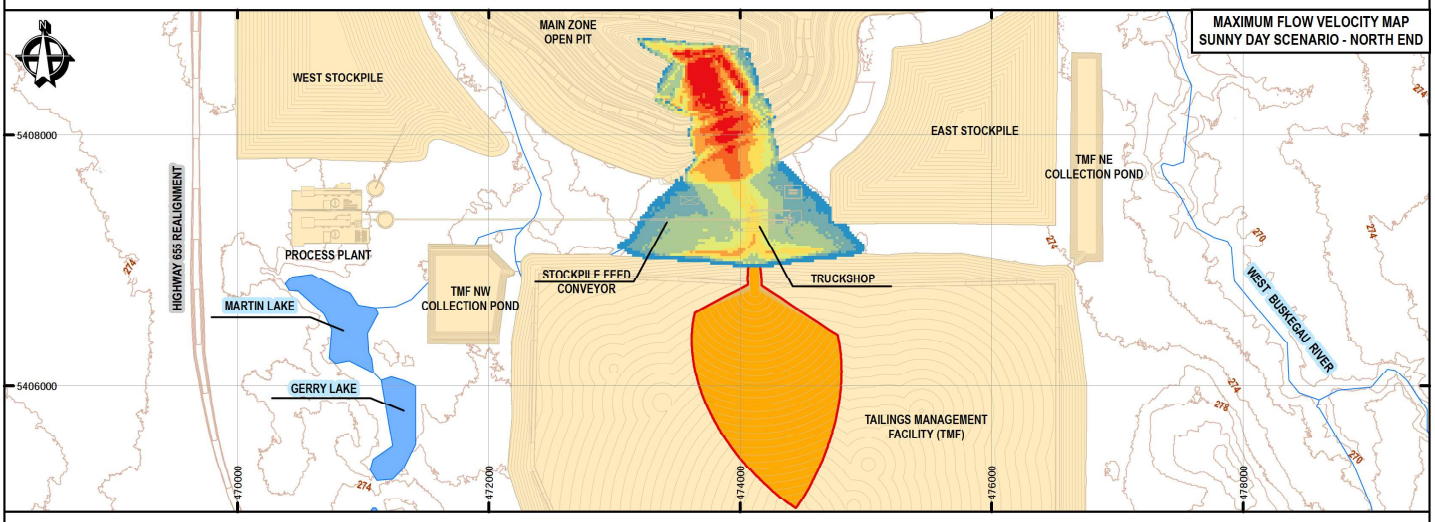
TITLE:

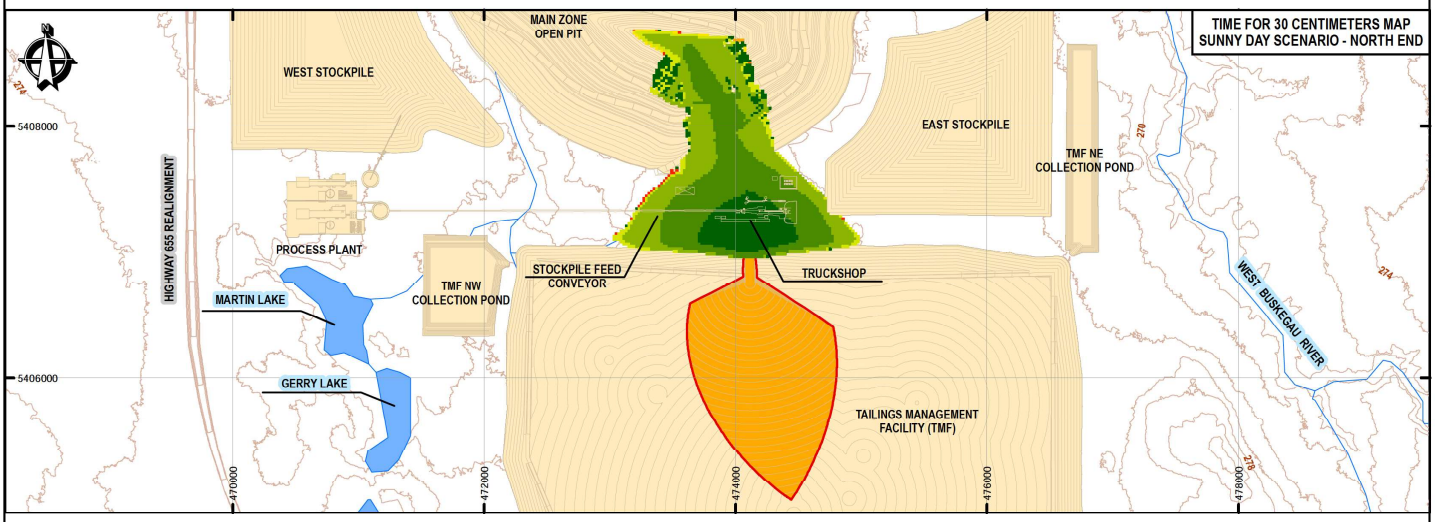
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - SOUTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A06-4
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:40,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 0.50	0.00 - 0.75	0.00 - 0.25
0.50 - 1.00	0.75 - 1.50	0.25 - 0.50
1.00 - 2.00	1.50 - 2.50	0.50 - 0.75
2.00 - 4.00	2.50 - 3.50	0.75 - 1.00
4.00 - 6.00	3.50 - 5.00	1.00 - 1.50
6.00 - 9.00	5.00 - 8.00	1.50 - 2.00
9.00 - 14.00	8.00 - 12.00	2.00 - 3.00
14.00 - 108.10	12.00 - 26.42	3.00 - 6.44

