Independent Expert Engineering Investigation and Review Panel

Report on Mount Polley Tailings Storage Facility Breach
Media Presentation

January 30, 2015

PURPOSE OF INVESTIGATION

The purpose of the investigation has been as follows:

- To investigate and report on the cause of the failure of the tailings storage facility that occurred on August 4, 2014 at the Mount Polley Mine in B.C.
- In addition, the Panel may make recommendations to government on actions that could be taken to ensure that a similar failure does not occur at other mine sites in B.C.
- The Panel is authorized, as part of its investigations and report, to comment on what actions could have been taken to prevent this failure and to identify practices or successes in other jurisdictions that could be considered for implementation in B.C.

PURPOSE OF INVESTIGATION

Further, it was expected that the Panel would:

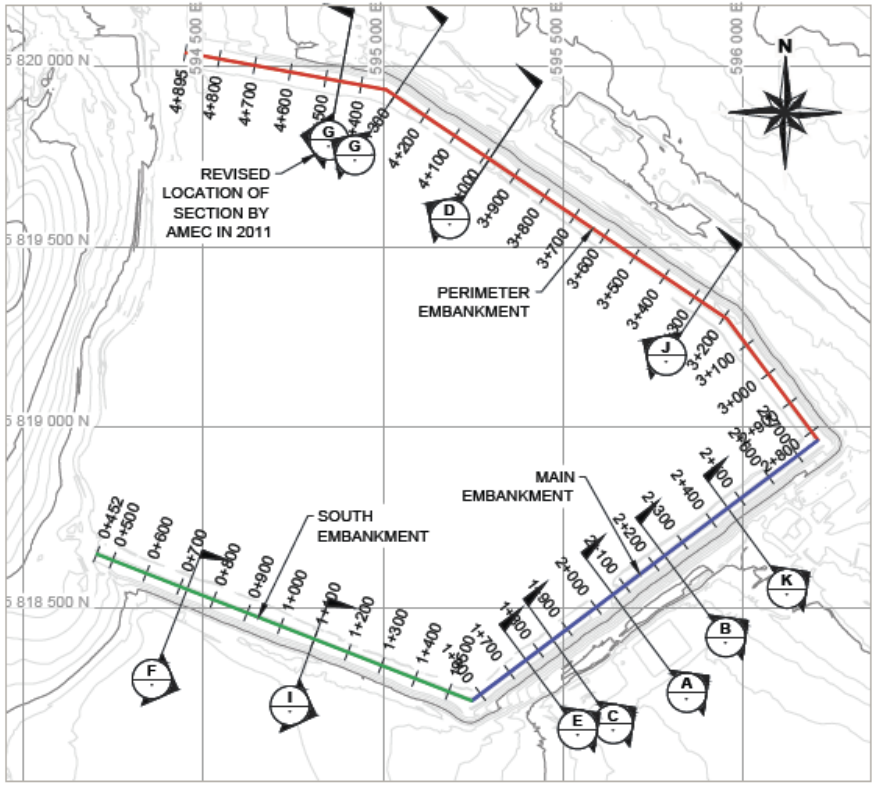
- Identify any mechanism(s) of failure of the tailings storage facility.
- Identify any technical, management or other practices that may have enabled or contributed to the mechanism(s) of failure. This may include an independent review of the design, construction, operation, maintenance, surveillance and regulation of the tailings storage facility.
- Identify any changes that could be considered to reduce the potential for future such occurrences.

