

# Cheekye Panel Report

Squamish Council

July 15, 2014

John Clague P.Geo.

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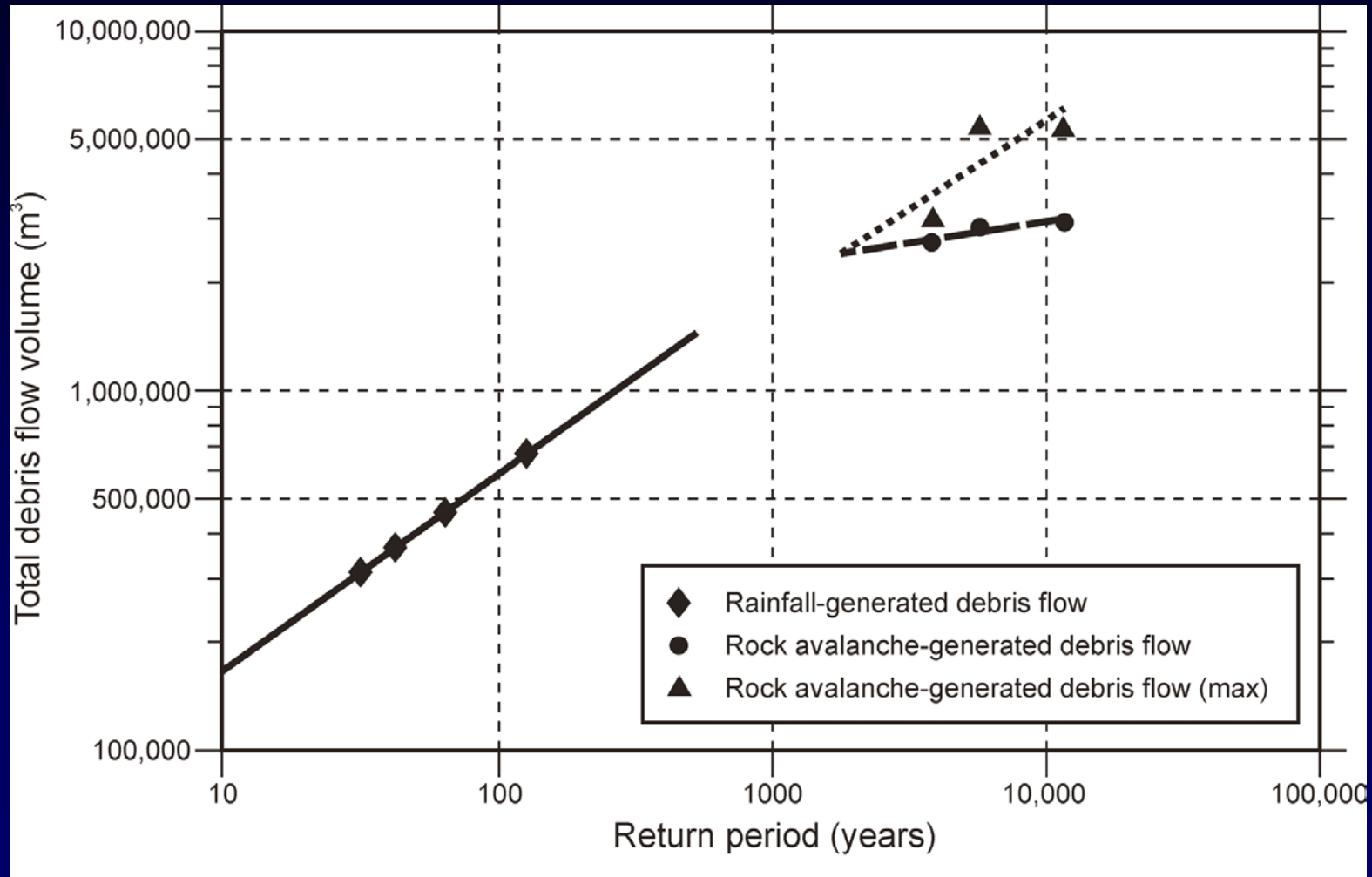
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Geo