0 0.5 1 2 Kilometers

Scale: 1:40 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

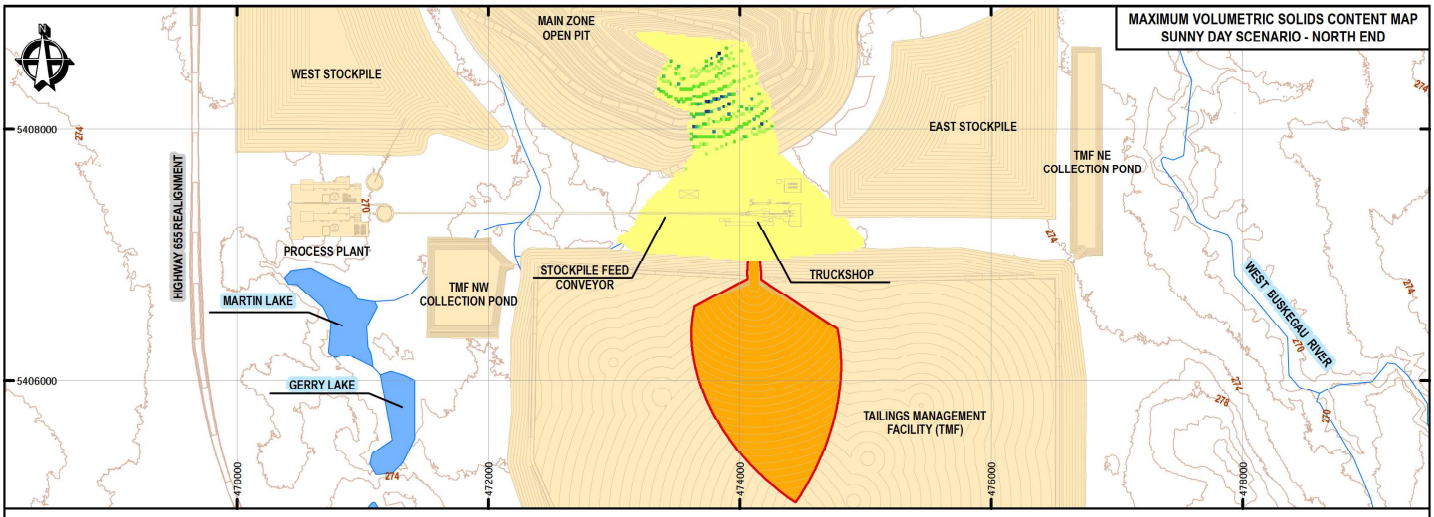
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

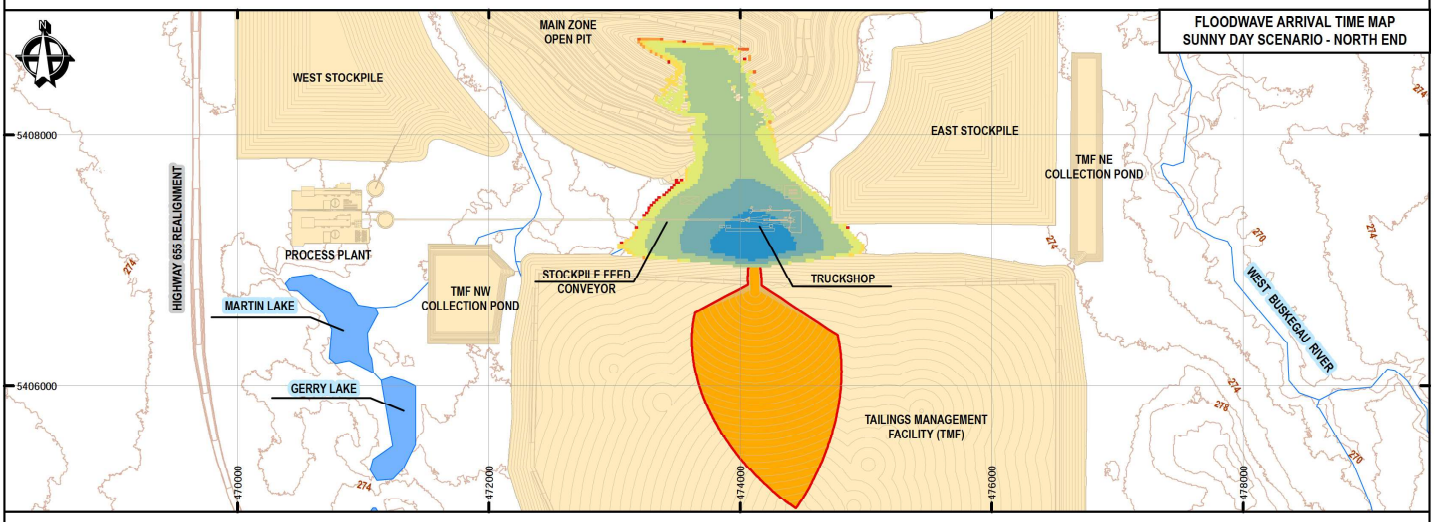
TITLE:

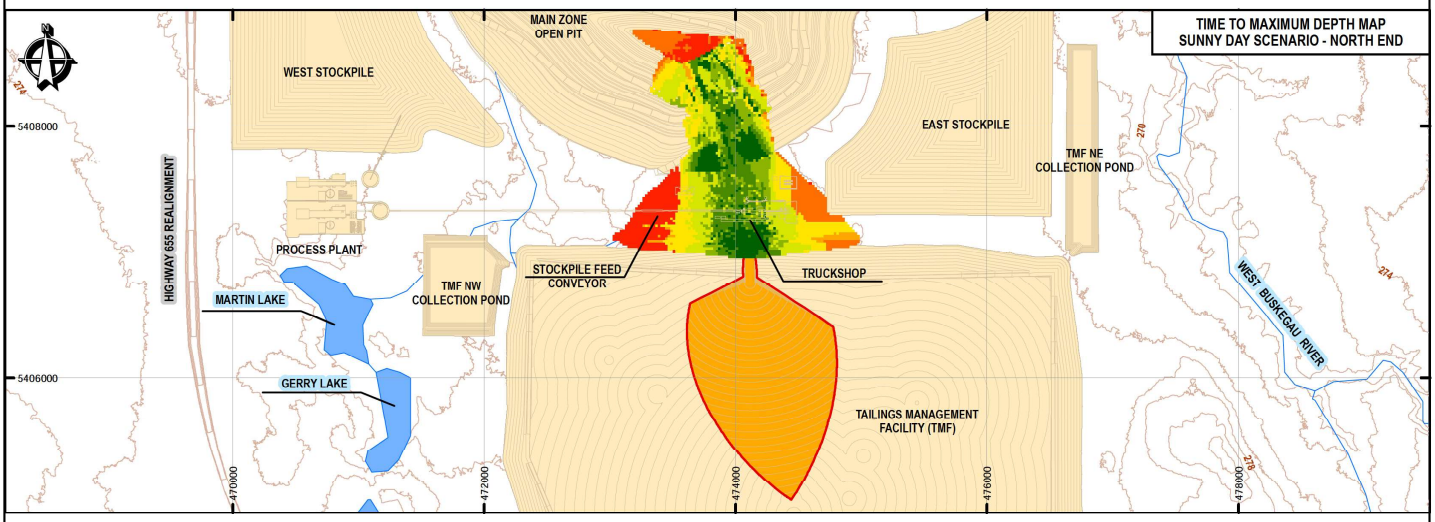
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - NORTH END

