Emergency Management Guidance

- Mining Association of Canada (MAC) Guidelines - 2019

Emergency: A situation that poses an impending or immediate risk to health, life, property, and/or the environment and which requires urgent intervention to prevent or limit the expected adverse outcomes.

Overall Objective

- The emergency management procedures will have two key overarching objectives:
  - avoid injury or death of persons working on pipeline systems, and
  - prevent or minimize environmental damage.

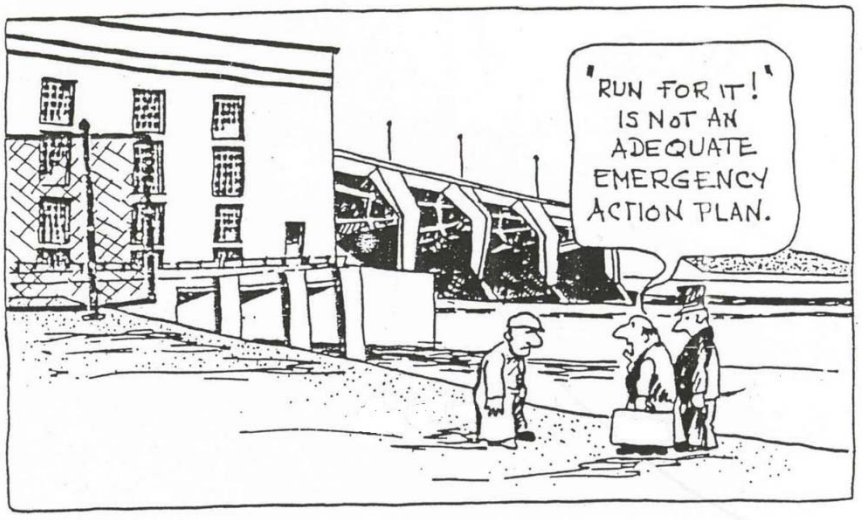

Image Ref:
dnr.wi.gov/topic/dams/documentsEAP.html

1 Overview of Doris TIA

Existing and Phase 2 Plans at Hope Bay

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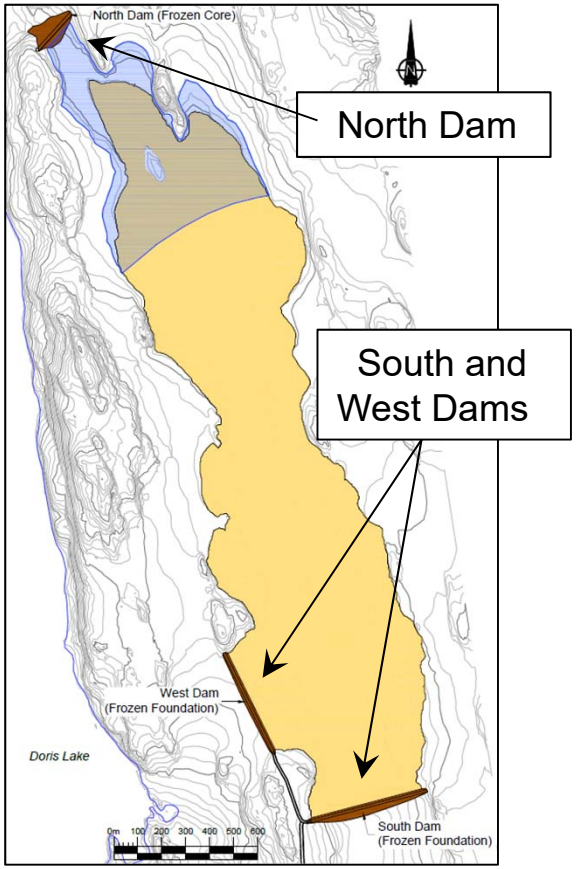
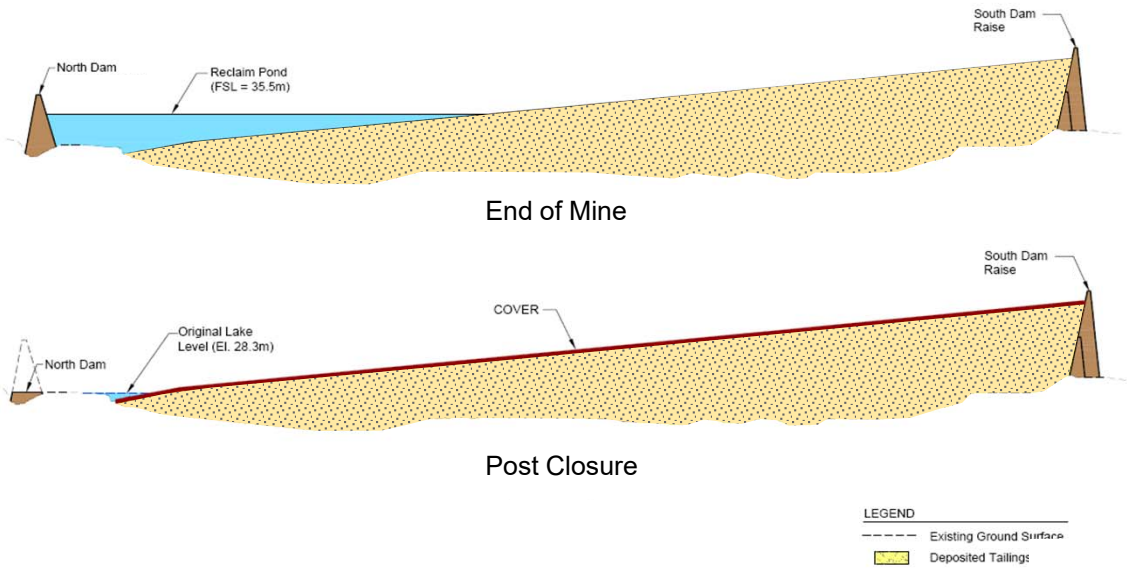
Tailings Impoundment Area (TIA)





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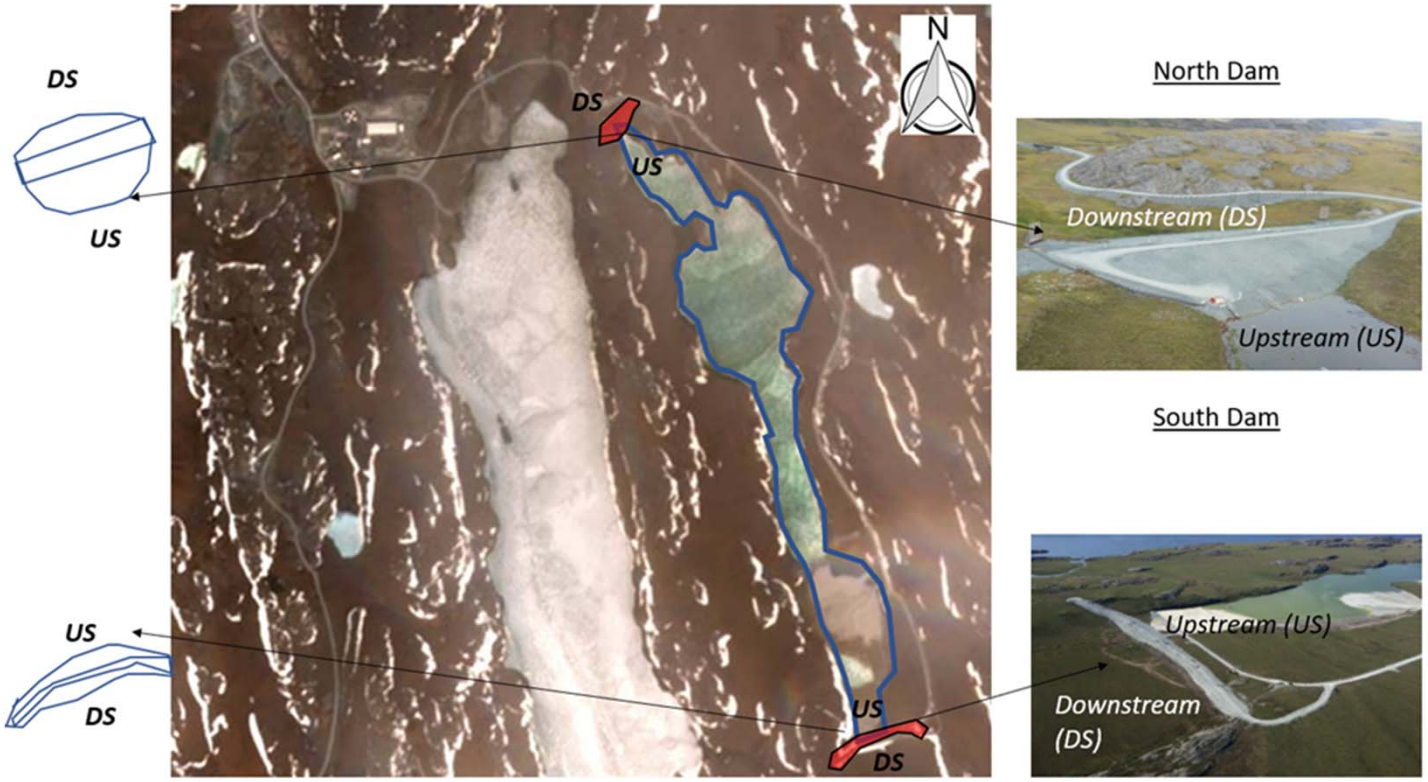
Tailings Impoundment Area (TIA) - current



- For 'UPSTREAM' think side that is holding back (retaining) water or tailings.
- For 'DOWNSTREAM' think the side with the less mining impacted environment

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2 Dam Hazard Ratings

Dams on site

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CDA - Dam Classification System

Does not take into account current state or probability. Just based on most significant possible outcome. The highest category of any category is what is adopted for the dam.

CDA consequence category	Potential loss of life	Environmental and cultural values	Infrastructure and economics
EXTREME	More than 100	Major loss… Restoration impossible…	Extreme losses…
VERY HIGH	100 or fewer	Significant loss… Restoration impractical…	Very high economic losses…
HIGH	10 or fewer	Significant loss… Restoration probable…	High economic losses…
SIGNIFICANT	Unspecified	No significant loss…	Loss to recreational facilities…
LOW	0	No long term loss…	Low economic loss…

Source: Canadian Dam Association Dam Safety Guidelines 2007 (2013 Edition) and Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (2014). The table is an extract of the CDA Dam consequence categories and criteria.

Secondary ref: https://www.bhp.com/-/media/documents/media/reports-and-presentations/2019

Hope Bay - Dam Classifications

The dams associated with the TIA area consist of

- **North Dam** - Frozen core rock fill dam with GCL
- **South Dam** – Frozen foundation dam with GCL. Constructed in two phases with downstream raises of GCL and rock fill.
- **West Dam** – Frozen foundation rock fill dam with geomembrane

The North, South, and West Dams were assigned a **HIGH** dam hazard classification in accordance with the CDA (2013) dam safety guidelines.

Dam Class	North Dam	South Dam	West Dam
Population at Risk	significant	significant	significant
Loss of Life	significant	significant	significant
Environmental and Cultural Values	high	high	high
Infrastructure and Economics	low	low	low
Overall Hazard Classification	high	high	high

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3 Dam Break Analysis

Inputs and Outputs from Preliminary Checks

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What is a dam break study and why do we do it?

- Tailings dam failures can have catastrophic consequences
- Dam break assessments provide important information to develop safety protocols and to manage risk
- Currently a legislative requirement in most North American jurisdictions
- Results of the dam break assessment are used to determine the TSF classification and develop Emergency Action Plans

Breach of Teton Dam, June 5, 1976

Ref: en.wikipedia.org/wiki/Teton_Dam

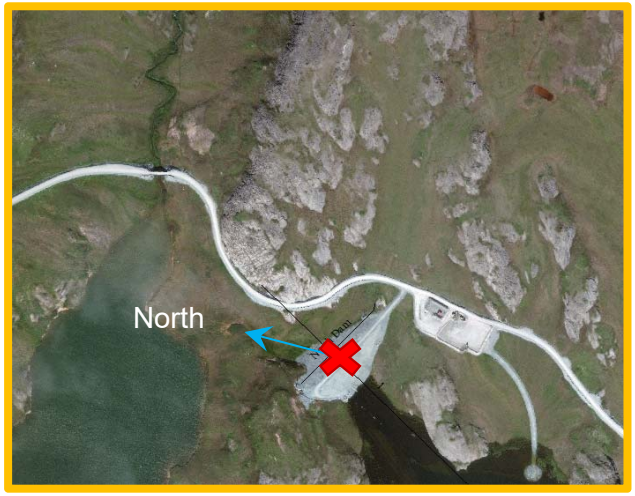
Analysis sequence

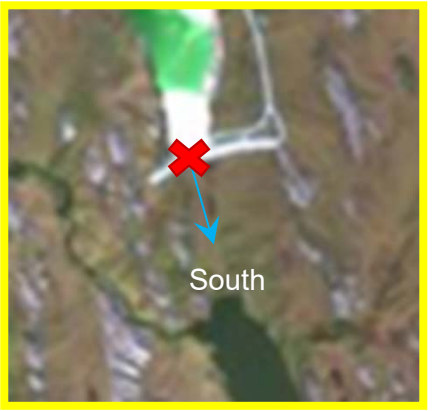
1. Identify and select critical breach location(s)
2. Estimate the volume of tailings and water that will be released
3. Determine breach parameters and assign hydrograph
4. Route the flood downstream (1 or 2D models)
5. Prepare inundation maps

Analysis sequence
1. Selecting breach location

1. **Breach location(s)**
2. Release volumes
3. Breach hydrograph
4. Flood routing
5. Inundation maps

- Typically select one (or multiple), critical locations That have the highest potential for downstream impacts

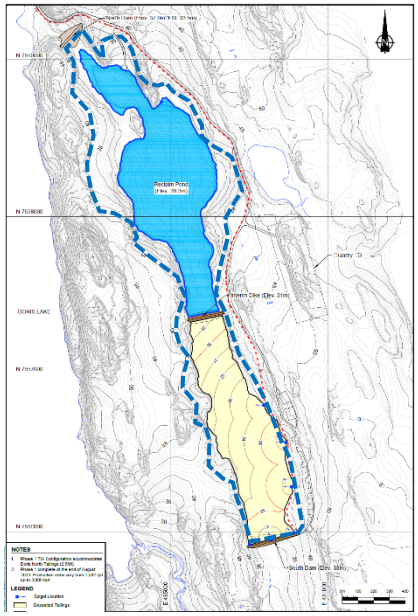




Analysis sequence
2. Estimating release volumes

1. Breach location(s)
2. **Release Volumes**
3. Breach hydrograph
4. Flood routing
5. Inundation maps

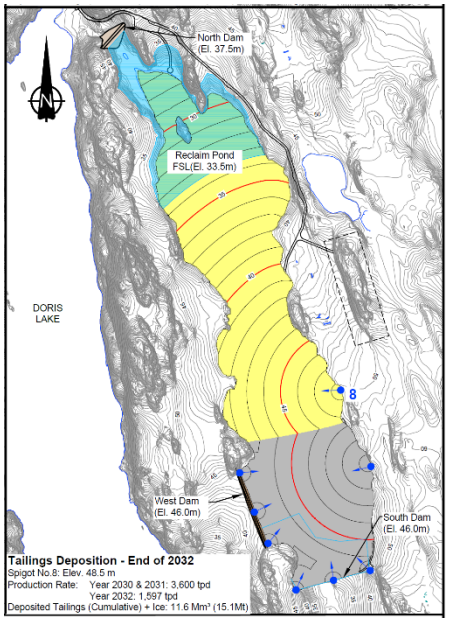
– How much is released is difficult to predict. Making what we believe to be conservative (higher volume) assumptions.