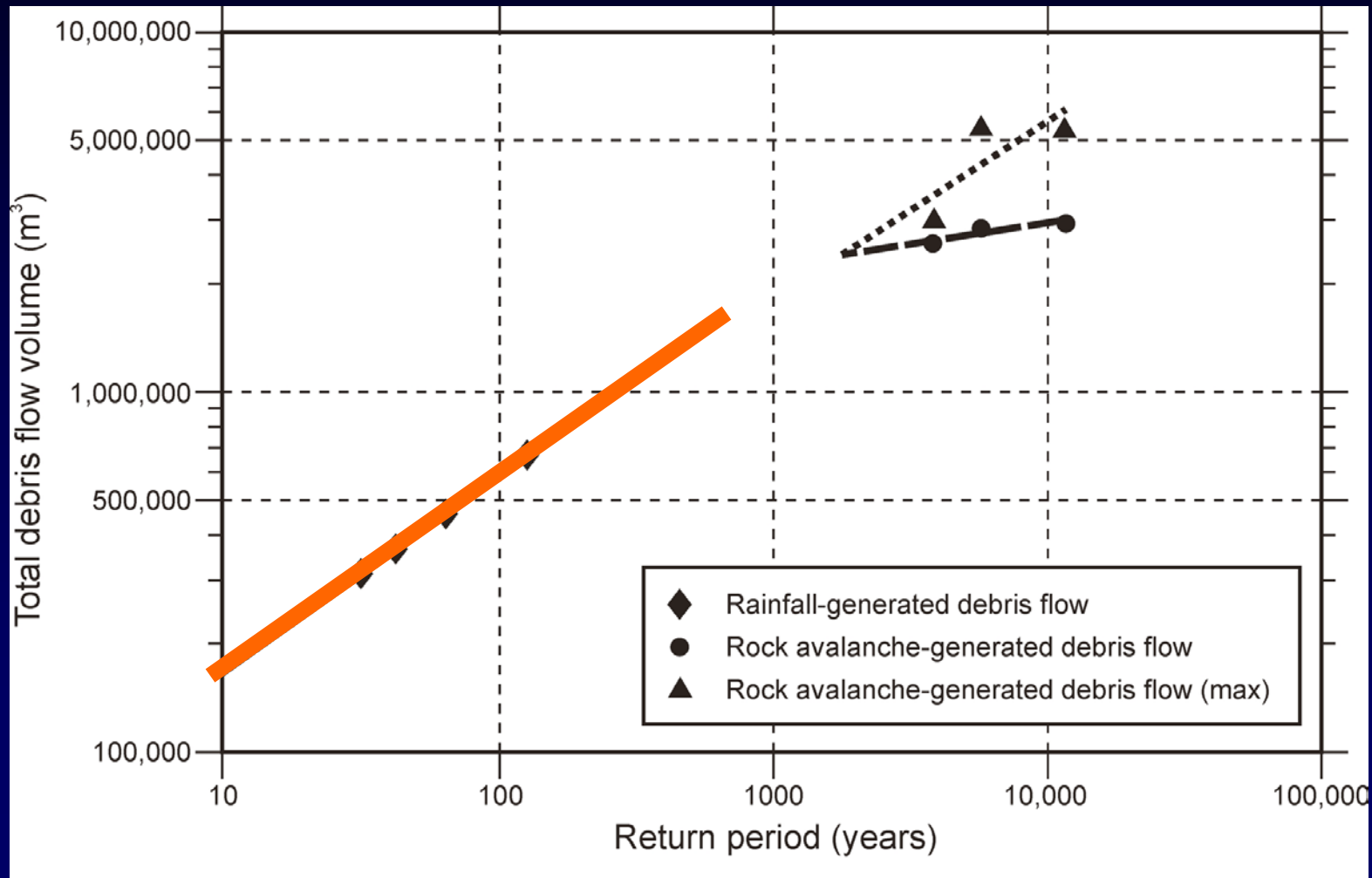
# Panel Terms of Reference

- Consider landslide volume estimates for a range of annual exceedance probabilities that the Panel deem relevant. Identify key sources of uncertainty and comment on the associated confidence intervals for these volume estimates

- The Panel's opinion is that BGC's MCF relationships are the most reliable MCF relationships currently available for Cheekye Fan ...



...The solid line on the left side of the MCF curve is credible and could be a basis for debris flow mitigation strategies for this range of smaller volume, rainfall/surface water runoff-generated debris flows.