Ausenco | Canada Nickel Company

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A07-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:40,000

SYMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
38.0% - 38.2%	0.01 - 0.20	0.41 - 0.60
38.2% - 38.4%	0.20 - 0.40	0.60 - 0.65
38.4% - 38.6%	0.40 - 0.60	0.65 - 0.70
38.6% - 38.8%	0.60 - 0.80	0.70 - 0.80
38.8% - 39.0%	0.80 - 1.00	0.80 - 0.90
39.0% - 39.2%	1.00 - 1.50	0.90 - 1.00
39.2% - 39.6%	1.50 - 3.00	1.00 - 6.00
39.6% - 40.0%	3.00 - 6.44	6.00 - 24.00

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 Kilometers

Scale: 1:40 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

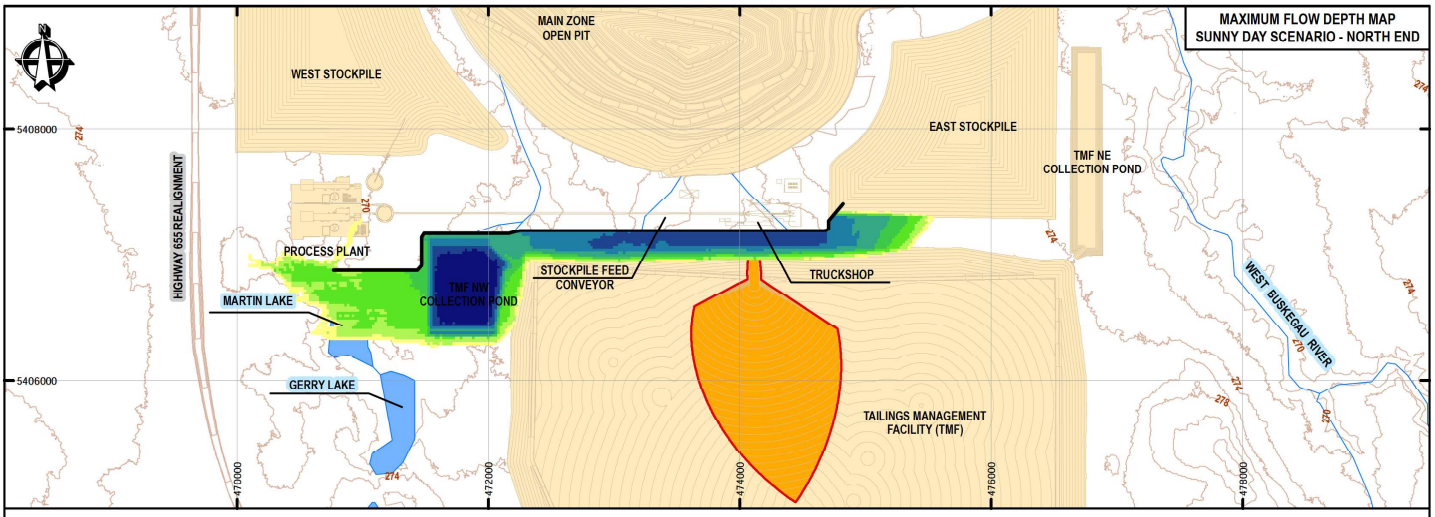
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

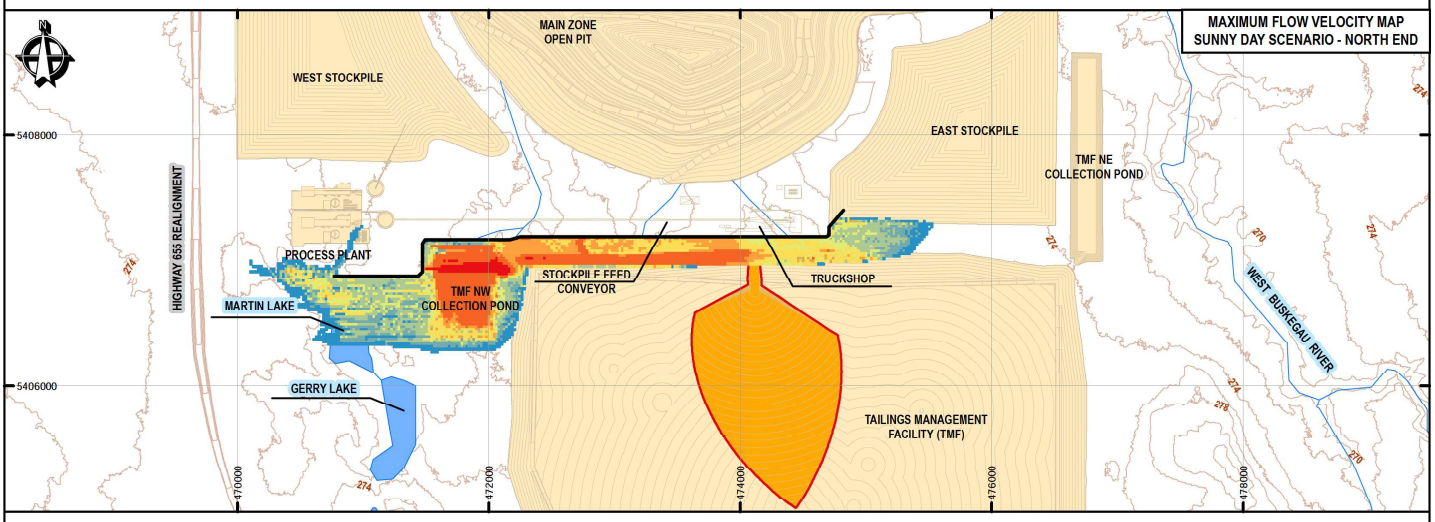
TITLE:

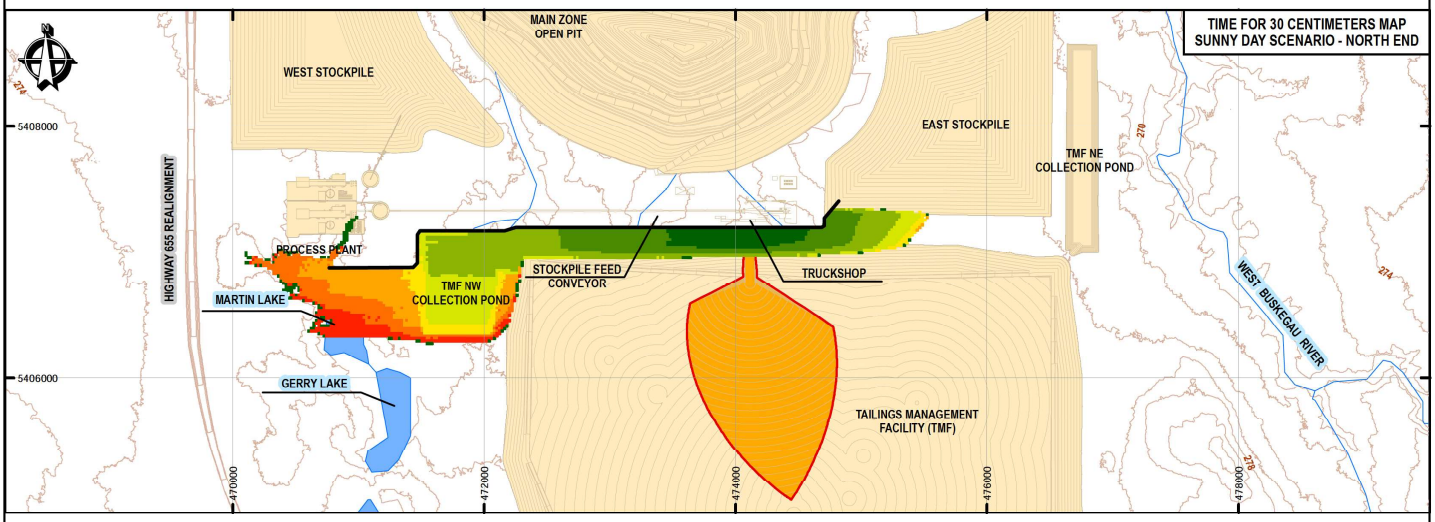
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO - NORTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A07-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:40,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 1.50	0.00 - 0.00	0.00 - 0.20
1.50 - 3.00	0.80 - 1.20	0.20 - 0.40
3.00 - 4.50	1.20 - 1.60	0.40 - 0.60
4.50 - 6.00	1.60 - 2.00	0.60 - 0.80
6.00 - 8.50	2.00 - 3.00	0.80 - 1.00
8.50 - 11.00	3.00 - 4.00	1.00 - 1.50
11.00 - 15.00	4.00 - 7.50	1.50 - 2.00
15.00 - 26.15	7.50 - 18.44	2.00 - 4.05

0 0.5 1 2 Kilometers

Scale: 1:40 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- PROJECTED BERM
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

PROJECT:

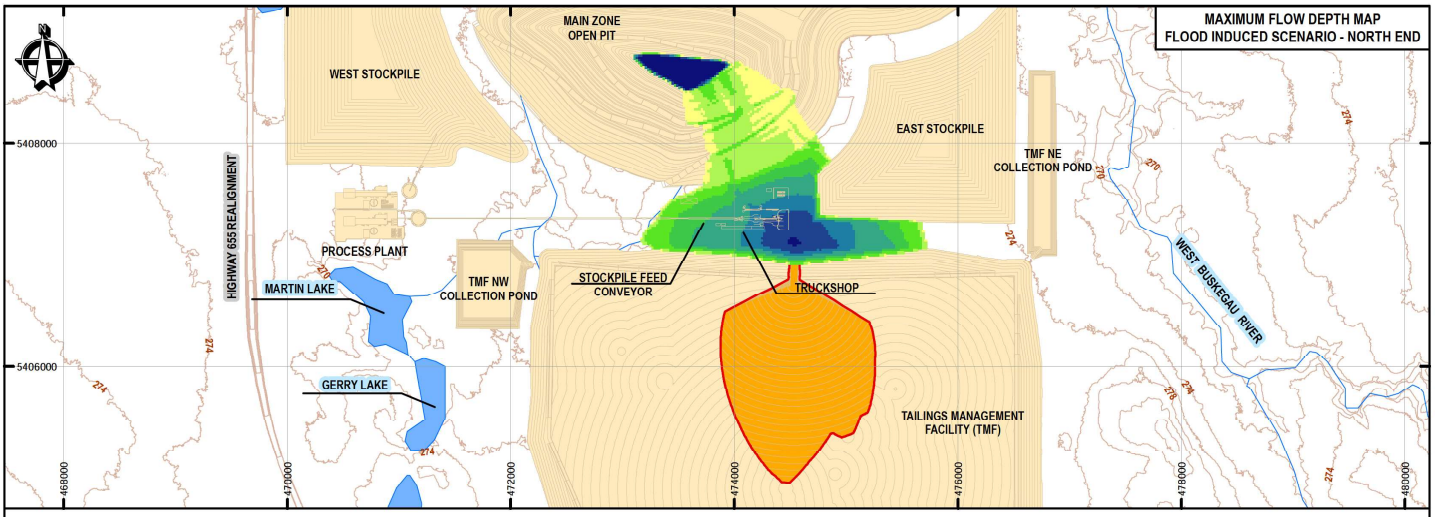
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