LIMITATIONS: WHAT THE PANEL DID NOT DO

- The Panel shall perform its duties without expressing any conclusions or recommendations regarding the potential civil or criminal liability of any person or organization.
- The Panel shall further ensure that the conduct of the inquiry does not in any way impede or conflict with any other ongoing investigation or proceeding related to these matters.
- Specifically, the Panel's review will not in any way impede investigations conducted by Mines Inspectors, Conservation Officers or other regulatory agencies and any related proceedings

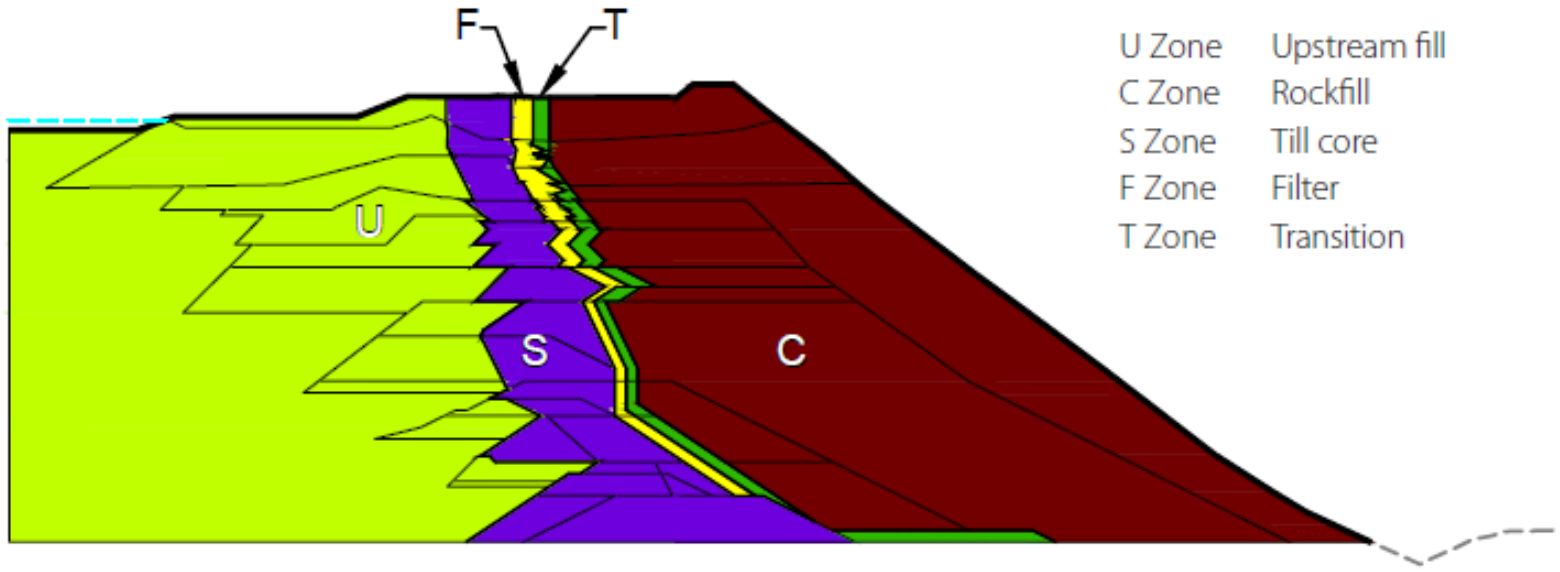
BREACH ORIENTATION

FIGURE 3.1.1: TAILINGS STORAGE FACILITY PLAN



DAM ZONATION

FIGURE 4.1.1: SIMPLIFIED CROSS-SECTION OF THE MOUNT POLLEY DAM



MULTIPLE HYPOTHESES OF FAILURE

Based on the experience of the Panel with both water and tailings dams, the Panel determined that the following four classes of failure mechanisms required consideration:

- Human intervention
- Overtopping
- Piping and cracking
- Foundation failure

ELIMINATION OF HYPOTHESES

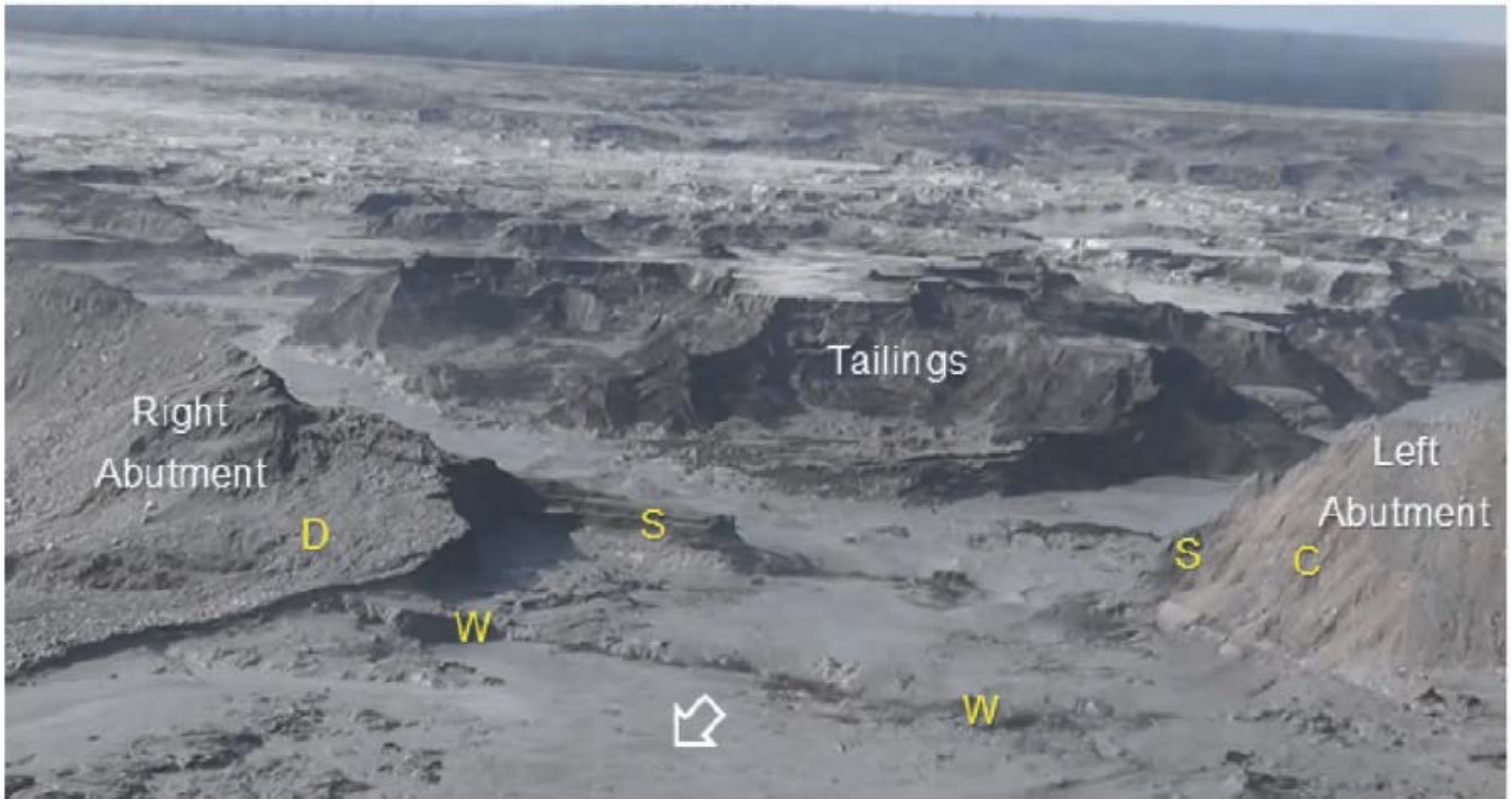
- The Panel found no evidence of failure due to human intervention.
- The Panel has found no evidence of failure due to overtopping prior to breach development.
- Notwithstanding a number of concerns, the Panel did not find evidence that the breach was caused by piping and/or cracking resulting in uncontrolled internal erosion

CRITICAL FAILURE MODE

- The Panel concluded that evidence indicates the breach was the result of failure in the foundation of the embankment, a failure that occurred in a glaciolacustrine (GLU) layer of the embankment's foundation.
- According to the Panel's report: "The Panel concluded that the dominant contribution to the failure resides in the design. The design did not take into the account the complexity of the sub-glacial and pre-glacial geological environment associated with the perimeter embankment foundation. As a result, foundation investigations and associated site characterization failed to identify a continuous GLU layer in the vicinity of the breach and to recognize that it was susceptible to undrained failure when subject to the stresses associated with the embankment."