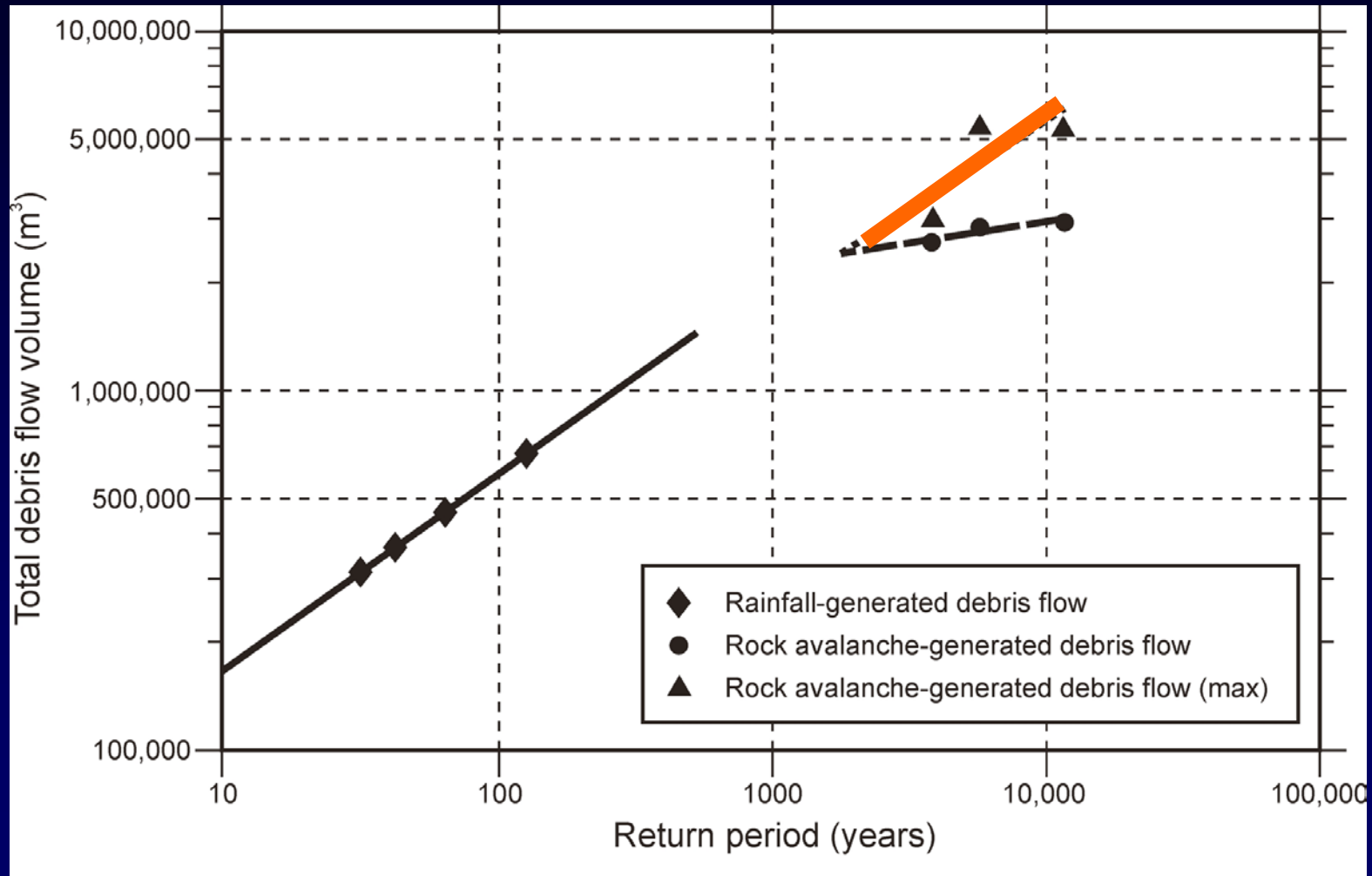




# Panel Terms of Reference

- Identify and characterize the landslide that corresponds to a 1:10,000 annual probability exceedence event

- The Panel's opinion is that the upper (orange line on the right side of BGS's MCF relation) provides a prudent estimate of the largest volume of debris that could be transported to Cheekye Fan during a rock slide-generated debris flow. The volume of this 1:10,000-year event is 5.5 million m<sup>3</sup>



- This estimate is more conservative than was recommended by BGC (2008), but is consistent with several previous estimates, as reviewed in the Panel's report, and considers the unknowns, uncertainties, and assumptions discussed in the report, specifically...
- *A reliable estimate of the 10,000-year event requires a record that spans more than 10,000 years. The Cheekye watershed record spans only 10,000 years. Therefore a statistical estimate evaluation of the 10,000-year debris flow cannot be relied on and estimates of future potential must be based on professional judgment*
- *The right side of BGC's MCF relation is based on three debris flows, only the smallest of which can be quantified with some reliability, as discussed by BGC (2008). The volume of either of the other two debris flows could have been as large as 5.5 million m<sup>3</sup>*