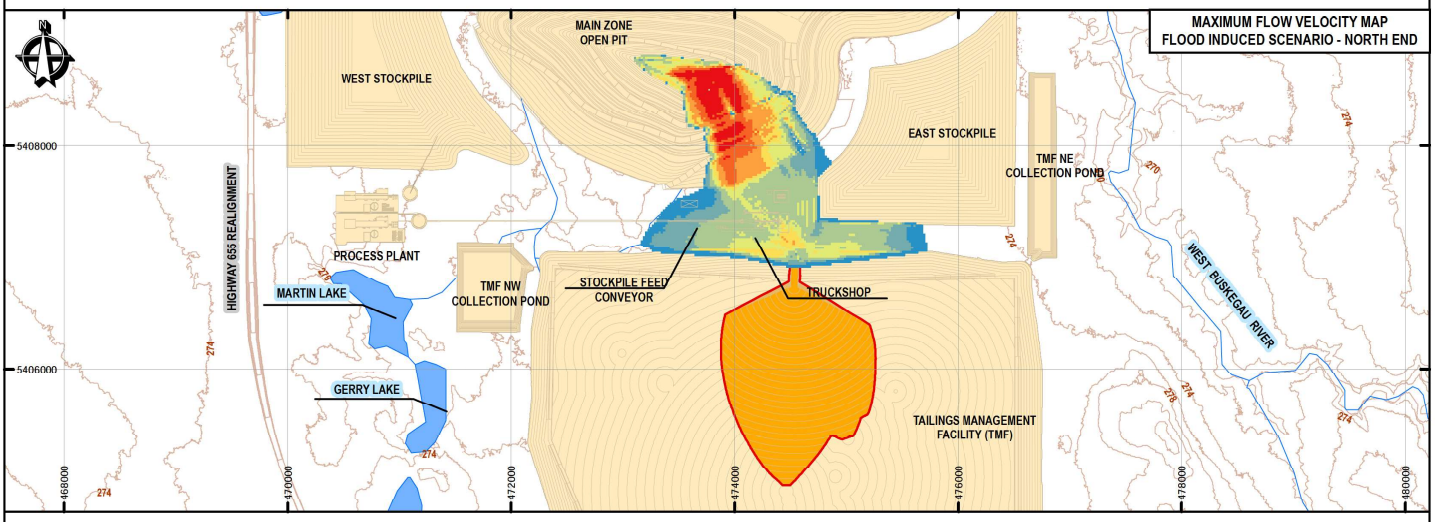
TITLE:

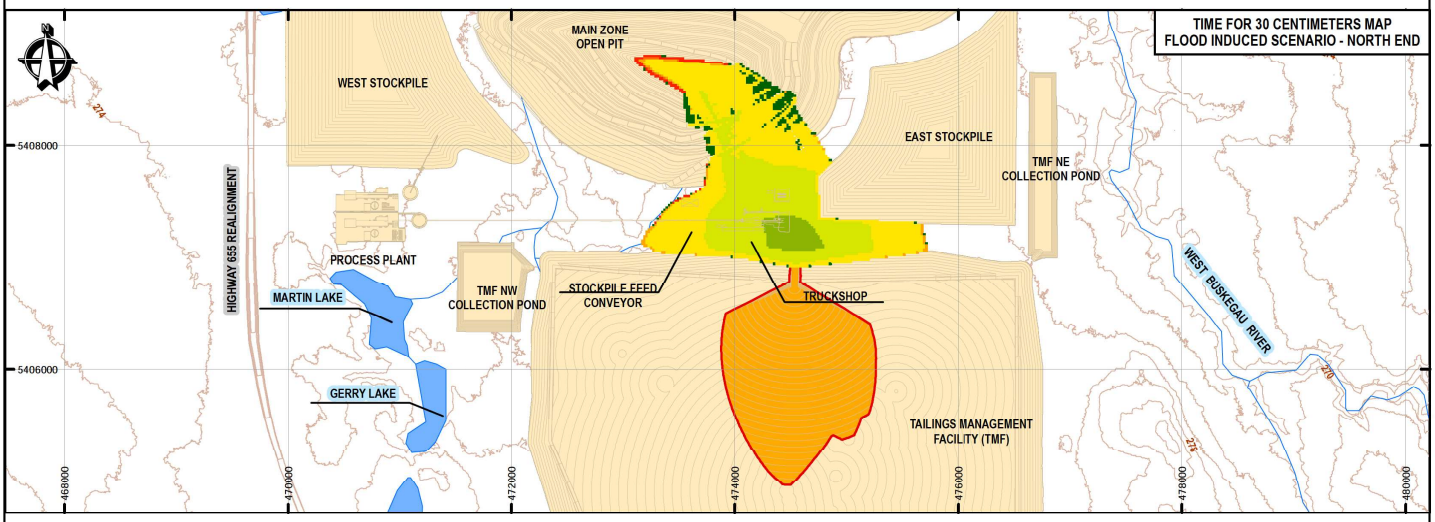
TAILINGS DAM BREACH ANALYSIS
SUNNY DAY SCENARIO WITH BERM - NORTH END

Ausenco | Canada Nickel Company

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A07-3
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:45,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.00 - 0.50	0.00 - 0.75	0.00 - 1.00
0.50 - 1.50	0.75 - 1.50	1.00 - 1.50
1.50 - 3.50	1.50 - 2.50	1.50 - 2.00
3.50 - 5.50	2.50 - 3.50	2.00 - 2.50
5.50 - 8.50	3.50 - 5.00	2.50 - 3.00
8.50 - 11.50	5.00 - 8.00	3.00 - 3.50
11.50 - 18.50	8.00 - 14.00	3.50 - 4.00
18.50 - 180.94	14.00 - 26.35	4.00 - 34.80