North Dam

Volume Released	12,938,000 m^3

Volume below elevation 37.5m



South Dam

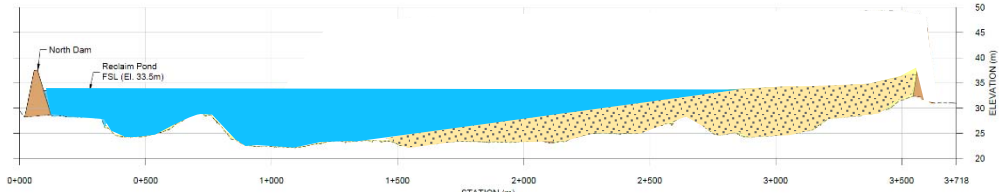
Volume Released	14,034,000 m^3

Volume between approx elev 30 to 46m

Analysis sequence
2. Estimating release volumes

1. Breach location(s)
2. **Release Volumes**
3. Breach hydrograph
4. Flood routing
5. Inundation maps

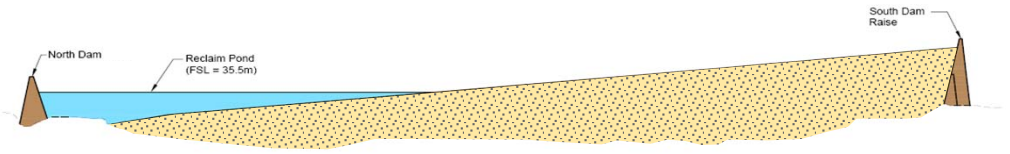
– How much is released is difficult to predict. Making what we believe to be conservative (higher volume) assumptions.



End of Phase 1
Just before Phase 2

North Dam

Volume Released	12,938,000 m^3



End of Mine
End Phase 2

South Dam

Volume Released	14,034,000 m^3

Analysis sequence
2. Estimating release volumes

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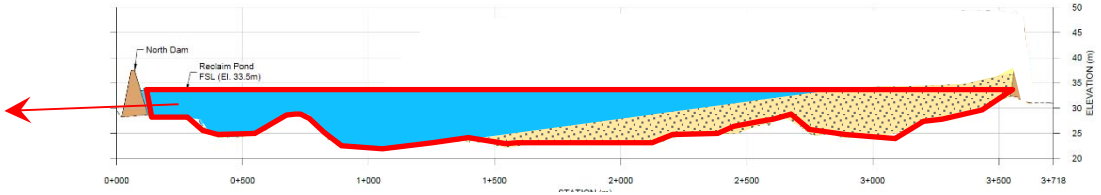
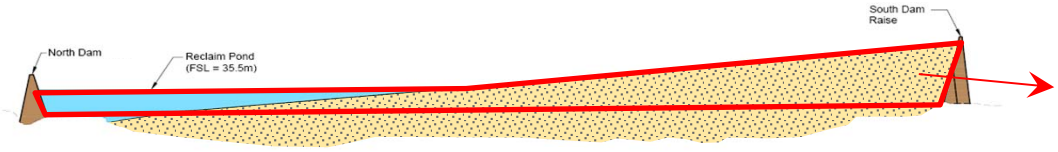


End of Phase 1
Just before Phase 2

North Dam

Volume Released	12,938,000 m^3



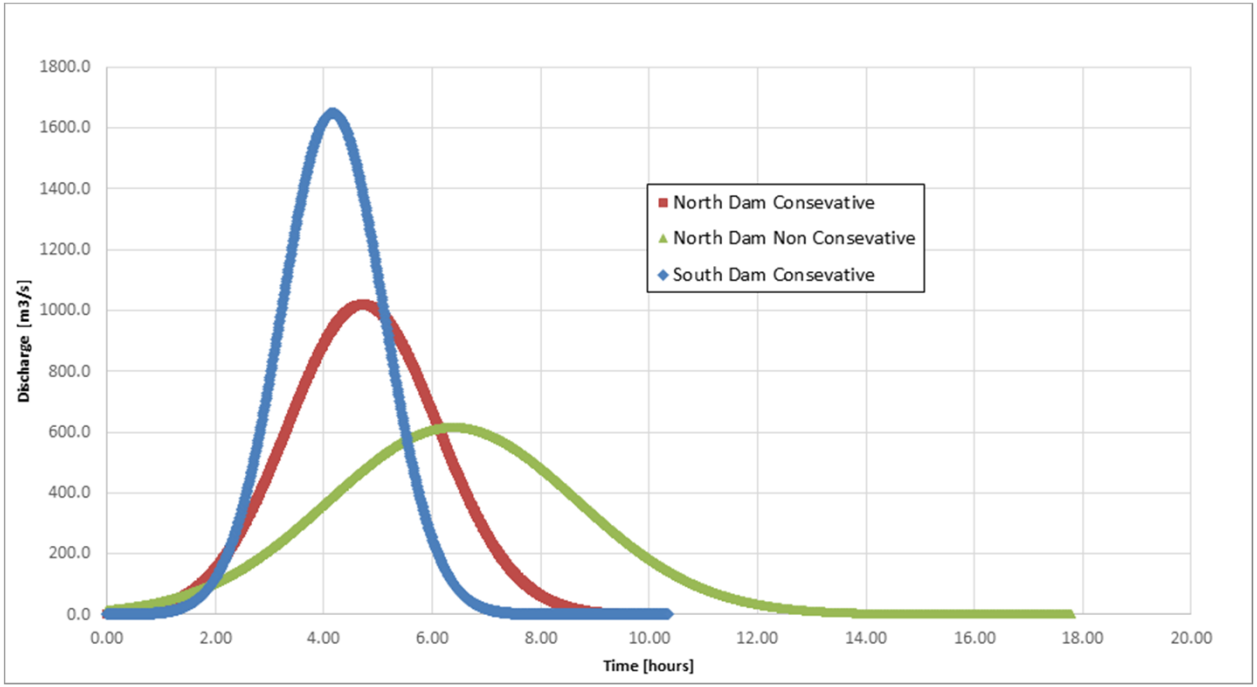
End of Mine
End Phase 2

South Dam

Volume Released	14,034,000 m^3

Analysis sequence
3. Determine breach parameters and assign hydrograph

1. Breach location(s)
2. Release volumes
3. **Breach Hydrograph**
4. Flood routing
5. Inundation maps



Analysis sequence
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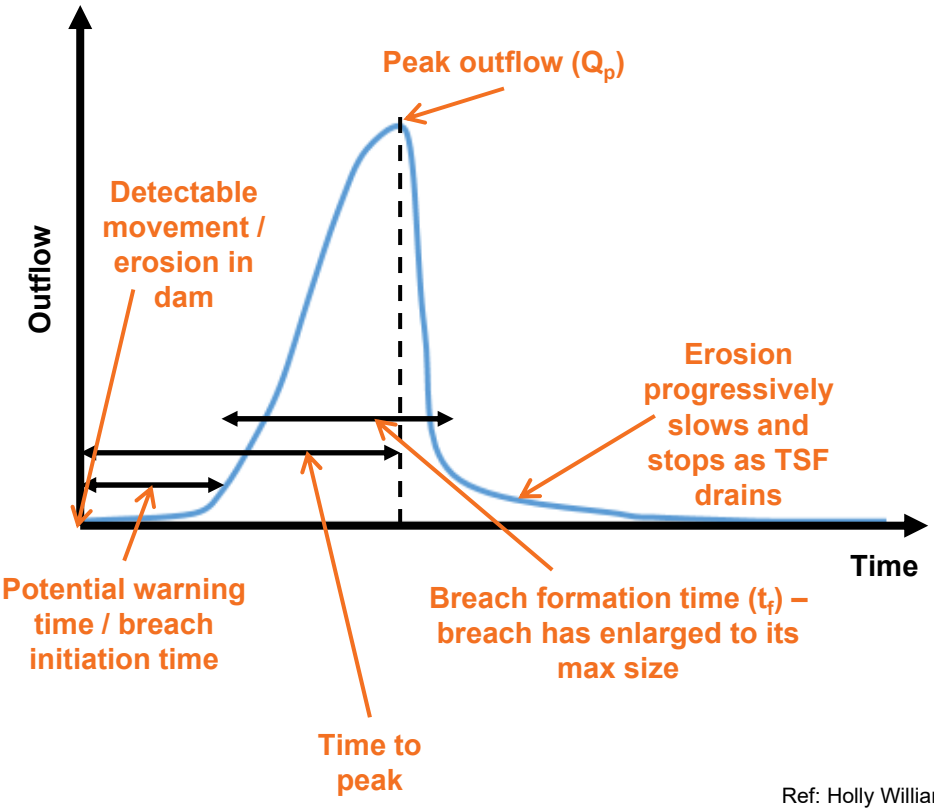
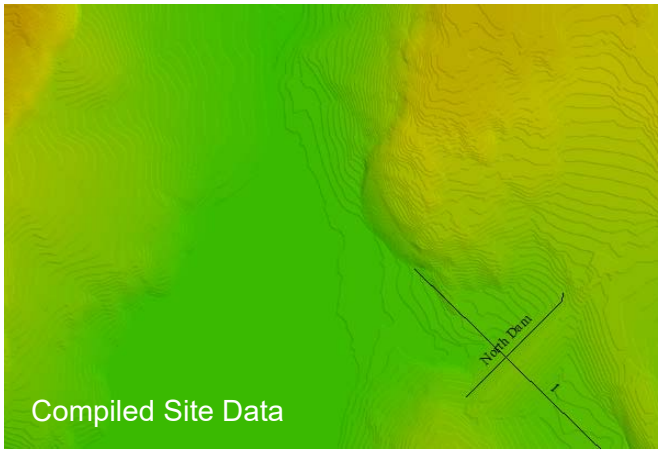


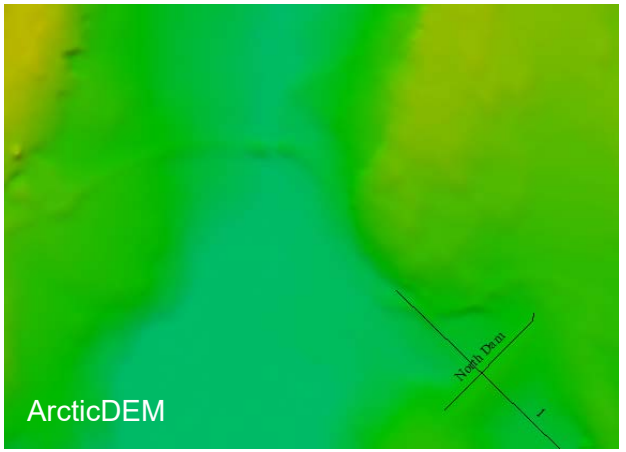
Ref: Holly Williams, SRK, 2017

Running a model
4. Flood routing - topography

1. Breach location(s)
2. Release volumes
3. Breach hydrograph
4. **Flood Routing**
5. Inundation maps

- The accuracy of the flood routing and subsequent inundation mapping is dictated by the topographic resolution
  - Crap input = crap output
- When do you stop a model?
  - Typical guidelines say flood routing should be continued to a point downstream where the dam break flood is considered to no longer pose a risk to life and there is limited potential for further damage.

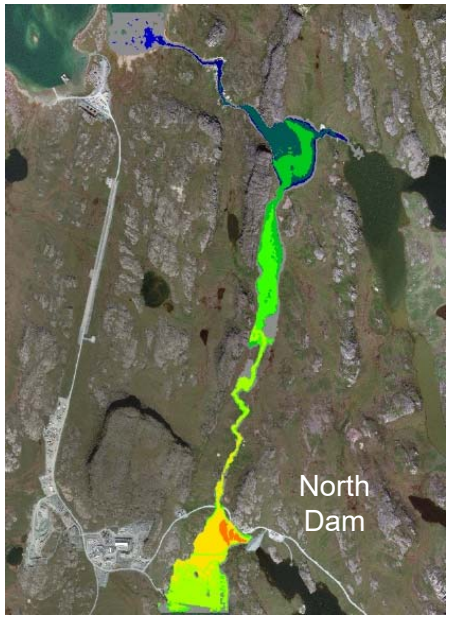


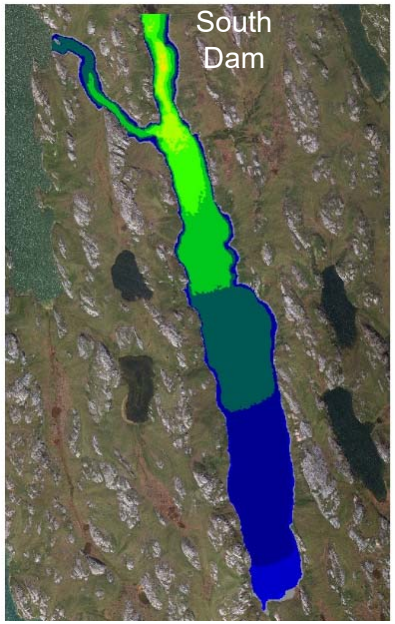


Running a model
5. Preparing inundation maps

1. Breach location(s)
2. Release volumes
3. Breach hydrograph
4. Flood routing
5. **Inundation maps**

- Include flood inundation extents, arrival times, depths, and velocities and areas / infrastructure at risk





Summary of Dam Break Set-up / Inputs

North Dam – large scale model (to ocean)

Breach Type	Overtopping
Volume Released	12,938,000 m^3
Rheology	Water *(conservative – longer quicker flow case)*
Breach Formation Time	7.5 hrs *(Xu & Zhang, 2009)*
Peak Outflow Rate	1020 m^3/s *(615 m^3/s estimated by Xu& Zhang, 2009, so reasonable fit)*
Flood Routing Model	FLO-2D
Grid Size	5x5m *(square model grid)*
Model Time	12 hrs (calculations set to stop after model time reach)
Time Step	0.1 hrs (6 minutes)
Manning	0.05 *(smooth terrain -*

South Dam – larger scale model (to Doris Lake)

Breach Type	Overtopping
Volume Released	14,034,000 m^3
Rheology	Water *(conservative – longer quicker flow case)* Tailings (shorter travel distance) case also run
Breach Formation Time	5.7 hrs *(Xu & Zhang, 2009)*
Peak Outflow Rate	1647 m^3/s *(1610 m3/s estimated by Xu& Zhang, 2009, so pretty close to perfect fit)*
Flood Routing Model	FLO-2D
Grid Size	5x5m *(square model grid)*
Model Time	7 hrs (calculations set to stop after model time reach)
Time Step	0.1 hrs (6 minutes)
Manning	0.05 *(smooth terrain - most of the flow with go through existing creeks, rock outcrops and tundra vegetation or frozen ground)*

4 Inundation Maps

Impacts

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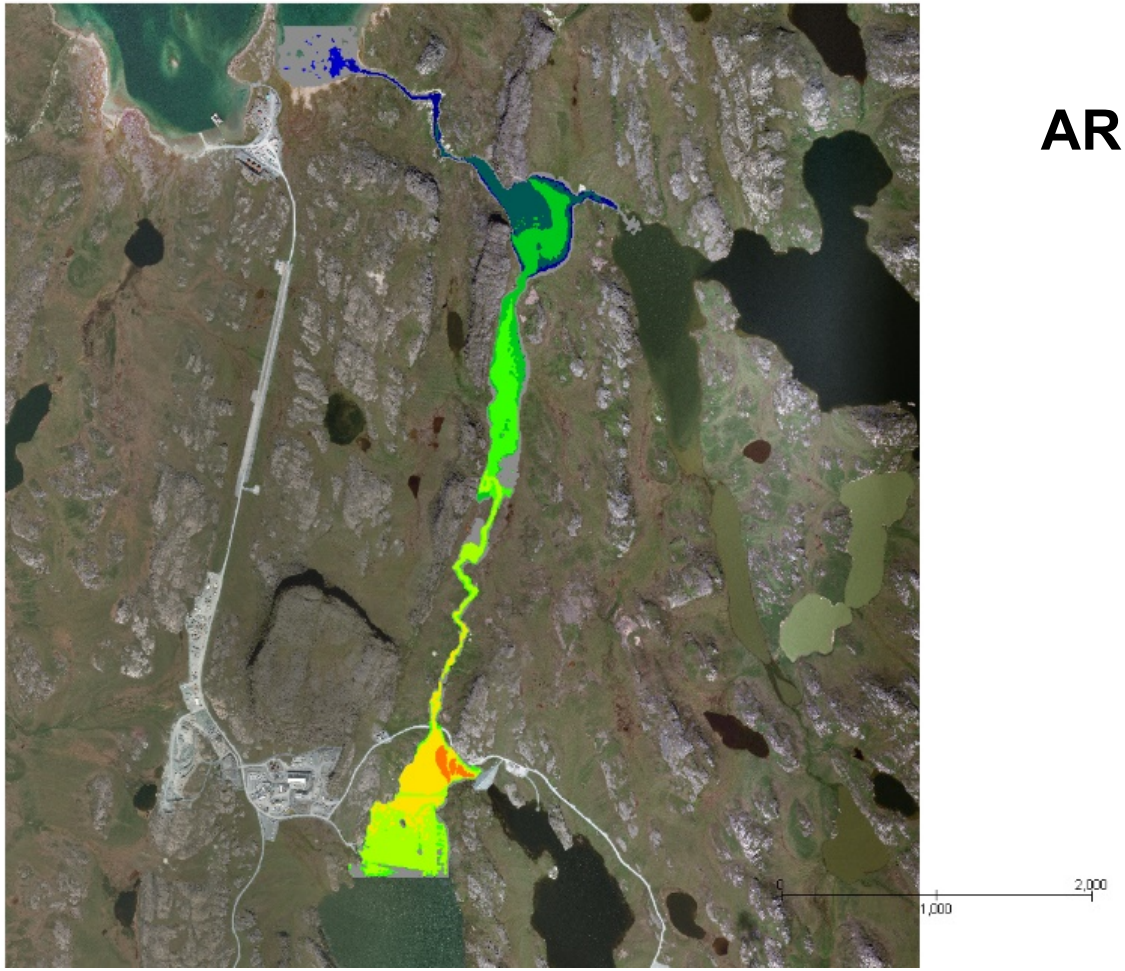
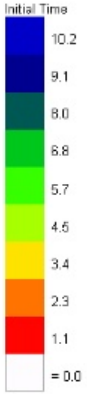
North Dam – General / Global Model (to ocean)

Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



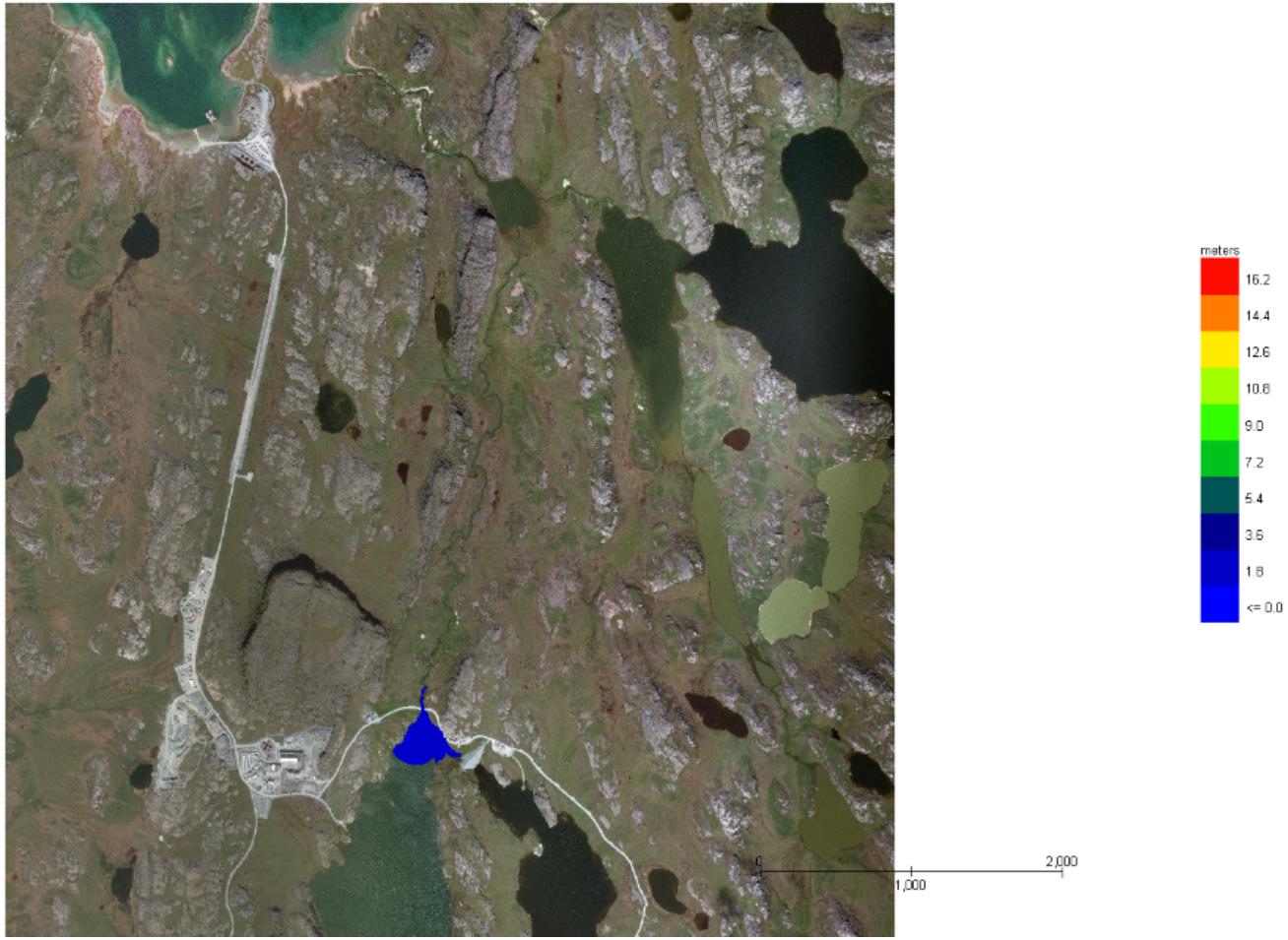
ARRIVAL TIME

(~hrs)

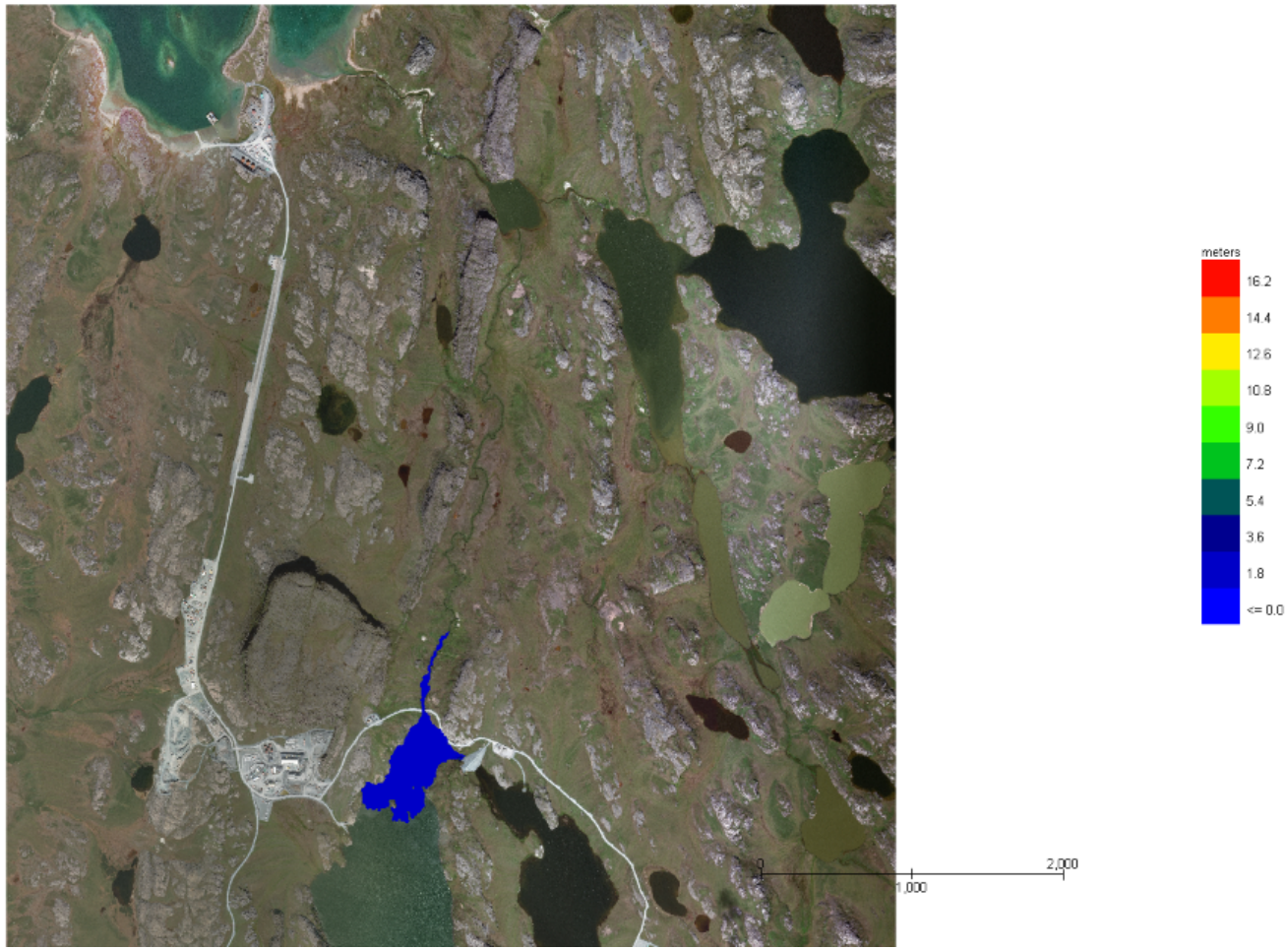


Grid Element Flow Depth (1800 sec.) [0.5:0:0]

Grid Element Flow Depth (3600 sec.) [1:0:0]



Grid Element Flow Depth (7200 sec.) [2:0:0]



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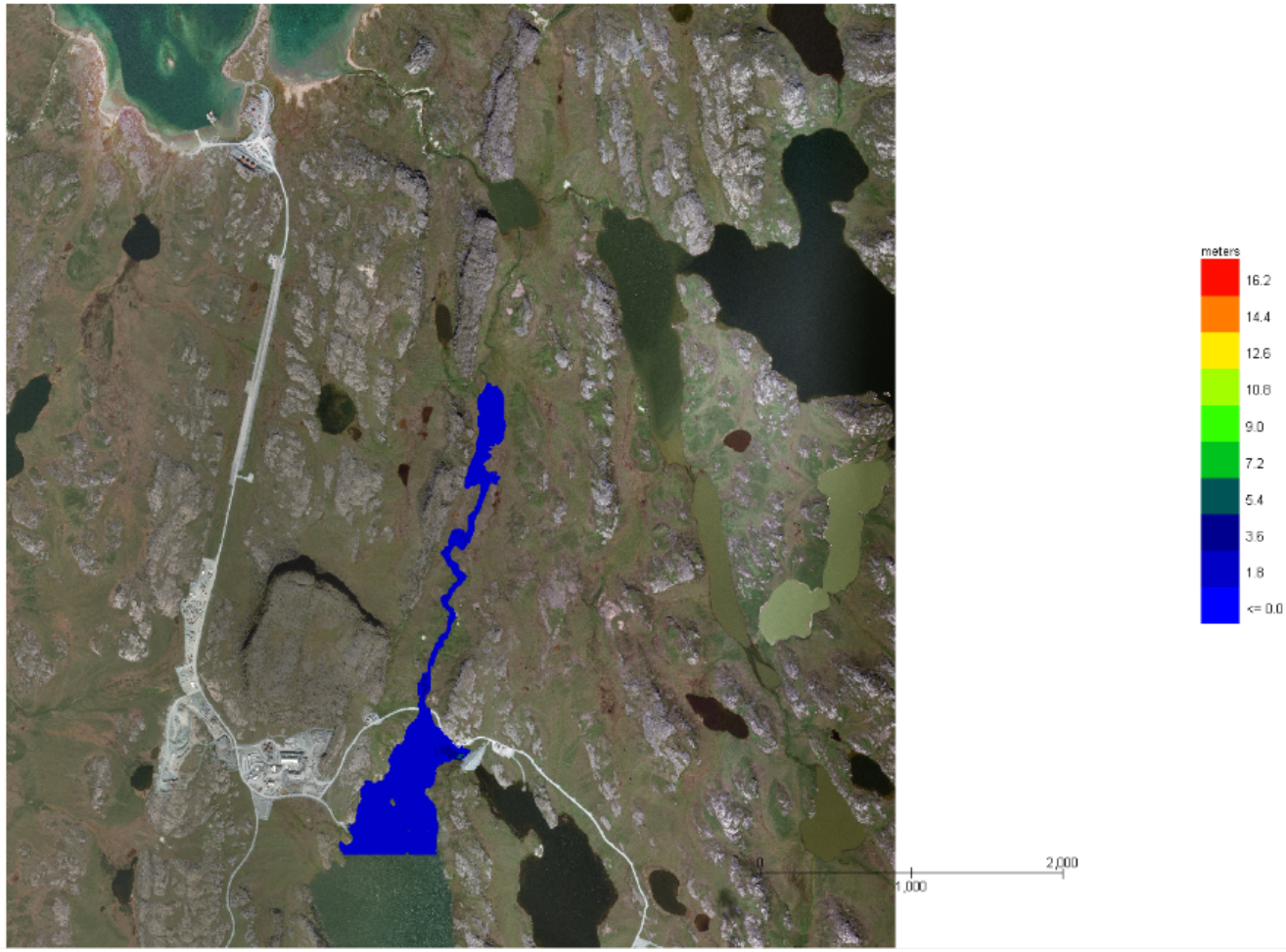
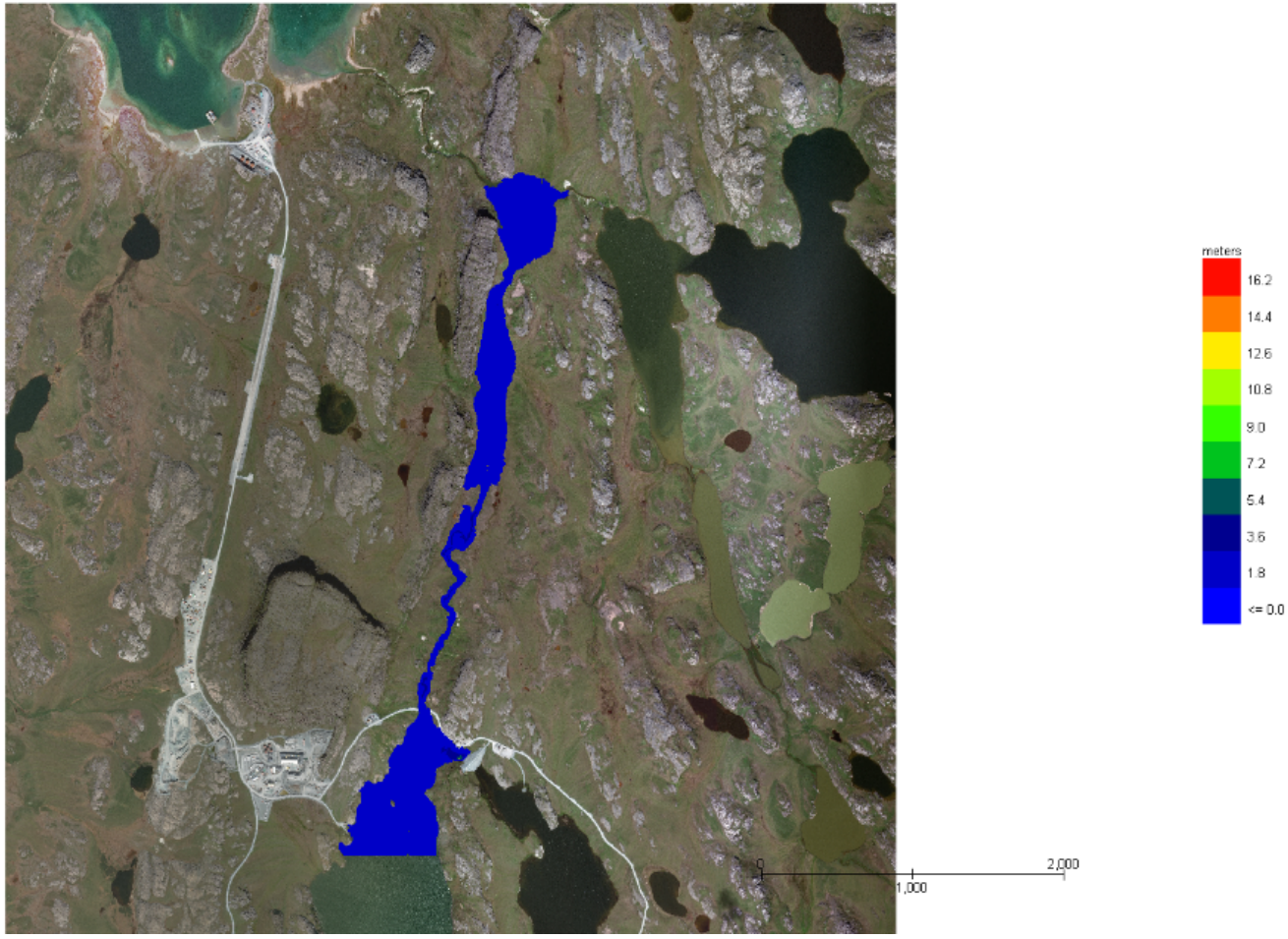
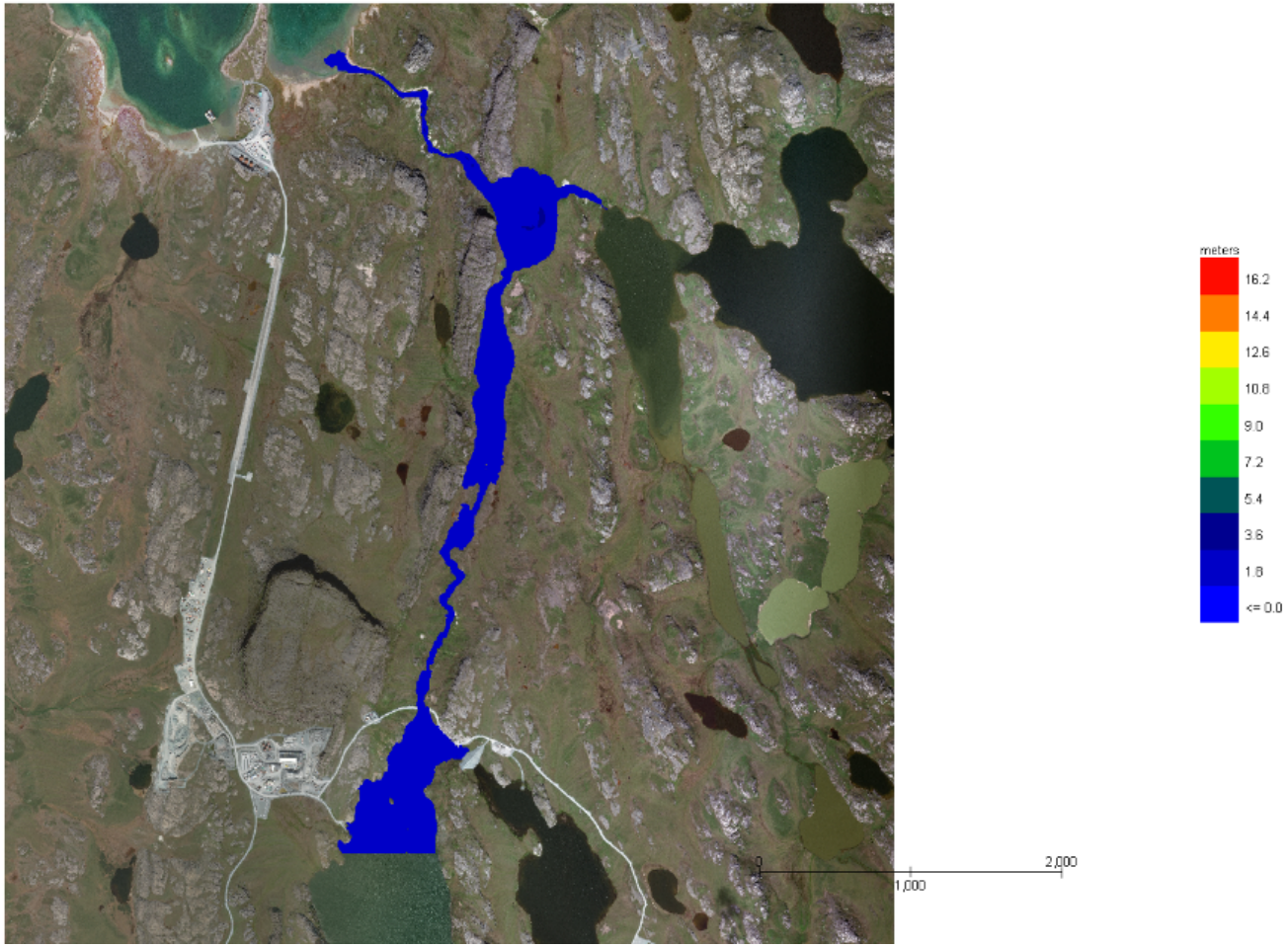