WHAT DID WE FIND?

FIGURE 5.1.1: VIEW LOOKING UPSTREAM THROUGH THE BREACH (ARROW SHOWS DIRECTION OF OUTFLOW)



WHAT DID WE FIND?

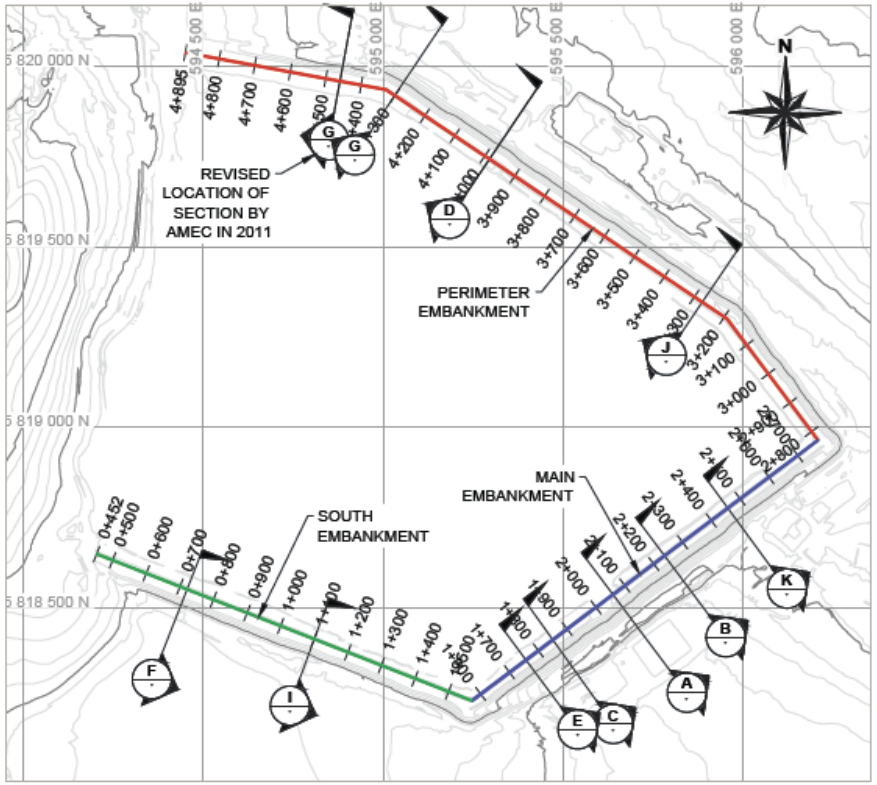
FIGURE 5.1.5: APPARENT BEDDING ROTATION ON LEFT ABUTMENT OF BREACH (SEPT. 4, 2014 PHOTO)

WHAT DID WE FIND?

FIGURE 5.1.6: SLIDING-RELATED FEATURES AT RIGHT ABUTMENT (SEPT. 4, 2014 PHOTO)