- *It is possible that future rock slide-generated debris flows that could reach Cheekye Fan could be larger than those in the past. The scenarios analyzed by BGC (2008) were predicted on an assumption of limited availability of water to mobilize debris that potentially could reach the fan*



*Since 2008, the 2010 Mount Meager landslide occurred in rocks very similar to those in the headwaters of the Cheekye River watershed, involved about 48 million m<sup>3</sup> of material, and travelled for a distance of 12.7 km to a fan similar to Cheekye Fan. One of the reasons for the extreme travel distance was the unexpected large volume of water that was present in the source area. Much of this water was present in the failed rock mass itself*



- *At km 8, the Mount Meager debris flow ran 270 m up the opposing wall of Meager Creek and then split, with one lobe of debris traveling up Meager Creek and the other down Meager Creek to Lillooet River*

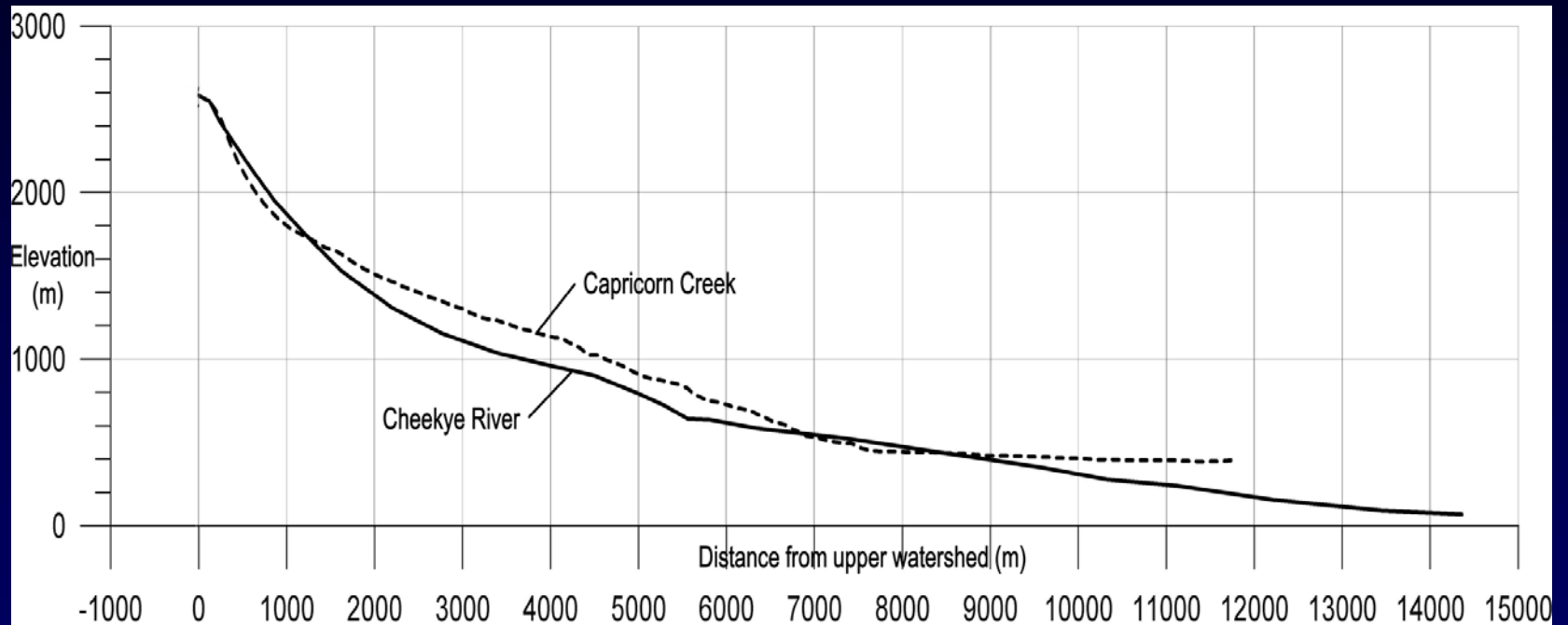




- *The geology of Mount Meager and Mount Garibaldi is similar*



- *The longitudinal profile of Cheekye River and Capricorn-Meager Creek are similar*