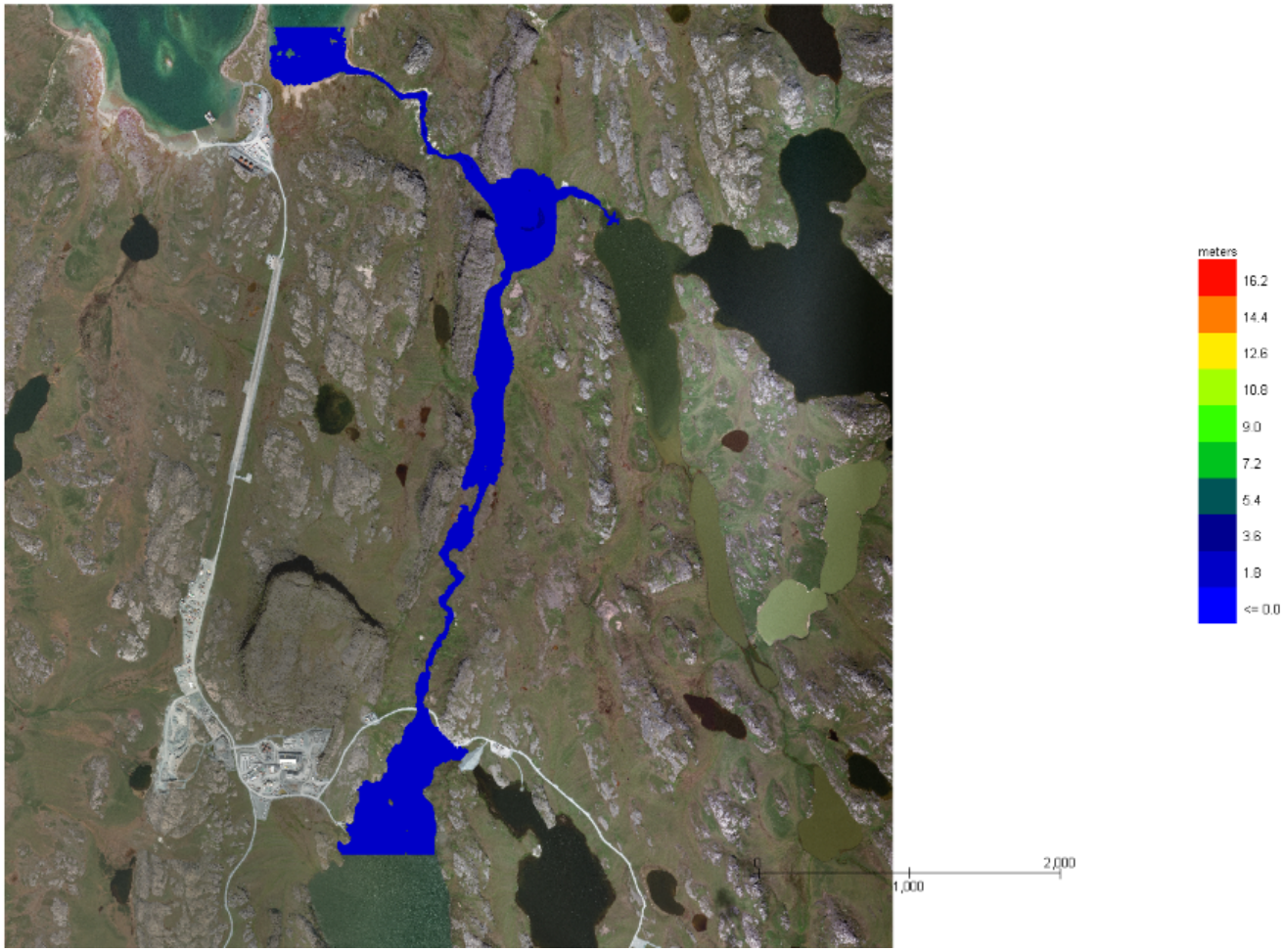
Grid Element Flow Depth (21600 sec.) [6:0:0]



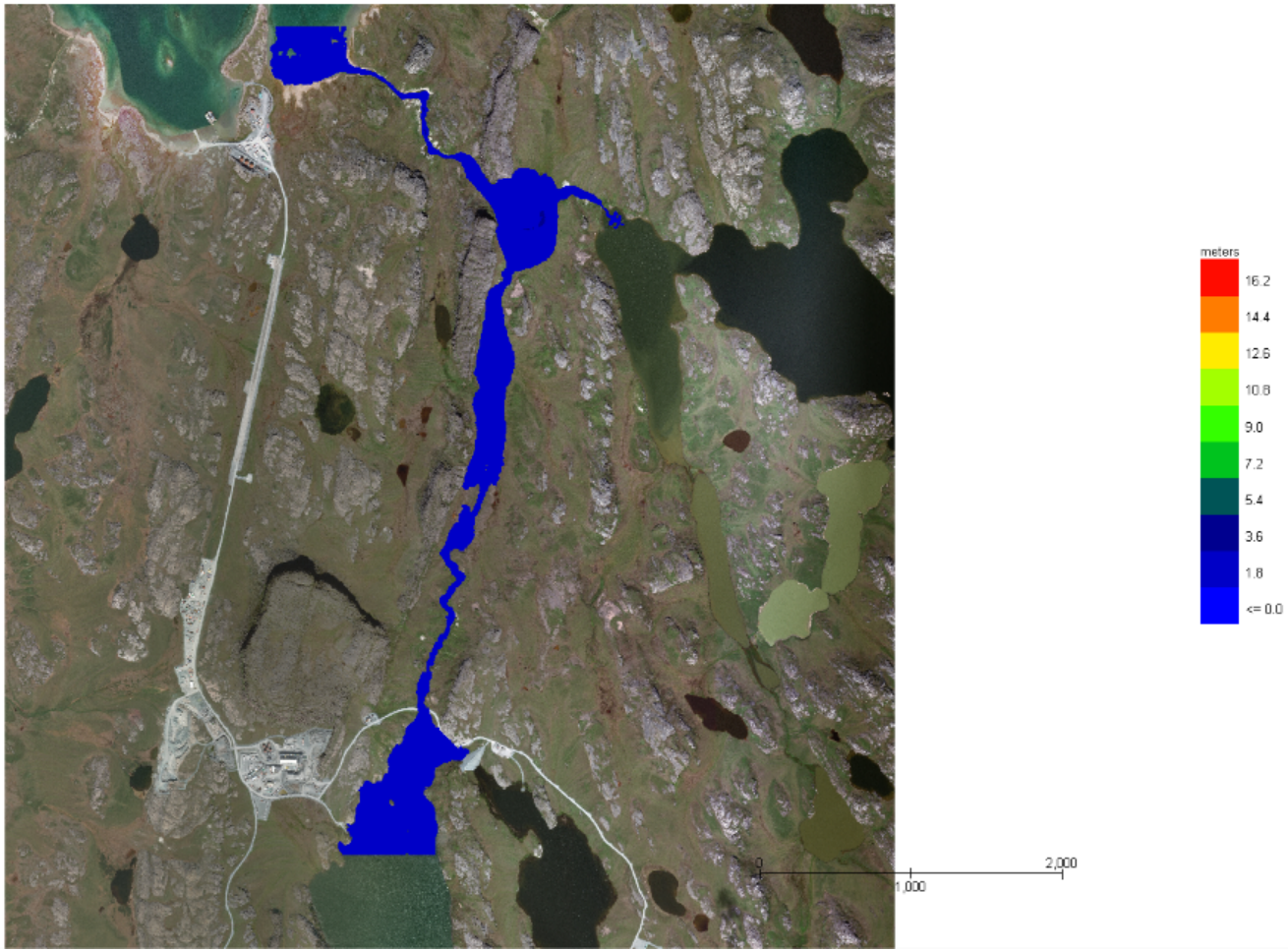
Grid Element Flow Depth (28800 sec.) [8:0:0]



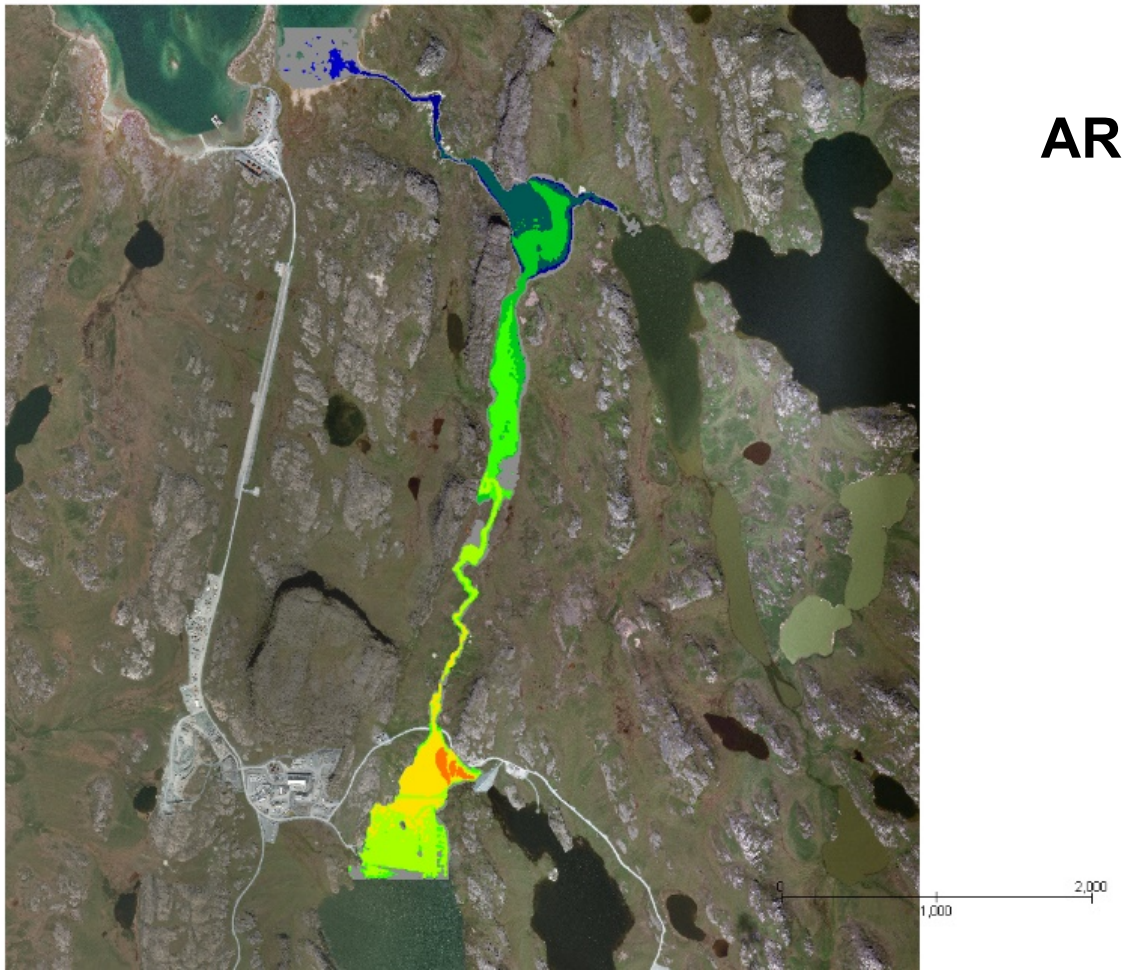
Grid Element Flow Depth (36000 sec.) [10:0:0]



Grid Element Flow Depth (43200 sec.) [12:0:0]



Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



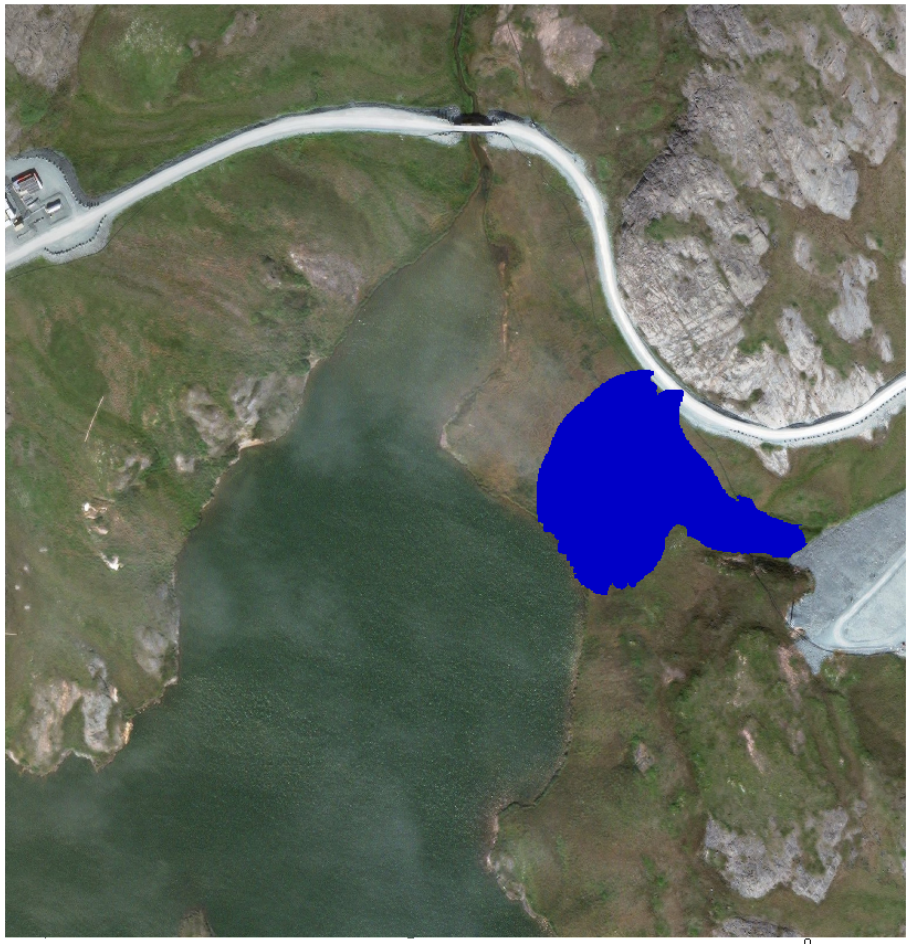
ARRIVAL TIME

(~hrs)

North Dam – Detailed / Local Model (focus on bridge)

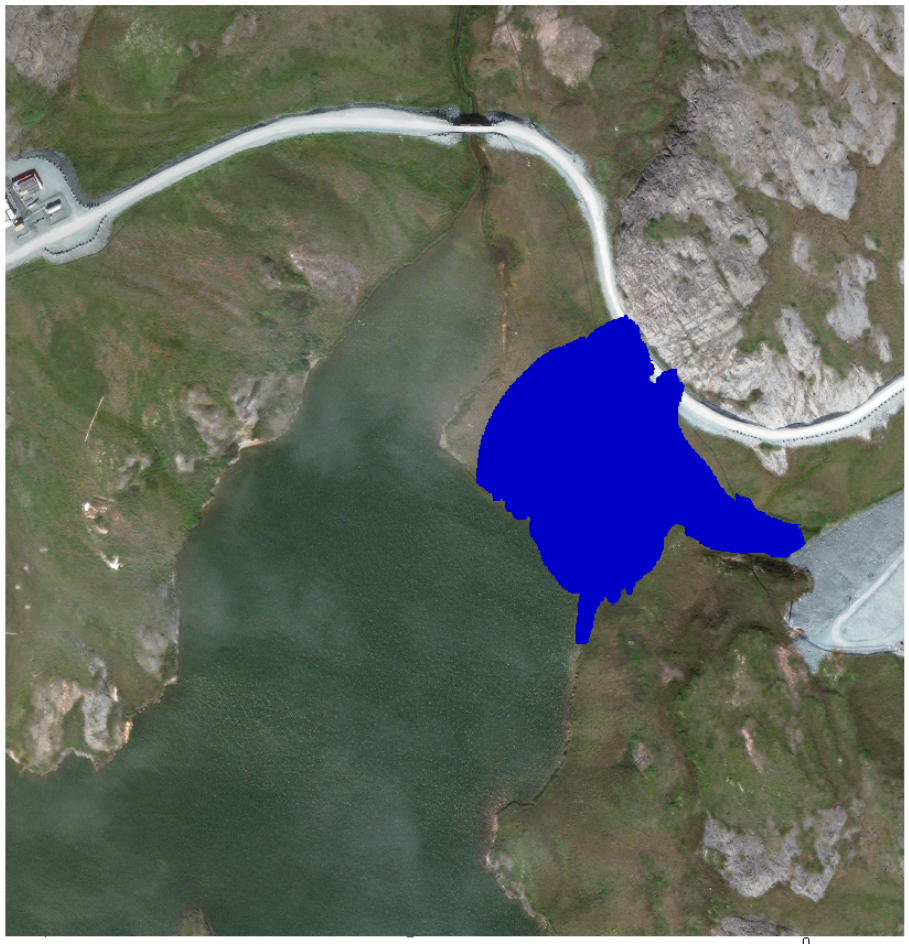
Grid Element Flow Depth (360 sec.) [0:6:0]

Grid Element Flow Depth (720 sec.) [0:12:0]

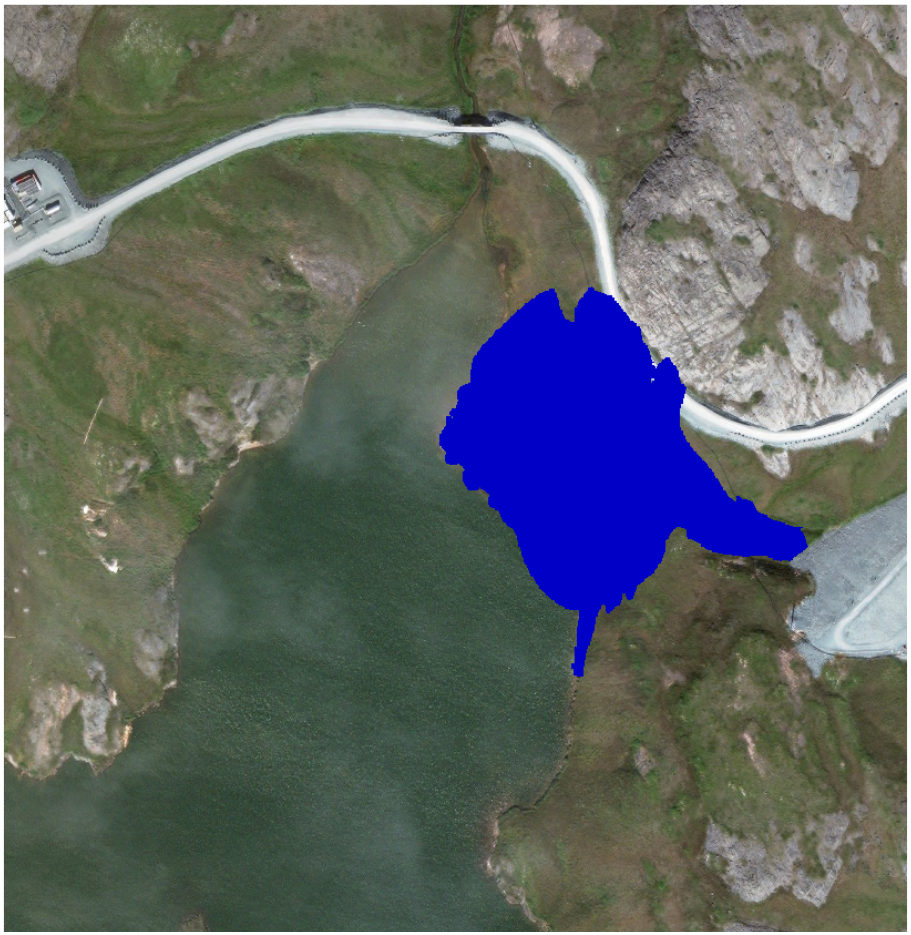


~ 12 mins

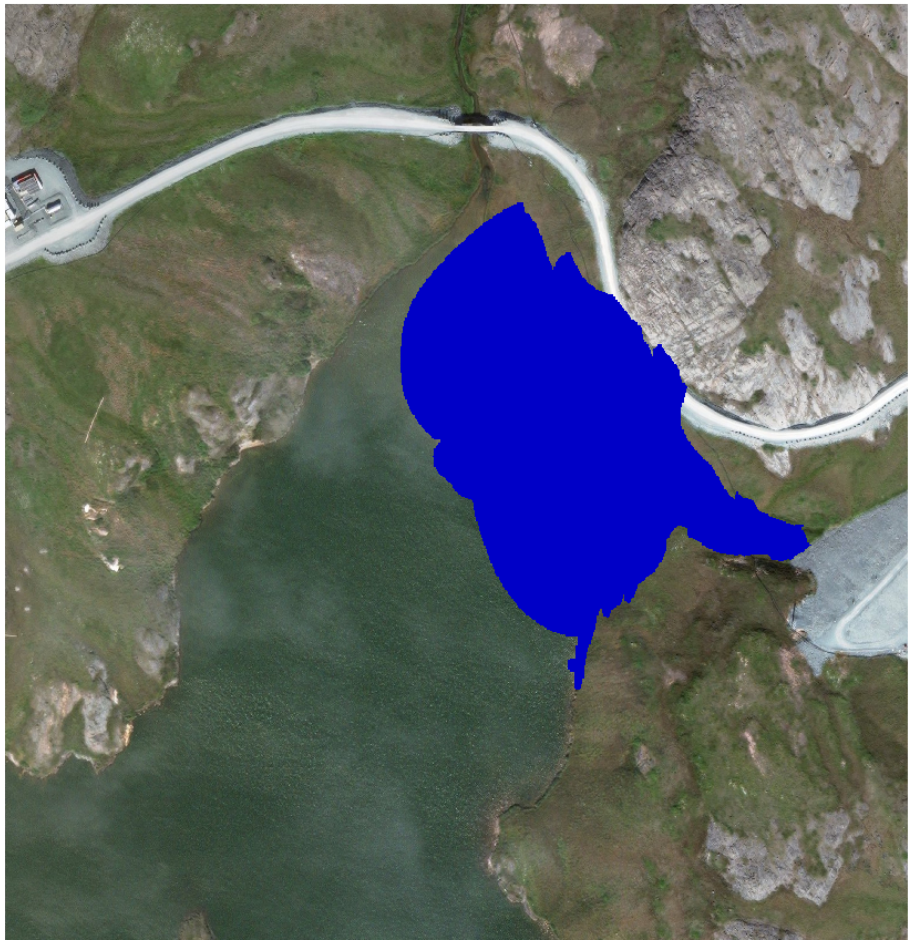
Grid Element Flow Depth (1080 sec.) [0:18:0]



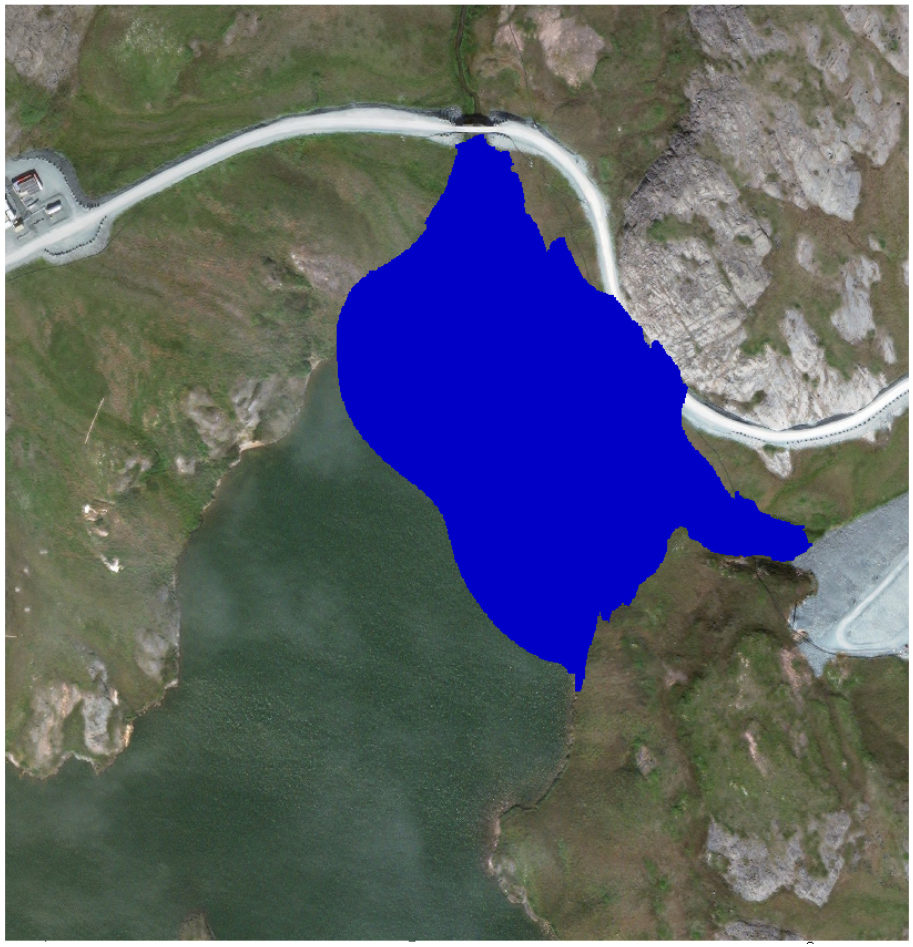
Grid Element Flow Depth (1440 sec.) [0:24:0]



Grid Element Flow Depth (2160 sec.) [0:36:0]

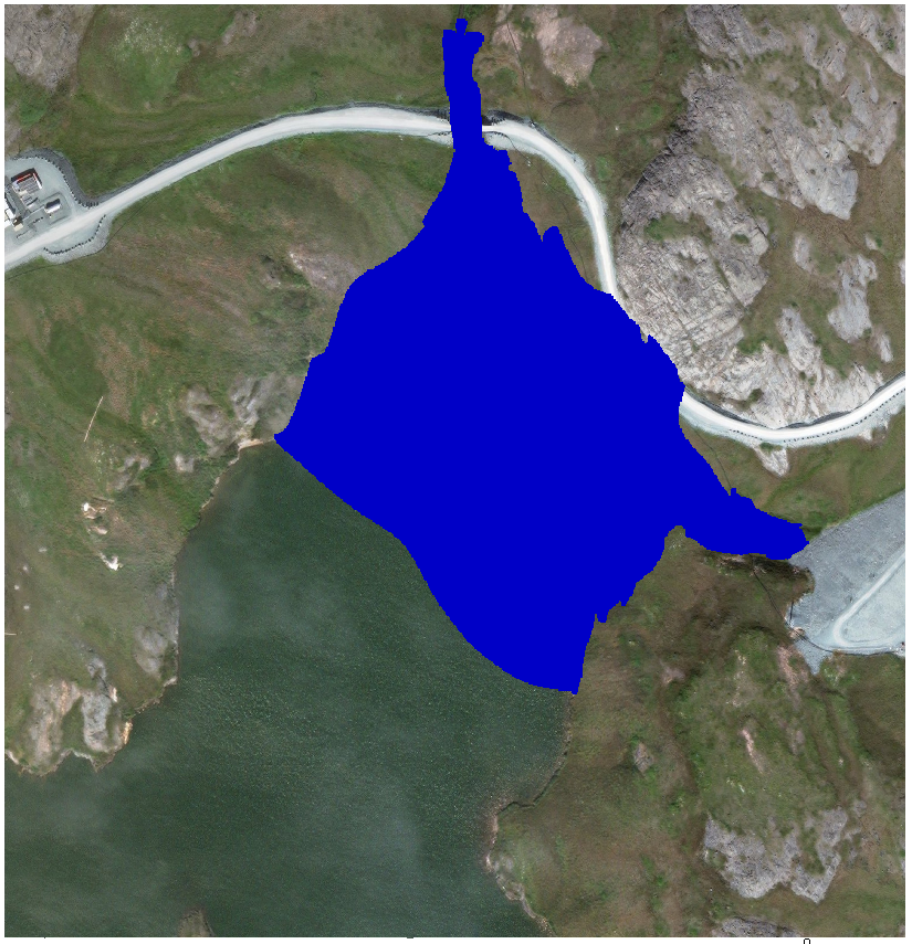


Grid Element Flow Depth (2880 sec.) [0:48:0]