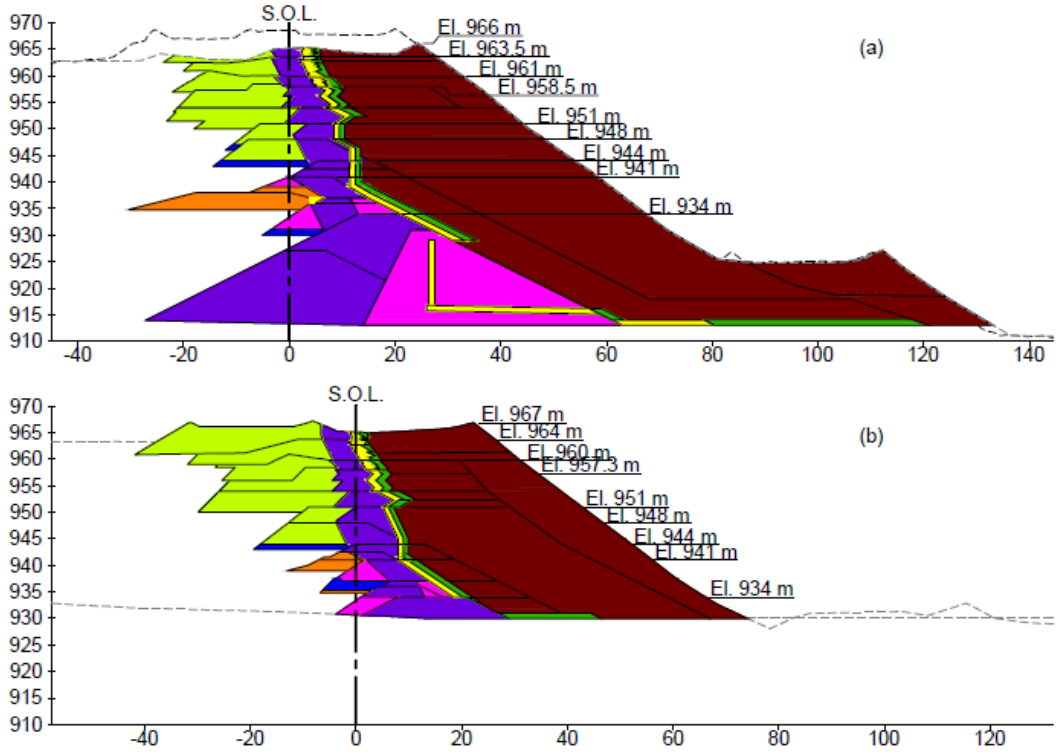
BREACH ORIENTATION

FIGURE 3.1.1: TAILINGS STORAGE FACILITY PLAN

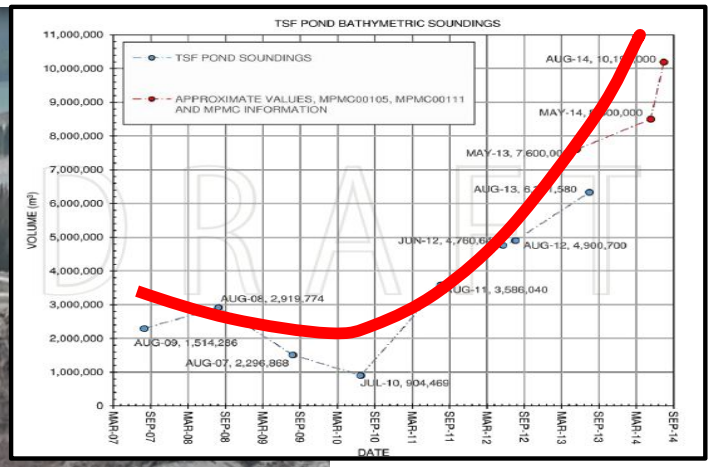


WHAT DID WE FIND?

FIGURE 5.4.10: DAM CONFIGURATION ON AUGUST 3, 2014. (a) MAIN EMBANKMENT (b) PERIMETER EMBANKMENT AT BREACH SECTION



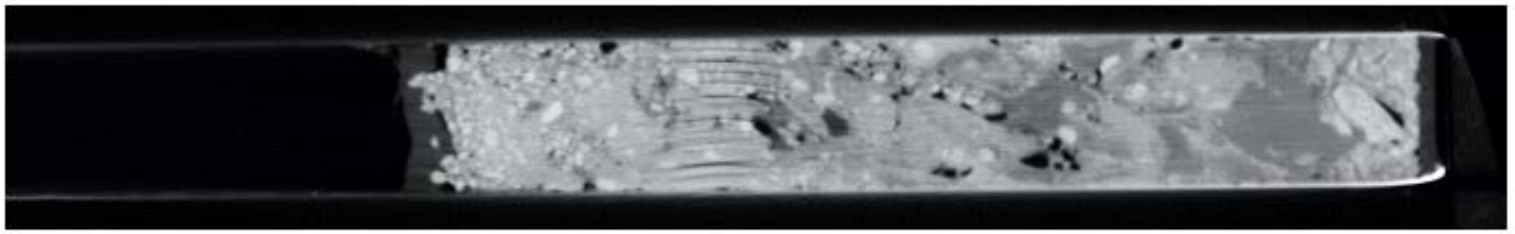
WHAT DID WE FIND?