0 0.5 1 2 Kilometers

Scale: 1:45 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

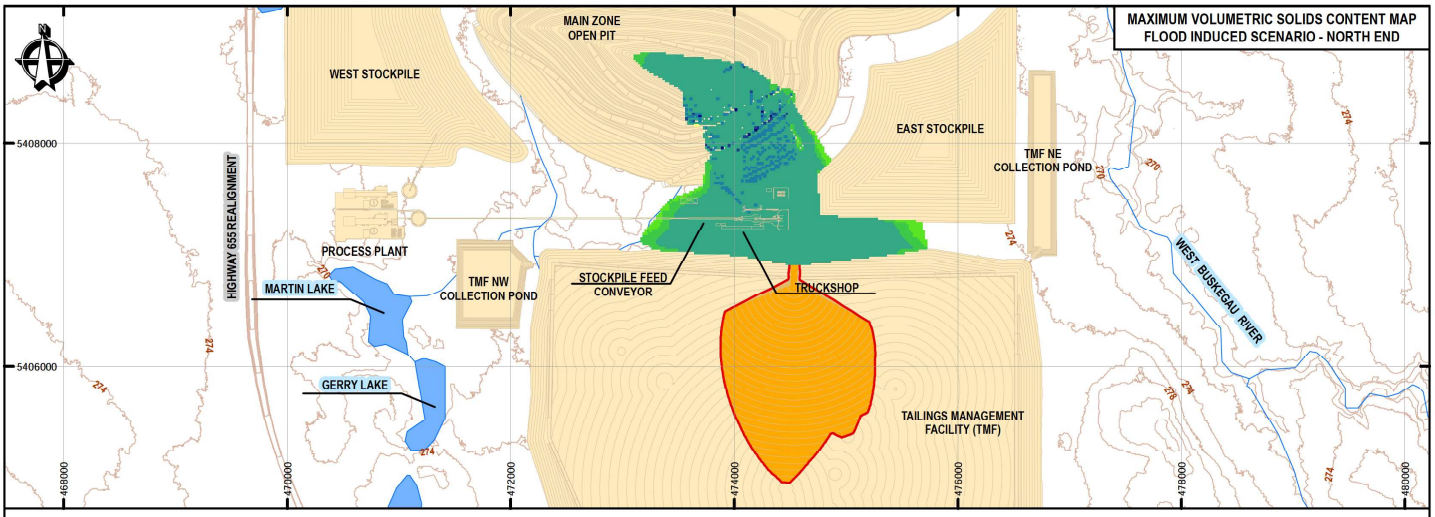
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

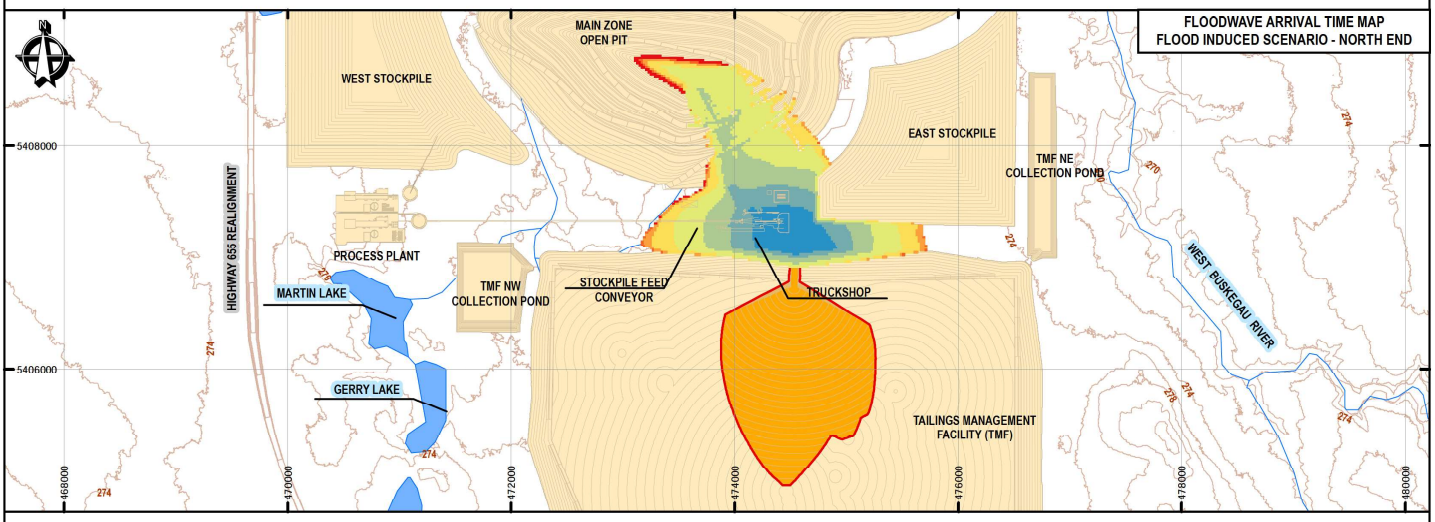
TITLE:

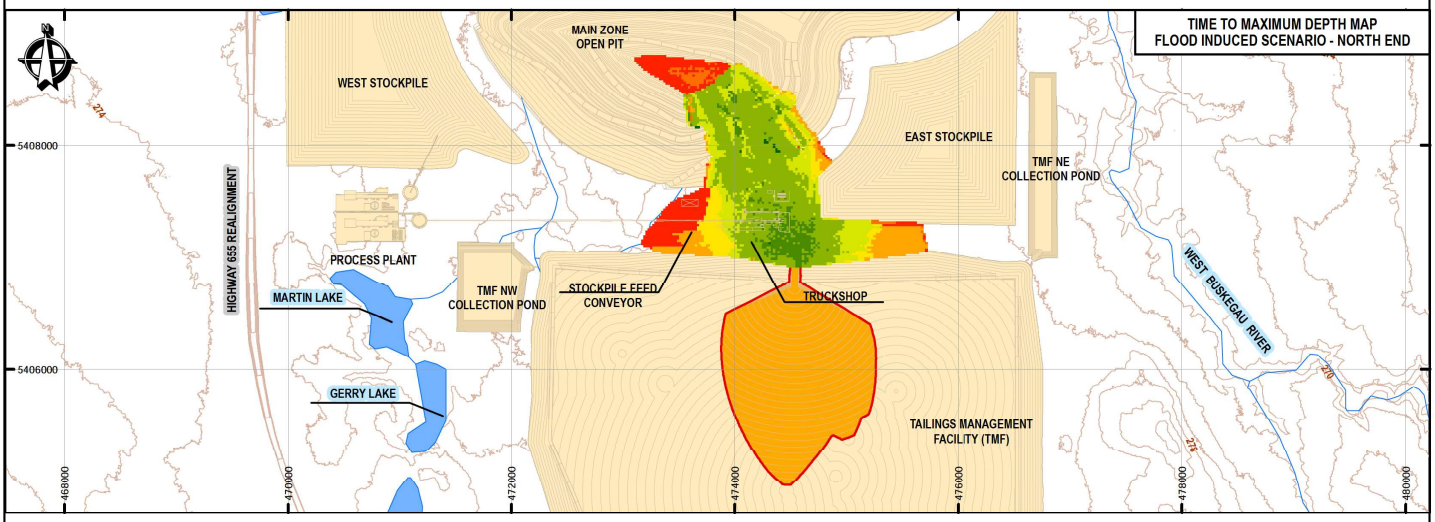
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - NORTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A08-1
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:45,000

SYMBOLOGY

MAXIMUM VOLUMETRIC SOLIDS CONTENT	FLOODWAVE ARRIVAL TIME (hr)	TIME TO MAXIMUM DEPTH (hr)
31% - 33%	1.70 - 2.10	2.50 - 2.60
33% - 34%	2.10 - 2.30	2.60 - 2.70
34% - 35%	2.30 - 2.50	2.70 - 2.80
35% - 36%	2.50 - 2.70	2.80 - 2.90
36% - 37%	2.70 - 2.90	2.90 - 3.00
37% - 38%	2.90 - 3.10	3.00 - 3.50
38% - 39%	3.10 - 3.50	3.50 - 30.00
39% - 40%	3.50 - 34.80	30.00 - 36.00

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

0 0.5 1 2 Kilometers

Scale: 1:45 000

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

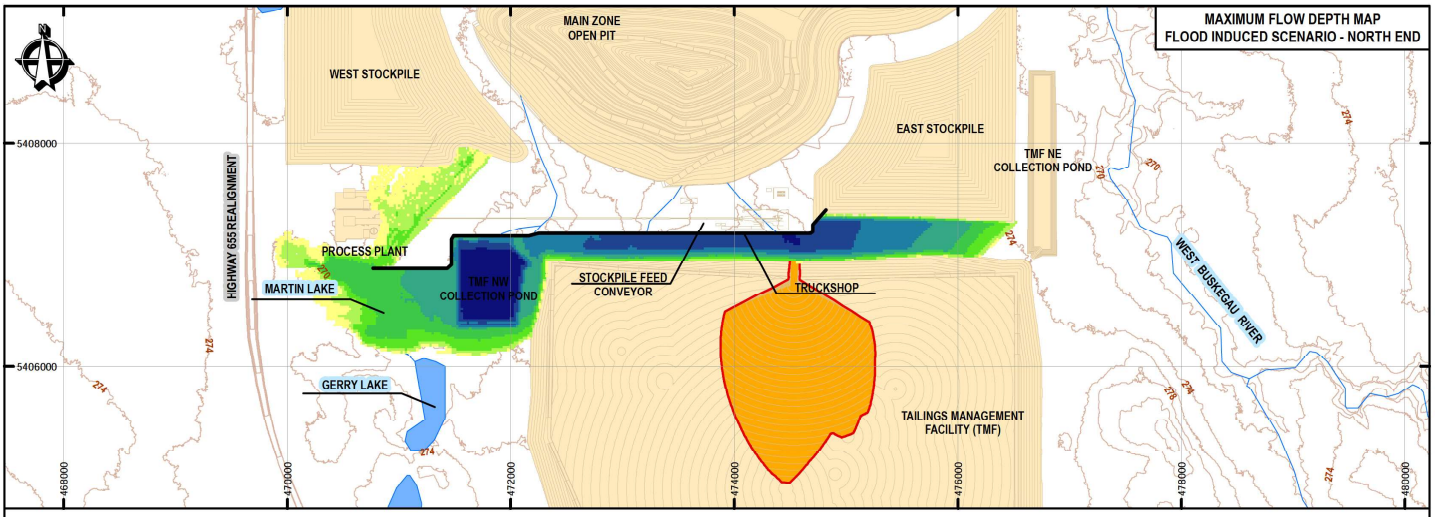
CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