~ 48 mins

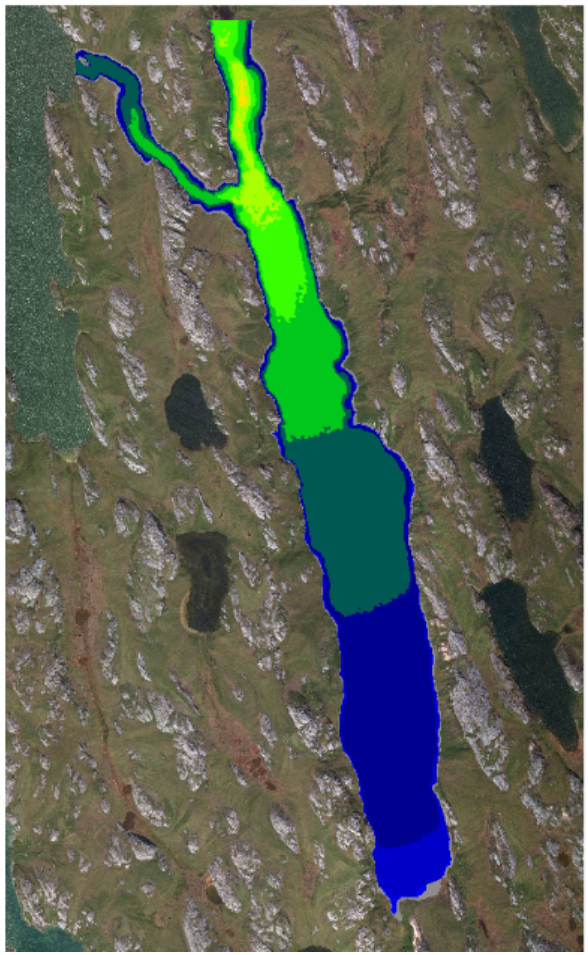
Grid Element Flow Depth (3600 sec.) [1:0:0]



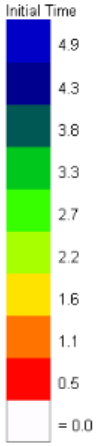
~ 60 mins

South Dam - General / Global Model (to Doris Lake)

Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



ARRIVAL TIME
(~hrs)



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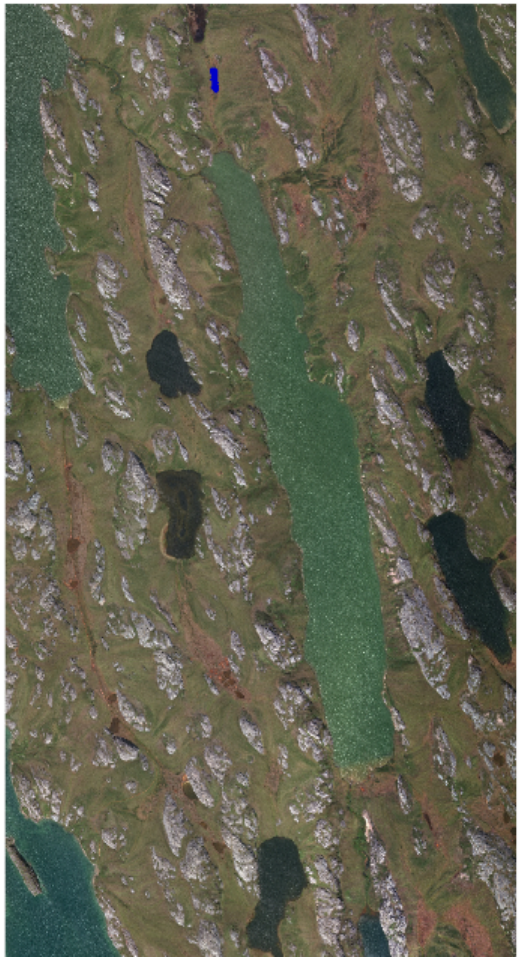
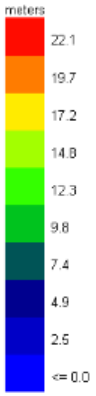
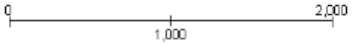
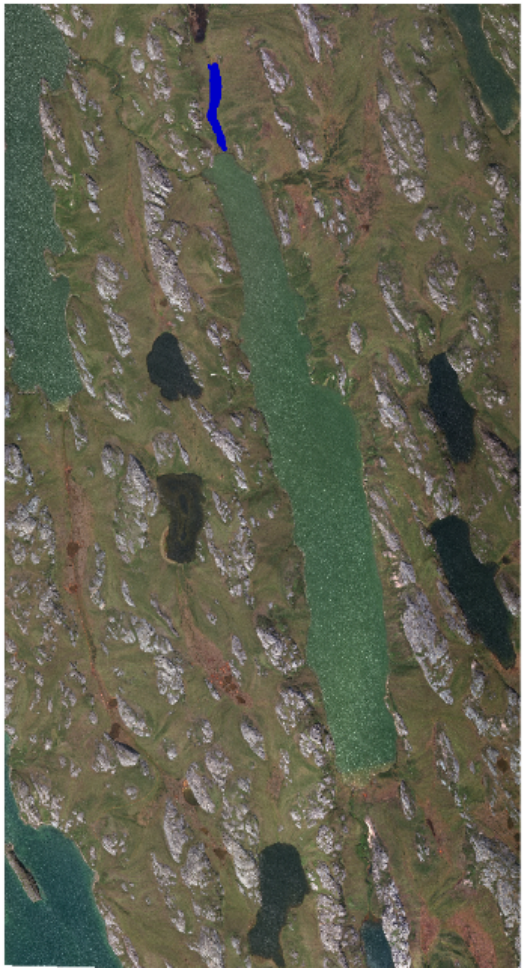
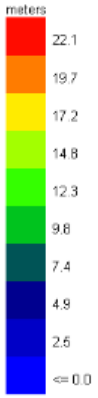




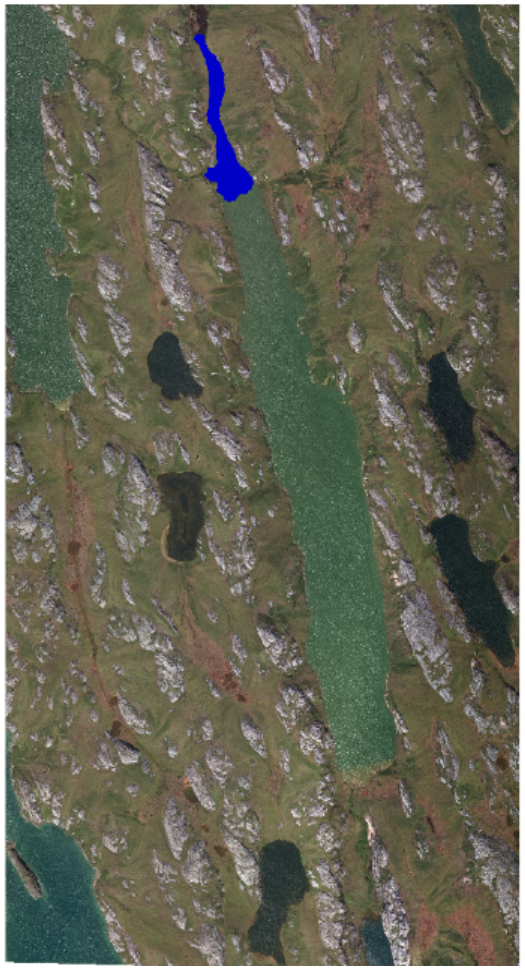


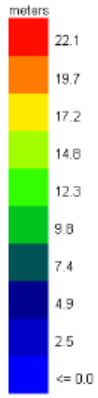
Grid Element Flow Depth (3600 sec.) [1:0:0]

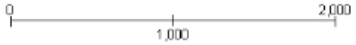




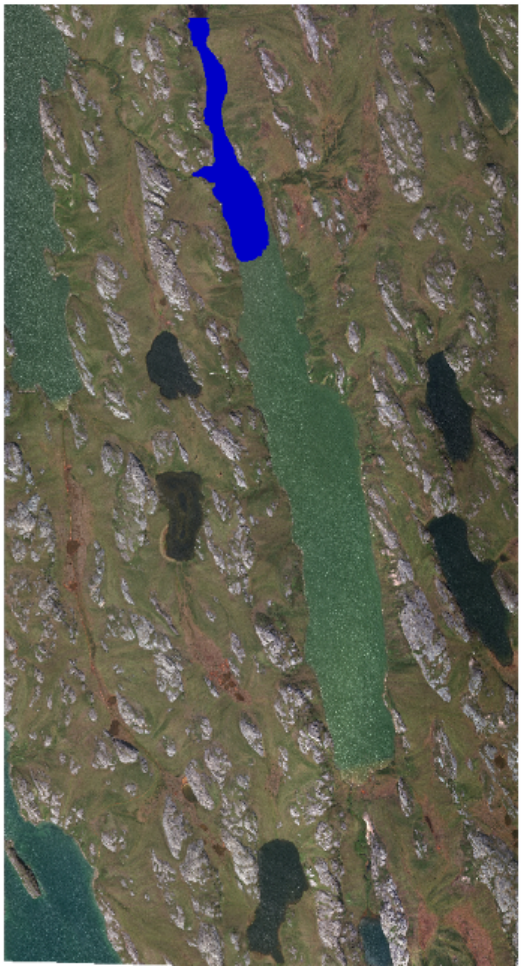
Grid Element Flow Depth (5400 sec.) [1:30:0]

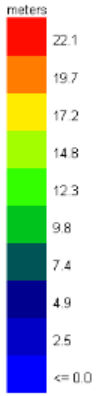


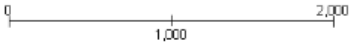




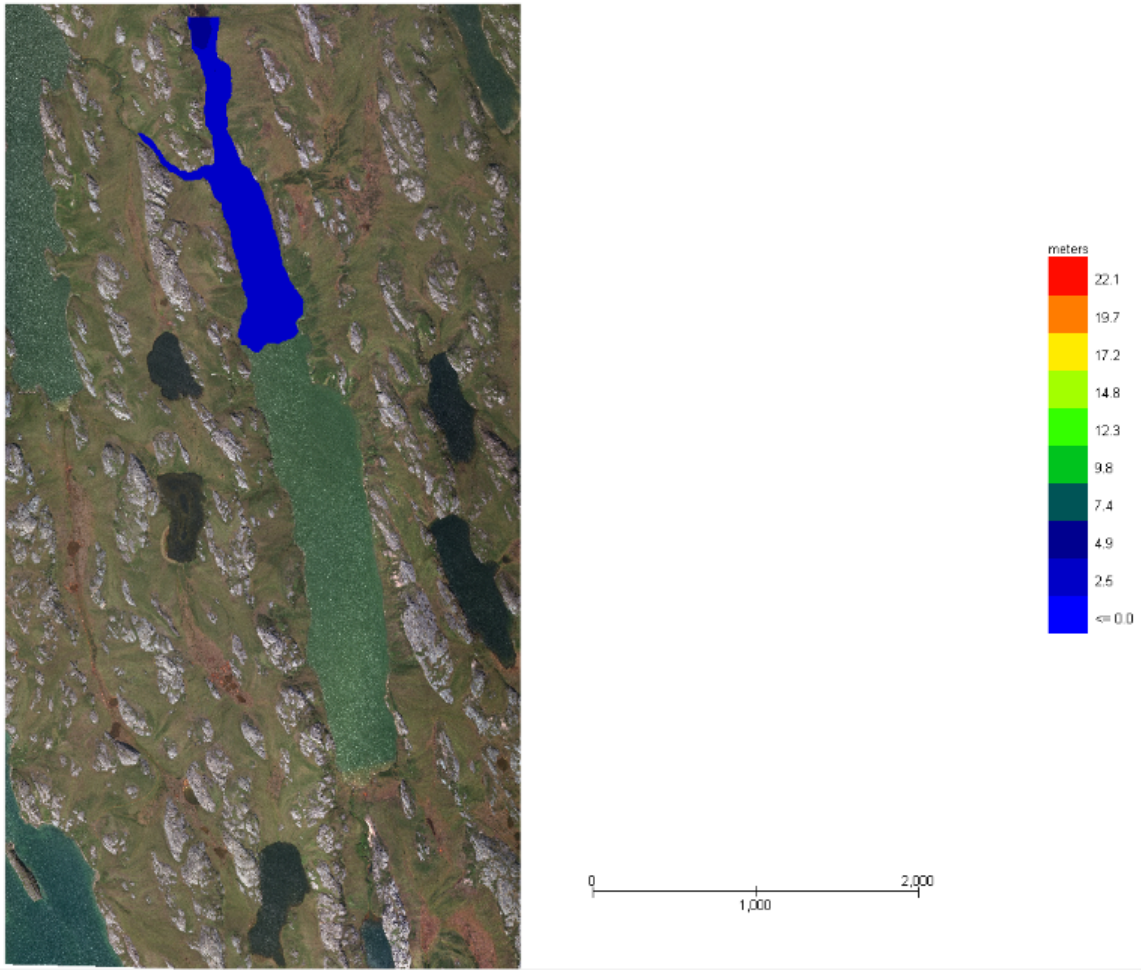
G Grid Element Flow Depth (7200 sec.) [2:0:0]