- Most of the tailings were released by erosion from the large volume of water available

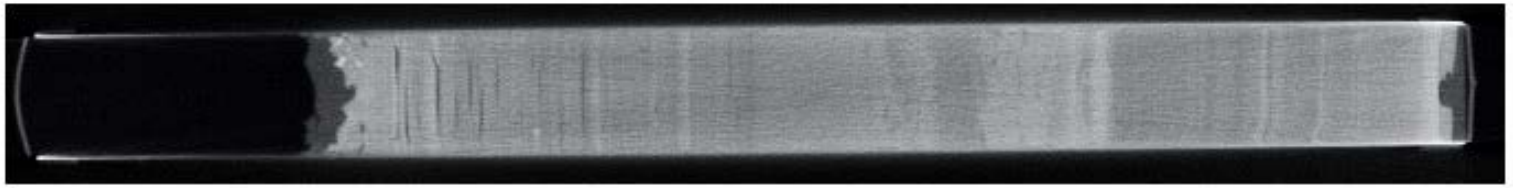
WHAT DID WE FIND?

WHAT DID WE FIND?



TILL SAMPLE (MR14-104-SA8)

DEPTH: 11.4 TO 12.0 M / EL. 920.3 TO 919.7 M



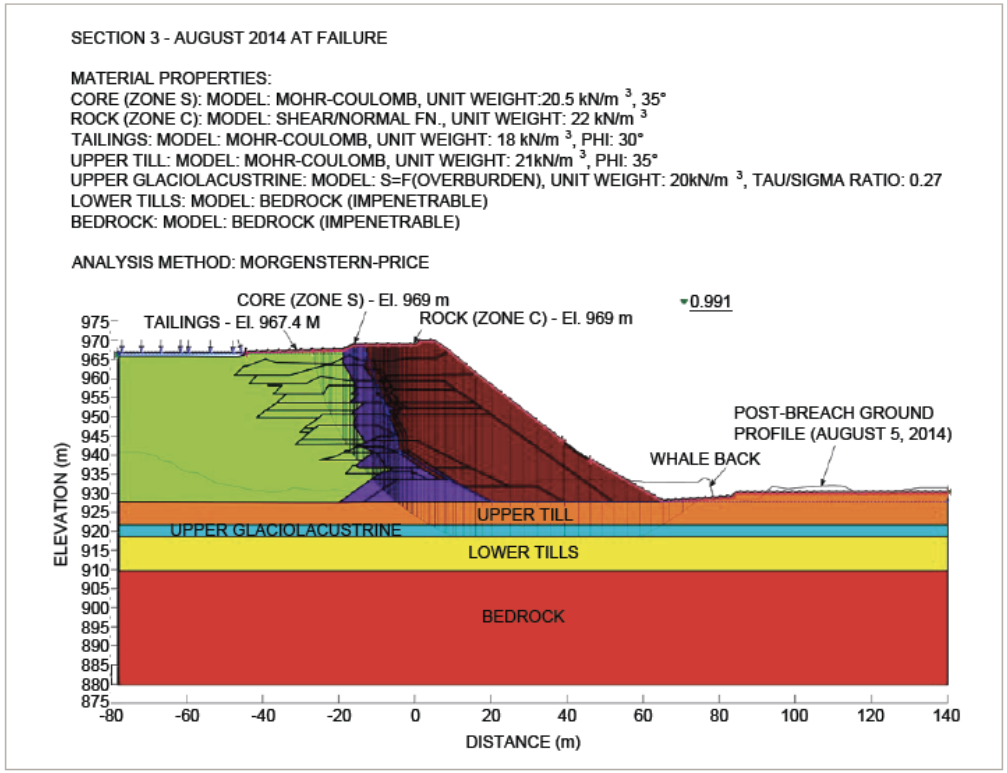
UPPER GLU SAMPLE (MR14-106E-SA3)

DEPTH: 8.2 TO 8.8 M / EL. 920.5 TO 919.9 M

WHAT DID WE FIND?