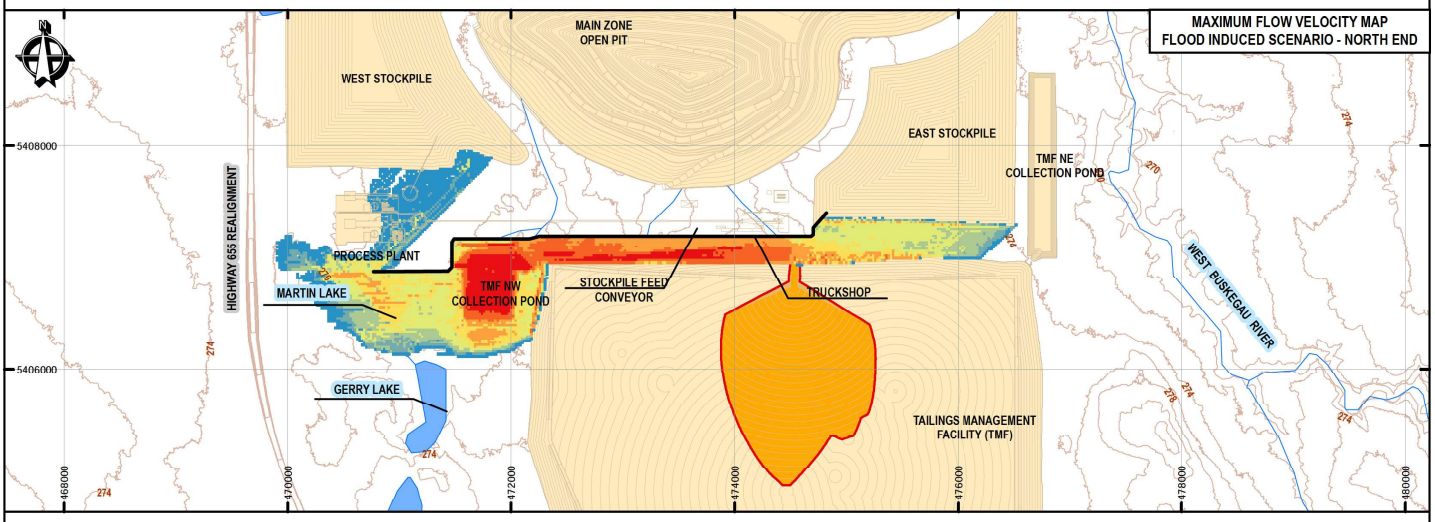
TITLE:

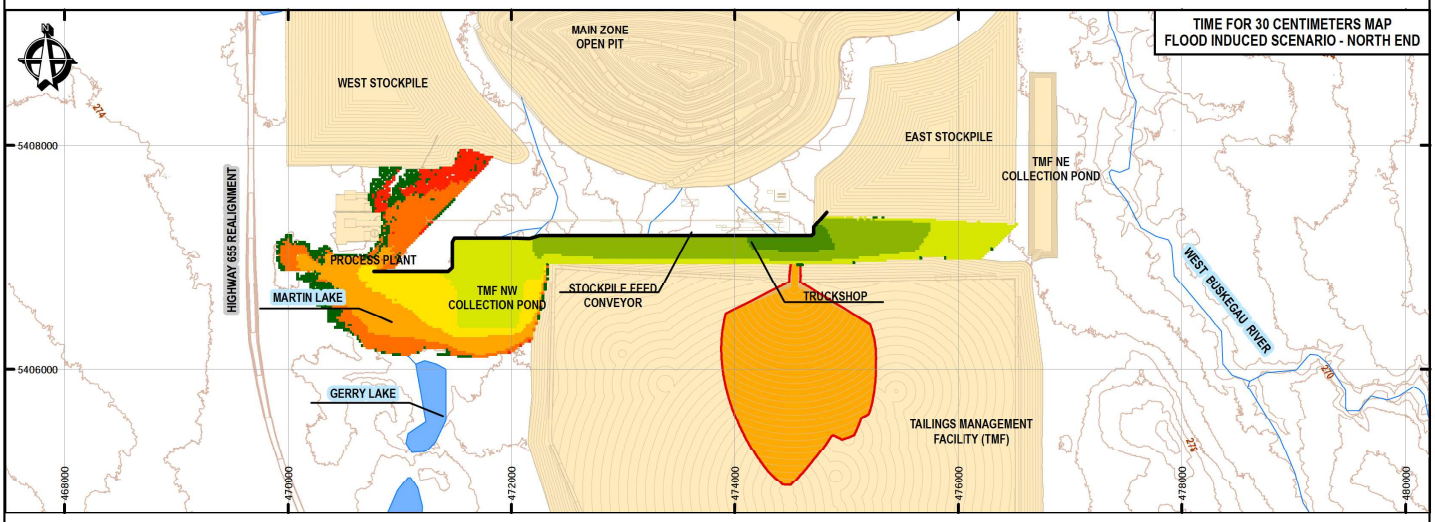
TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO - NORTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A08-2
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED







SCALE: 1:45,000

SYMBOLOGY

MAXIMUM FLOW DEPTHS (m)	MAXIMUM VELOCITIES (m/s)	TIME FOR 30 CENTIMETERS (hr)
0.004 - 0.500	0.00 - 0.30	0.00 - 1.00
0.50 - 1.50	0.30 - 0.60	1.00 - 2.00
1.50 - 3.00	0.60 - 1.00	2.00 - 2.50
3.00 - 4.50	1.00 - 1.50	2.50 - 3.00
4.50 - 7.00	1.50 - 2.00	3.00 - 3.50
7.00 - 10.00	2.00 - 3.00	3.50 - 4.00
10.00 - 15.00	3.00 - 6.00	4.00 - 6.00
15.00 - 28.49	6.00 - 14.05	6.00 - 20.30

0 0.5 1 2 Kilometers

Scale: 1:45 000

LEGEND

- DAM BREACH AREA WITHIN TMF IMPOUNDMENT
- PROJECTED BERM
- COMPONENT FOOTPRINT
- PROJECT COMPONENTS
- RIVERS AND STREAMS
- WATER BODIES
- CONTOUR LINES (INTERVAL: 2m)

NOTES:

1. PROJECTION: UTM WGS 84 - ZONE 17N.
2. TOPOGRAPHY: LIDAR DATA INFORMATION PROVIDED BY THE CLIENT.
3. SATELLITE IMAGE: WORLD TOPOGRAPHIC MAP

PROJECT:

CRAWFORD NICKEL PROJECT - PERMITTING SUPPORT

TITLE:

TAILINGS DAM BREACH ANALYSIS
FLOOD INDUCED SCENARIO WITH BERM - NORTH END

Ausenco | CANADA NICKEL COMPANY

PROJECT N°:	104945-05	REVISION:	D
ISSUE DATE:	SEP 06, 2024	MAP N°:	A08-3
DRAWN BY:	L. PICON		
CHECKED BY:	V. MEDINA		
APROBED BY:	G. STERLING		
PROJETCION:	UTM	ZONE:	17N
DATUM:	WGS84	SCALE:	INDICATED

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