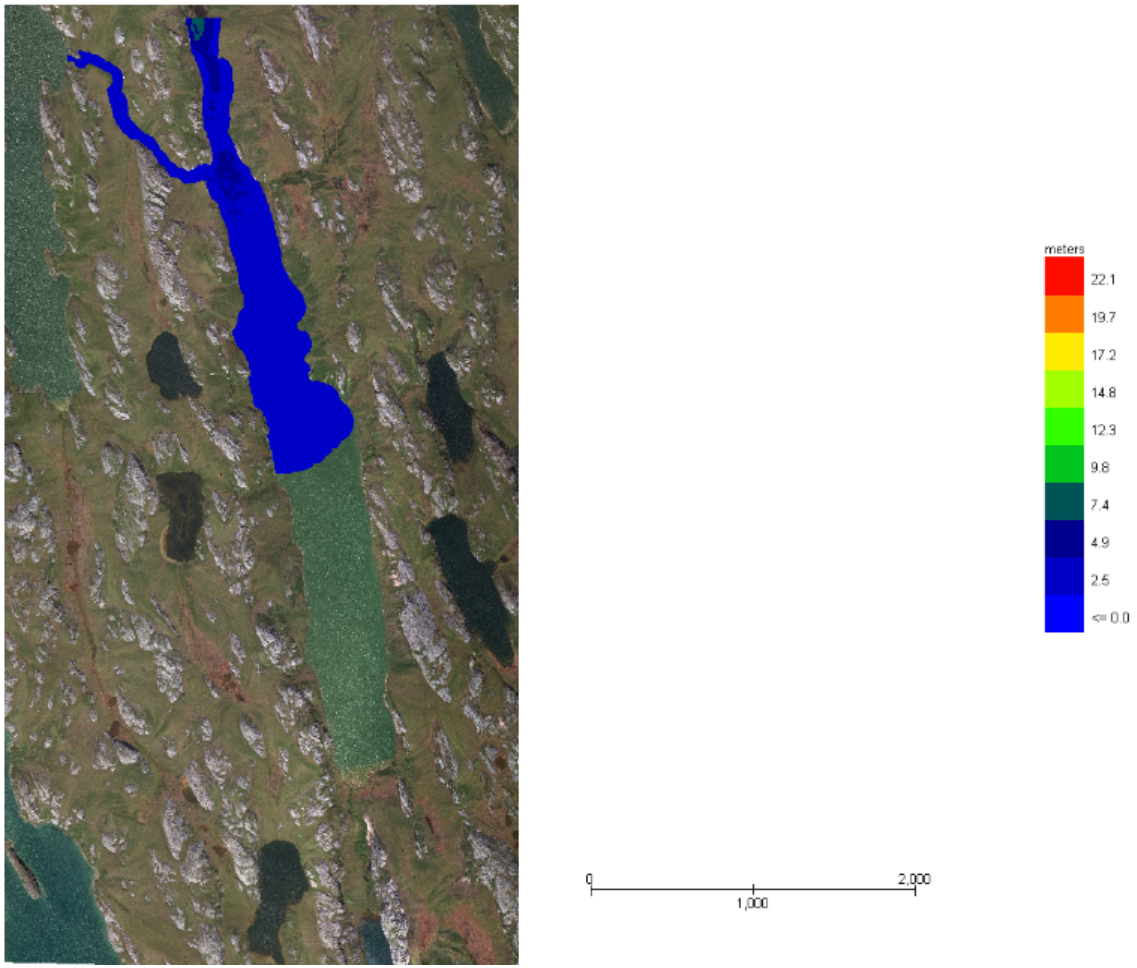




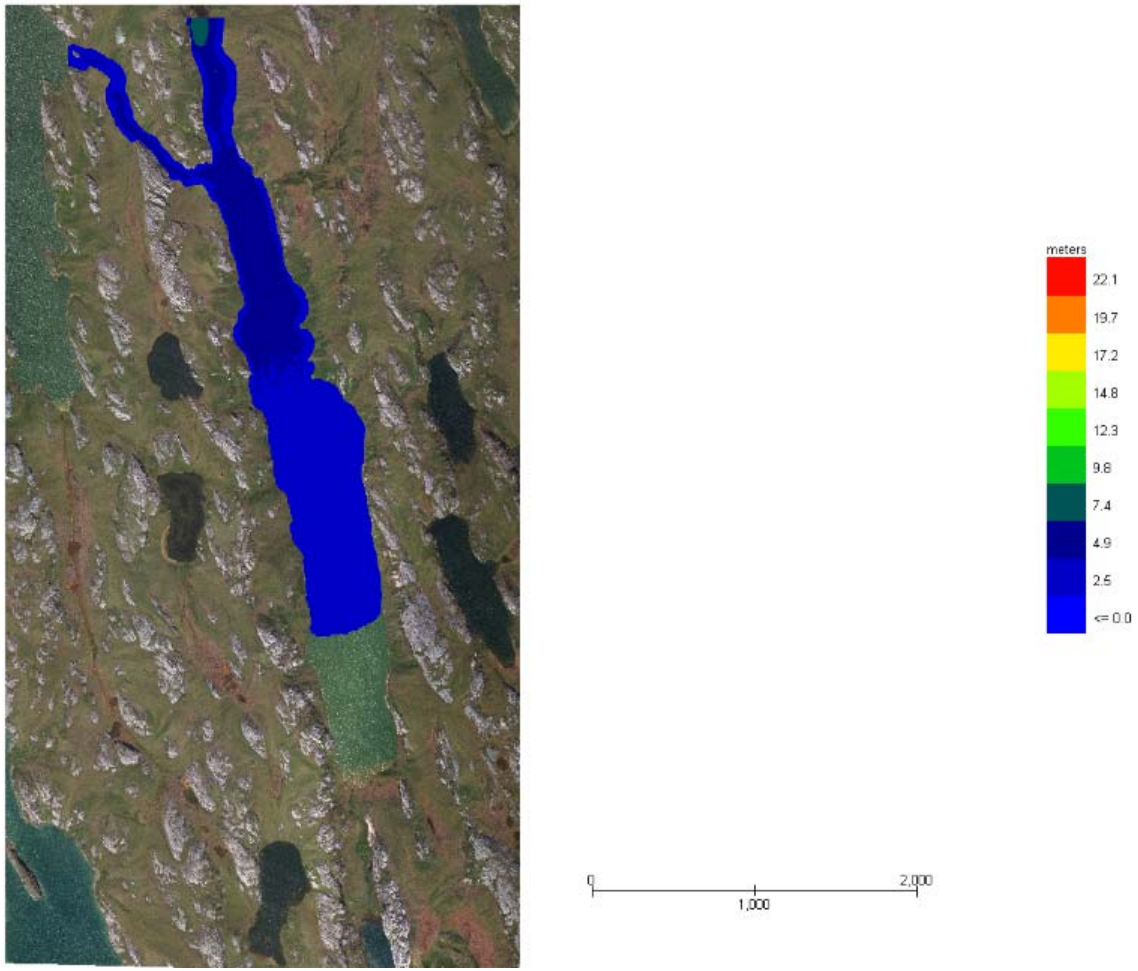
Grid Element Flow Depth (9000 sec.) [2:30:0]



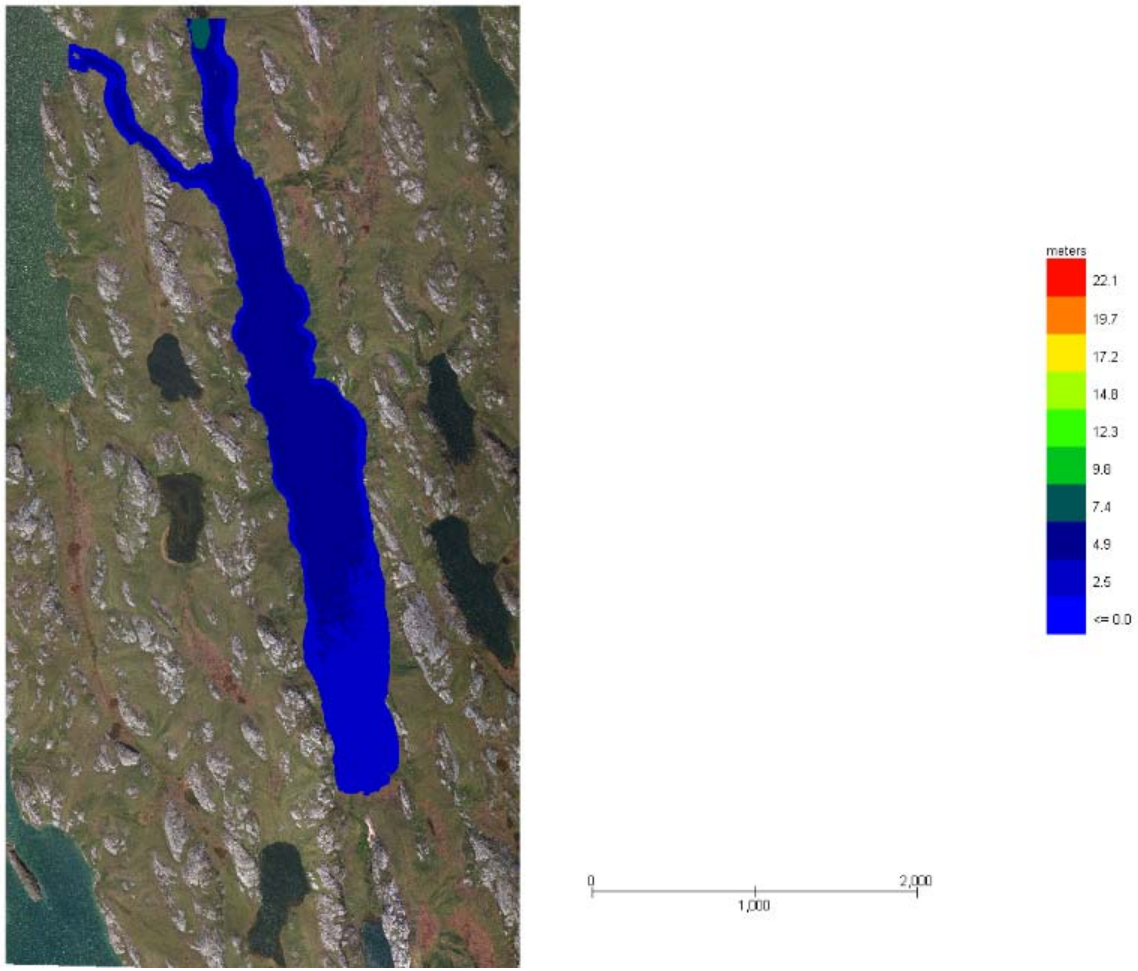
Grid Element Flow Depth (10800 sec.) [3:0:0]



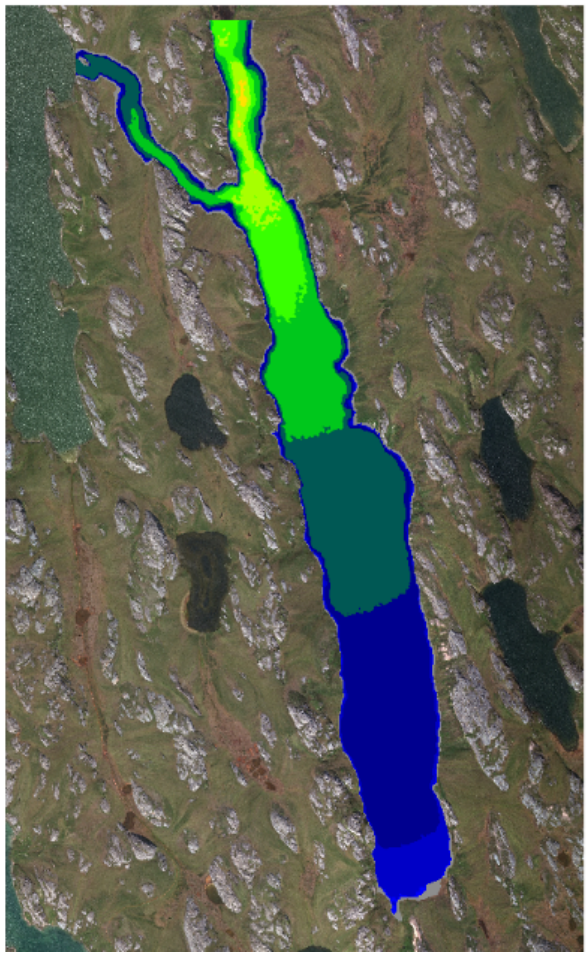
GRID ELEMENT FLOW DEPTH 12600 Sec [03:30:00]



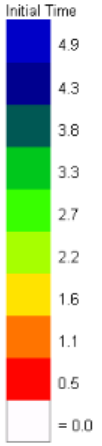
GRID ELEMENT FLOW DEPTH 14400 Sec [04:00:00]



Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



ARRIVAL TIME
(~hrs)



7 Summary of ERP (Dam) Scenarios

Informed from Inundation Maps

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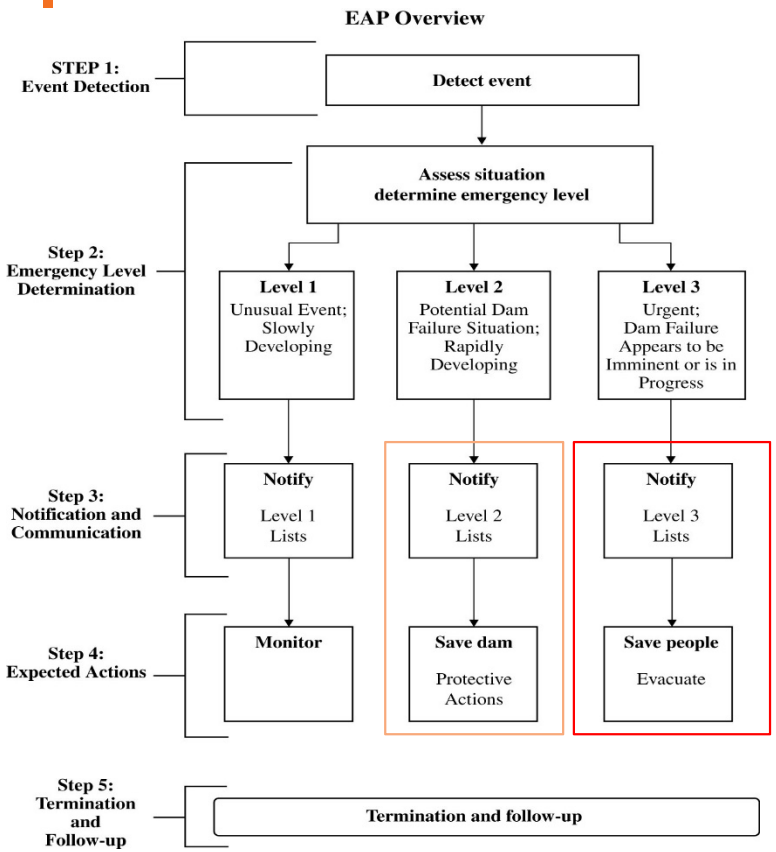
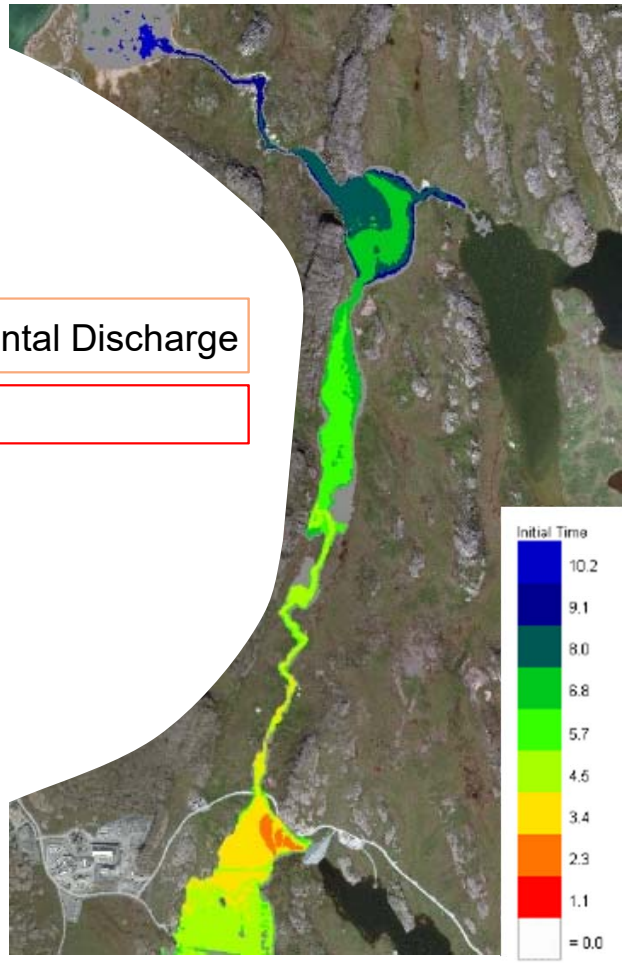
North Dam



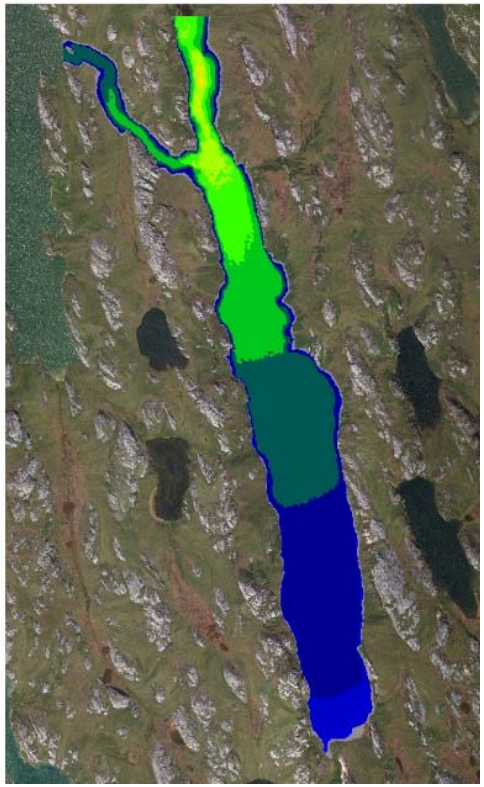
Ref: *BC MFLNRO – Guide & Template for Preparing Dam Emergency Plan in British Columbia, 2016*

Main scenarios are:

- Undesirable Environmental Discharge
- Breach of North Dam.
  - Breach travels North



South Dam



Main scenario is:

- Breach of South Dam
  - Breach travels south

5 Discussions on ERP (Dam) Scenarios

Dam Break or Uncontrolled Environmental Discharge

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North Dam

North Dam – Undesirable Environmental Discharge

To avoid compromising the dam stability, supernatant water would either be pumped:

- To the downstream side of the dam into Doris Lake, and then Doris creek, and conceivably (at lower concentrations) reach the entire north downstream catchment all the way to Roberts Bay; or
- Pumped via the Roberts Bay Discharge system out to the ocean (Roberts Bay)

North Dam

North Dam –Breach

Breaching of the North Dam would reach:

- Tail Lake outflow,
- Doris Lake, Doris Creek,
- and Little Roberts Lake further downstream.

Supernatant Water
Supernatant water could conceivably reach the entire north downstream catchment all the way to Roberts Bay.

Tailings Solids
Based on the current deposition plans (off the South and West dams on the south end of the TIA) there is no conceivable chance of tailings solids being released as a result of a breach of the North Dam.