WHAT WAS ANALYSED?

FIGURE 6.2.1: DETAILED SECTION USED FOR LIMIT EQUILIBRIUM ANALYSIS (HIGH WATER TABLE, UNDRAINED STRENGTH RATIO 0.27)



ROOT CAUSE

- The root cause of the breach was the undrained failure of the Upper GLU under the imposed load of the Perimeter Embankment on August 4, 2014.
- The design did not take into account the complexity of the sub-glacial and pre-glacial geological environment associated with the Perimeter Embankment foundation.
- The omissions associated with site characterization may be likened to creating a loaded gun.
- If constructing unknowingly on the Upper GLU constituted loading the gun, building with a 1.3H:1V angle of repose slope over this stratum pulled the trigger.

MANAGEMENT OVERSIGHT

- While the Panel has identified potential issues related to management responsibilities such as water balance concerns and possible limitations of construction material delivery, it is not able to offer an adequate assessment of the role of management and oversight in its contribution to the cause of the failure.

REGULATORY OVERSIGHT

- The Panel finds that the Ministry of Energy and Mines (MEM) Geotechnical Staff and the Contract Inspectors are well qualified to perform their responsibilities.

- Despite having a strong regulatory process and personnel, the Perimeter Embankment of the Mount Polley TSF still failed. It was a sudden failure without precursors. Additional inspections of the TSF would not have prevented the failure.

WHERE DO WE GO FROM HERE?

- The Panel firmly rejects any notion that business as usual can continue.
- The Panel advocates we move towards a zero failure rate.
- The path to zero failures needs an added dimension, and that dimension is technology.
- Recognizing that the path to zero failures involves a combination of Best Available Technology (BAT) and Best Applicable Practices (BAP).

WHERE DO WE GO FROM HERE?

FIGURE 9.1.1 FILTERED TAILINGS FACILITY, GREENS CREEK, ALASKA

CONCLUSIONS

- Recommendations for future **Best Available Practice (BAP)** require considerations that go beyond stability calculations.
- It is important that safety be enhanced by providing for robust outcomes in dam design, construction and operations.
- Examples of BAP call for improvements of corporate design responsibilities and adoption of independent tailings dam review boards.

CONCLUSIONS

Cause of the Failure

- The breach of the Perimeter Embankment on August 4, 2014 was caused by shear failure of dam foundation materials when the loading imposed by the dam exceeded the capacity of these materials to sustain it. The failure occurred rapidly and without precursors.
- Deposited in a complex geologic environment, the weaker glaciolacustrine layer was localized to the breach area. It went undetected, in part because the subsurface investigations were not tailored to the degree of this complexity. But neither was it ever targeted for investigation because the nature of its strength behaviour was not appreciated.

CONCLUSIONS

Cause of the Failure Cont'd.

- Throughout, the design investigations took note of the stiff, dense character of foundation soils and used corresponding strength properties in stability analyses.
- But it was not recognized that this character would change, with a corresponding change in strength behaviour under the increased loading as the dam grew higher.
- Adding to the antecedent foundation conditions was the unprecedented steepness of the 1.3H:1V Perimeter Embankment slope.

RECOMMENDATIONS

1. **To implement BAT using a phased approach.**
2. **To improve corporate governance.**
3. **To expand corporate design commitments.**
4. **To enhance validation of safety and regulation of all phases of a TSF.**
5. **To strengthen current regulatory operations.**
6. **To improve professional practice.**
7. **To improve dam safety guidelines.**