Note: under a conservative case where the largest possible volume of supernatant water (over 12 Mm^3) is discharged rapidly over a period of less than 8hrs, then the Doris Creek Bridge would also be damaged.

South Dam

South Dam –Breach

Breaching of the South Dam would reach

- Ogama Lake,
- Ogama Lake outflow, and
- Subsequently, Doris Lake.

Supernatant Water

Supernatant water would eventually progress all the way along the drainage network to Roberts Bay. This being noted primary impact to Ogama the Doris Lake (after this quite diluted)

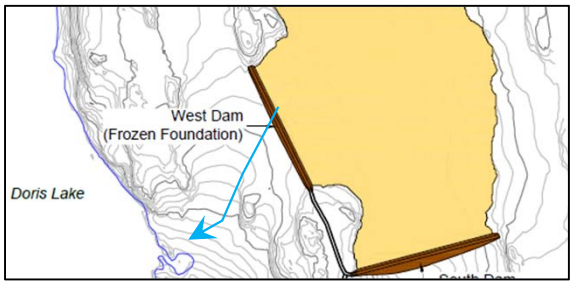
Tailings Solids

A breach of the South Dam could result in tailings solids releasing

- into Ogama Lake and
- though a remote chance, into the Ogama Lake outflow and ultimately Doris Lake.

Tailings solids would not be expected to be transported any further than Doris Lake, with most tailings between the South Dam and down to and into Ogama Lake.

West Dam

West Dam – Breach		
Tailings breaching the West Dam would reach Doris Lake.  	**Supernatant Water** Supernatant water could progress all the way along the drainage network to Roberts Bay.	**Tailings Solids** Tailings solids could reach Doris Lake, but at a location about 3.5 km away from the Doris Lake outflow. It is not expected the solids would migrate any further.

General Note:

- Once the West Dam (Phase 2) is built on site an updated extreme failure mode of ‘West Dam – Breach’ will be required to be added to this OMS and the site ERP.

6 Discussions on ERP (Pipelines and Pumping) Scenarios

Malfunctions, Leaks, Burst Punctures

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Pipelines and Pumping

7.1 Pipeline Burst, Leak, or Puncture

Notification

The table below identifies who should be informed when a puncture or burst in the TIA pipeline system is observed.

If you are a…	then immediately notify the…
TIA operator	mill manager.
non-TIA management person	surface operations supervisor.
surface operations supervisor	mill manager.

Inspection by Mill Manager

After inspecting the pipeline, can a repair be made without ceasing operations?

- If yes, see if an alternately pipeline can be used until the current line is repair.
- If yes, and an alternate pipeline is not above, coordinate an emergency mill shutdown complete repairs.
- If no, order repairs.

Repairs

Repairs are performed by the TIA operator or specialist contractor. Tailings in any damaged lines may be emptied into the Emergency Tailings Catch Basis if / as required to help facilitate repairs.

From latest version of TMAC Doris TIA OMS (updates in progress)

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Pipelines and Pumping

7.2 Heat Trace Cable Malfunction

When Required?	Heat tracing is only required for • no-flow conditions under freezing temperatures, • flow conditions below −30°C, and • shutdowns greater than 24 hours. Therefore, heat tracing is normally switched off, and preventative maintenance is carried out to maintain flow in all pipes.
Notification	The TIA operator should notify the mill manager immediately when a malfunction in the heat tracing cable is observed during required operating periods.
Inspection by Mill Manager	After inspecting the pipeline, determine the extent of the malfunction and time required for repair. Then, coordinate the repair.
Repairs	Repairs are performed by the TIA operator or specialist contractor.

From latest version of TMAC Doris TIA OMS (updates in progress)

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Pipelines and Pumping

7.3 Pumping or Reclaim System Malfunction

Notification

The table below identifies who should be informed if TIA or Roberts Bay Discharge system pipeline system malfunctions, fails or shuts off

If you are a…	then immediately notify the…
TIA operator	mill manager.
non-TIA management person	surface operations supervisor.
surface operations supervisor	mill manager.

Inspection by Mill Manager

After inspecting the pump, can a repair be made without ceasing operations?

- If yes, coordinate an emergency mill shutdown and complete repairs.
- If no, order repairs or install new pump / system.

Repairs

Repairs are performed by the TIA operator or specialist contractor.

From latest version of TMAC Doris TIA OMS (updates in progress)

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Attachment 2

Recommendations and TMAC Responses – TIA (TMAC, 2020)

Table 1 *2019 Tailings Impoundment Area Annual Geotechnical Inspection Report Recommendations and TMAC Response*

Inspection Item	2019 Recommendations	TMAC Response
General TIA Management Recommendations		
Third Party Dam Safety Review	Conduct an independent third-party Dam Safety Review for both the North and South Dams in the summer of 2021.	An independent third-party Dam Safety Review is scheduled to be conducted for both the North and South Dams in the summer of 2021
Tailings Operating, Maintenance and Surveillance (OMS) Manual and Emergency Response Plan (ERP)	An update to the OMS manual is in progress by SRK and will be submitted by Q4, 2020. This update is aimed to be a notable improvement to the current OMS. This noted, additional updates are expected in Q3 and Q4 2020. The focus of the OMS updates in Q3 and Q4 will be further refinement of the Trigger Action Response Plans (TARPs). The OMS for this facility will be a 'living' document that is expected to be reviewed annually.	N/A
	TMAC should ensure all staff are properly informed and trained on the contents of the OMS Manual.	TMAC conducts regular review of the OMS manual with key staff including emergency response scenarios. Components of the OMS manual are included with new hire orientations.
	At the time of writing this report, TMAC was in the process of developing a standalone 'Hope Bay Project Dam Emergency Plan', rather than updates to the ERP, to address dam emergencies. It will incorporate inundation mapping and dam break scenarios. The standalone dam emergency plan will be released upon completion of the OMS update to ensure alignment. An Emergency Reponses Plan exists for the site; however, this document was lacking sufficient detail for a specific emergency at the TIA, if one were to occur. In 2019 SRK visited site and held a session with site personnel to go over preliminary dam break inundation maps completed by SRK and to provide inputs into what should be included in the site ERP updates to ensure the TIA is properly covered in this document. An update to the ERP is recommended in 2020 to provide additional details for the TIA.	TMAC engaged SRK to assist with a dam break analysis of the North and South Dams to assist with updating the emergency response planning. TMAC is developing a standalone 'Hope Bay Project Dam Emergency Plan' to address dam emergencies.
TIA Responsible Parties	TMAC must agree on the roles and responsibilities for the TIA, train and inform personnel of their duties, and operate the facility accordingly. This will be an ongoing recommendation that is expected to be repeated annually. The roles and responsibilities for the TIA will be defined in	No discrepancies exist regarding the lines of responsibilities as they are defined in the TIA OMS. TIA OMS training and awareness will continue to provide for all departments and individuals

Inspection Item	2019 Recommendations	TMAC Response
	the OMS update, to be released in 2020.	responsible for operation of the facility.
Monitoring Standard Operating Procedures (SOPs)	Update the Monitoring SOP to include South Dam monitoring requirements. SRK is currently preparing a separate SOP for the South Dam, and one already exists for the North Dam. A draft version of the South Dam SOP was submitted to TMAC in June 2020 and a final version is expected in July 2020.	TMAC will adhere to the updated Monitoring SOP upon issuance for use.
Compliance with Monitoring Requirements	Conduct monitoring in accordance with the Monitoring SOP, paying attention to those areas where conformance is not consistently met.	TMAC will carryout monitoring activities as per the Monitoring SOP. Any deviations from protocol will be communicated to the Engineer of Record (EOR).
North Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs)	There are no specific recommendations for the installed GTCs. However, TMAC should aim to improve performance tracking of the dataloggers at the South Dam and check to see if cables are being damaged by wildlife after spring melt in order to confirm that current cable protection is adequate.	In cooperation with the EOR, TMAC will continue to inspect and track the performance of all instrumentation on both the North and South Dams.
Thermosyphons	The 2018 recommendations were completed in 2019 and Arctic Foundations Canada (AFC) visited the site for an inspection. Additional details are provided in this 2019 AGI (see Appendix A).	N/A
CR1000 Datalogger Battery Voltage	The external CR1000 datalogger batteries should continue to be monitored and recharged annually or replaced as needed.	Battery charge data is reviewed monthly and batteries are maintained accordingly.
Inclinometers	The inclinometer and associated readout device should be recalibrated every 3 years as per recommended best practice. SRK was aware that TMAC sent this instrument for recalibration but due to COVID-19, the instrument calibration was unable to be performed and had to be returned from the out of country manufacturers. This recommendation should be revisited before the spring of 2021.	The inclinometer and readout device will be sent out for calibration upon the onset of winter when dam movement is less likely to occur.
Survey Monitoring Points	Backfill the erosion around survey monitoring point ND−DSP−100 at the North Dam.	Erosion observed at ND-DSP-100 has been backfilled.
	Continue to carefully observe the North Dam downstream shell settlement points ND-SSP-080-3 and ND-SSP-110-3 to determine if thaw settlement of the toe is causing undue deformation.	Routine inspections of the downstream dam shell including ND-SSP-080-3 and ND-SSP-110-3 will continue as recommended.
Creep Displacement	None.	N/A

Inspection Item	2019 Recommendations	TMAC Response
Walkover Surveys	The required weekly walkover surveys at the North Dam are not being completed in accordance with the SOP. This is an important surveillance activity as defined in the OMS Manual and needs to be complied with.	TMAC acknowledges that not all 52 weekly inspections were completed. Improvements have been made to close this gap each year and TMAC will continue to aim for full compliance with the recommended frequency.
North Dam Seepage	Continue water quality monitoring of North Dam seepage according to the methods outlined in SRK (2018b) (this was completed in 2019).	TMAC will adapt the North Dam Seepage program to include the additional recommendations.
	Conduct at least one additional frost probe survey along the same transects in early summer and early fall, following the same procedure as in 2018 and 2019. Based on current favourable results, SRK will revisit the requirements for the frost probe surveys as part of the 2020 AGI and determine if further surveys are required beyond 2020.	TMAC will continue with the recommended frost probe survey in 2020.
AGI Physical Inspection	None.	N/A
South Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs) and D405 Dataloggers	· Complete a walk over survey of the South Dam after spring melt and look for any exposed or damaged ground temperature cables. This will allow for preventative maintenance to be done if exposed cables are observed, which will help to limit the potential for damage from wildlife. · SRK to further assess, if repairs are not possible, replacement of Ground Temperature Cables SD-VTS-155-US, SDVTS-240-US and SD-VTS-240-DS will be required. · Manually download data from each datalogger once annually or as specified by the EOR.	TMAC will conduct survey of all GTC cables and report results to EOR, Maintenance and repairs will be conducted as required. Manually downloads will be collected annually.
Survey Monitoring Points	None.	N/A
Physical Inspection of the South Dam and Walkover Surveys	Start weekly walkover surveys of the South Dam in 2020. This is an important surveillance activity. Additional details will be provided to TMAC in the South Dam SOP.	Weekly walkover surveys started in 2020 and will continue as per the South Dam SOP.
TIA-Wide Monitoring		
Tailings Deposition System	TMAC should install the dedicated mine water discharge pipeline to the TIA as soon as possible to allow tailings deposition to recommence from the South Dam. It is critical that tailings deposition from South Dam recommence in order to maintain a beach length of at least 100 m at all times, for all TIA water levels. *UPDATE: this was*	N/A

Inspection Item	2019 Recommendations	TMAC Response
	addressed at the start of 2020 and is now complete. The Roberts Bay Discharge system is now operational.	
	Saline mine water may only be discharged together with tailings from, or within, 300 m of the South Dam provided the freezing point depression is less than 0.5oC (around 4,500 mg/L Cl maximum equivalent). If the freezing point depression exceeds 0.5oC, saline mine water may only be discharged with tailings at other designated tailings discharge points further than 300 m from the South Dam or directly into the Reclaim Pond. The freezing point depression calculation is provided in this AGI and will be incorporated by SRK into the updated OMS Manual (update currently in progress).	TMAC continues to analyze mine effluent and tailings to determine if the depression freezing point is less than 0.5°C as recommended by the EOR. Effluent or tailings that exceed the recommended freezing point are directed away from the South Dam maintaining the recommended 300m buffer.
	The tailings discharge system must be operated in accordance with the designated tailings discharge plan. Primary spigot moves should be expected around, or shortly afterwards, spring melt and again prior to winter freeze up.	Tailings deposition will be executed as per the guidance in the tailings deposition plan.
	Areas along the eastern shoreline of the TIA where tailings discharge has occurred at elevations above 36.5 m need to be carefully monitored to determine if permafrost damage is occurring due to tailings flow and vegetation dieback. Should any damage be noted, appropriate proactive mitigation may be required.	No vegetation dieback has been observed in these areas to date. TMAC will continue to monitor these areas and apply mitigate actions as required.
Emergency Dump Catch Basins	Repair the Western Emergency Dump Catch Basin at the earliest opportunity to ensure liner movement does not occur and impact the as-built storage capacity of this Emergency Catch Basin.	The tailings emergency catchment basin will be repaired at the earliest opportunity.
Pipelines (Reclaim, Tailings Deposition and TIA Discharge)	TMAC must carefully inspect all pipelines placed directly on the tundra for signs of vegetation dieback and associated flow path channelling. Where this is occurring, the pipeline must be relocated to follow existing all-weather road shoulders, and appropriate remediation needs to be put in place where damage has occurred. Going forward, TMAC should consider abandoning the practice of placing pipelines directly onto the tundra.	TMAC will continue to monitor all pipelines placed directly on the tundra for signs of tundra damage. To date, TMAC has not observed any issues with insulated lines on the tundra. If damage is observed, TMAC will take the appropriate action to prevent further damage to tundra and remediate where required.
	The permafrost thermal erosion feature that has developed along the northern shore of the TIA was backfilled by TMAC in 2019. This area should continue to be monitored to ensure that additional thermal erosion does not result in this area.	TMAC will continue to monitor the performance of the backfill and cover.
Shoreline Erosion	None.	N/A

Inspection Item	2019 Recommendations	TMAC Response
TIA Water Balance	It is of paramount importance that the Roberts Bay Discharge System Pipeline be completed during the summer of 2019. Further delay of this may result in reduced operations. *UPDATE: this was addressed at the start of 2020 and is **now complete**. The Roberts Bay Discharge system is now operational.*	N/A
Climate Data	None.	N/A
TIA Water Quality	No recommendations; however, the following comments are made below. · The water treatment plant for the TIA is required to be maintained in good operational condition so that discharge of supernatant water can occur once the Roberts Bay Discharge System Pipeline is operational, and allow treated water to be discharged in order to maintain water levels in the TIA below the full supply level. *UPDATE: as of the start of 2020 the Roberts Bay Discharge system and the connected water treatment plant is now operational.*	A water treatment facility was commissioned in November 2019 and is actively treating underground mine water. TIA discharge is currently occurring within the criteria outlined under the MDMER. TMAC will action water treatment for the TIA discharge water when required.
TIA Reclaim Water Pad / 710 Pumphouse Pad	Notable settlement was noted at the TIA Reclaim Jetty Pad (also referred to as the 710 Pumphouse pad). Upon visual inspection and from review of the as-built data, it looks like new ROQ material was placed off the edge of the pad in thick, end dumped lifts in order to widen the pad for the new 710 pumphouse. There are notable stability concerns with this pad as large settlements and notable cracking indicate that a failure of this pad (albeit slow) appears to be occurring. However, it should be noted that the rate of movement could increase suddenly causing a sudden failure, and this risk should not be ignored. Monitoring of this area (at least weekly during winter and daily during months with no ice cover on the lake) should be completed. It is recommended that remediation measures be completed for the pad in order to stabilize the fill and prevent further deformation. This is expected to consist of placing additional fill along the outside of the access road and pad to reduce the overall slope and provide additional confining stress at the toe of the pad (which is currently underwater). Rates of loading must be controlled and slow enough in order to avoid inducing excess pore pressures in the foundation. This means that it may take weeks to build this small additional fill and that the dumping faces should be spread	TMAC has been continuously monitoring settlement of the reclaim jetty. Fill will be placed along the toe of the jetty to improve slope stability in this area in 2020.

Inspection Item	2019 Recommendations	TMAC Response
	out as much as possible. Material should be end dumped back from the working face and spread with an excavator with the largest reach on site (to limit loading at the crest).	