- *A number of possible instabilities within the steep Cheekye River headwaters have been identified as potential source areas for major rock slides that could generate debris flows. Other potential source areas may exist that have not been identified and studied*





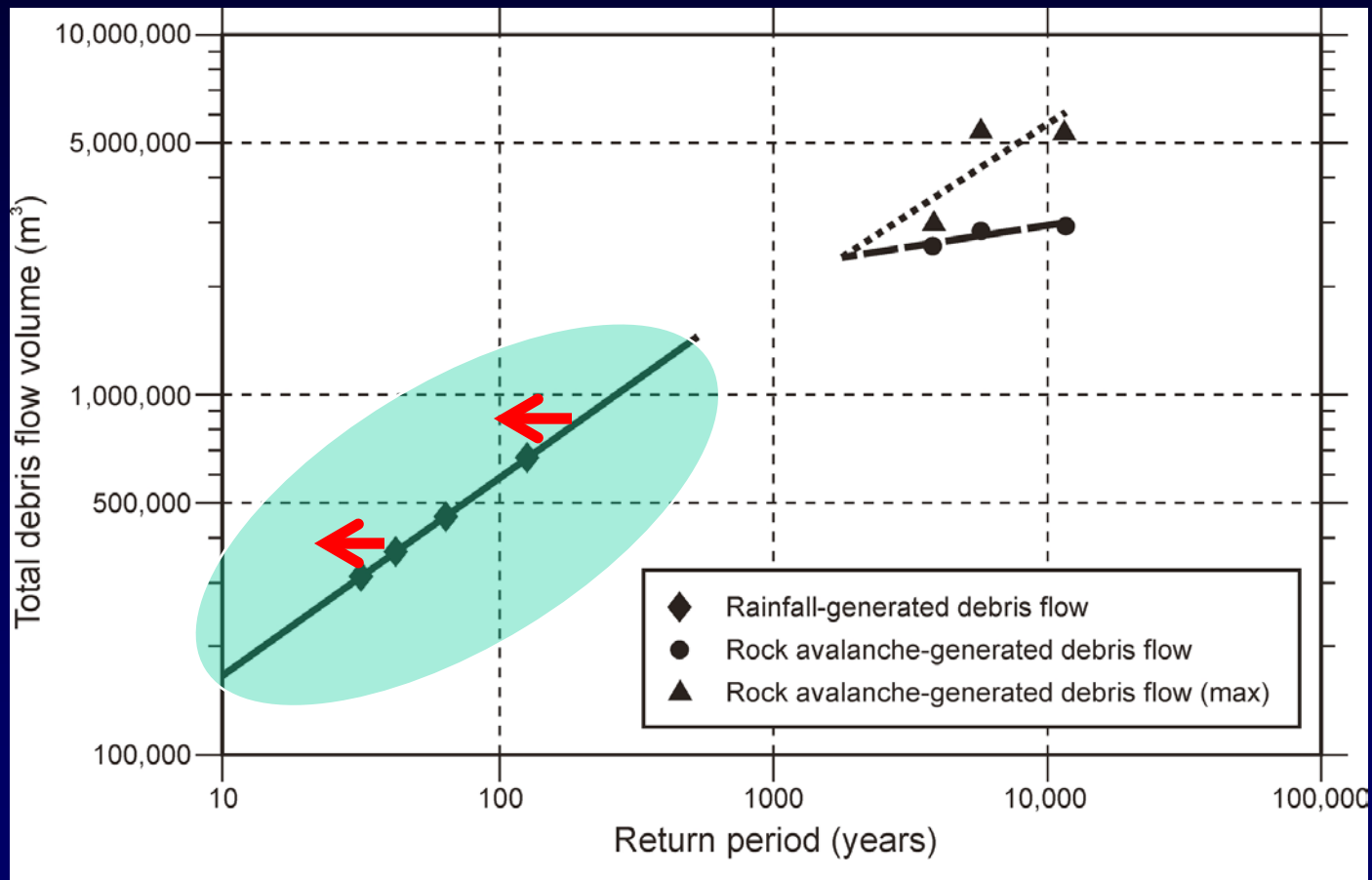
- In summary, the Panel's opinion is that, over a 10,000-year time frame, the very steep Cheekye River headwaters could experience an event larger than anything that has happened in the past



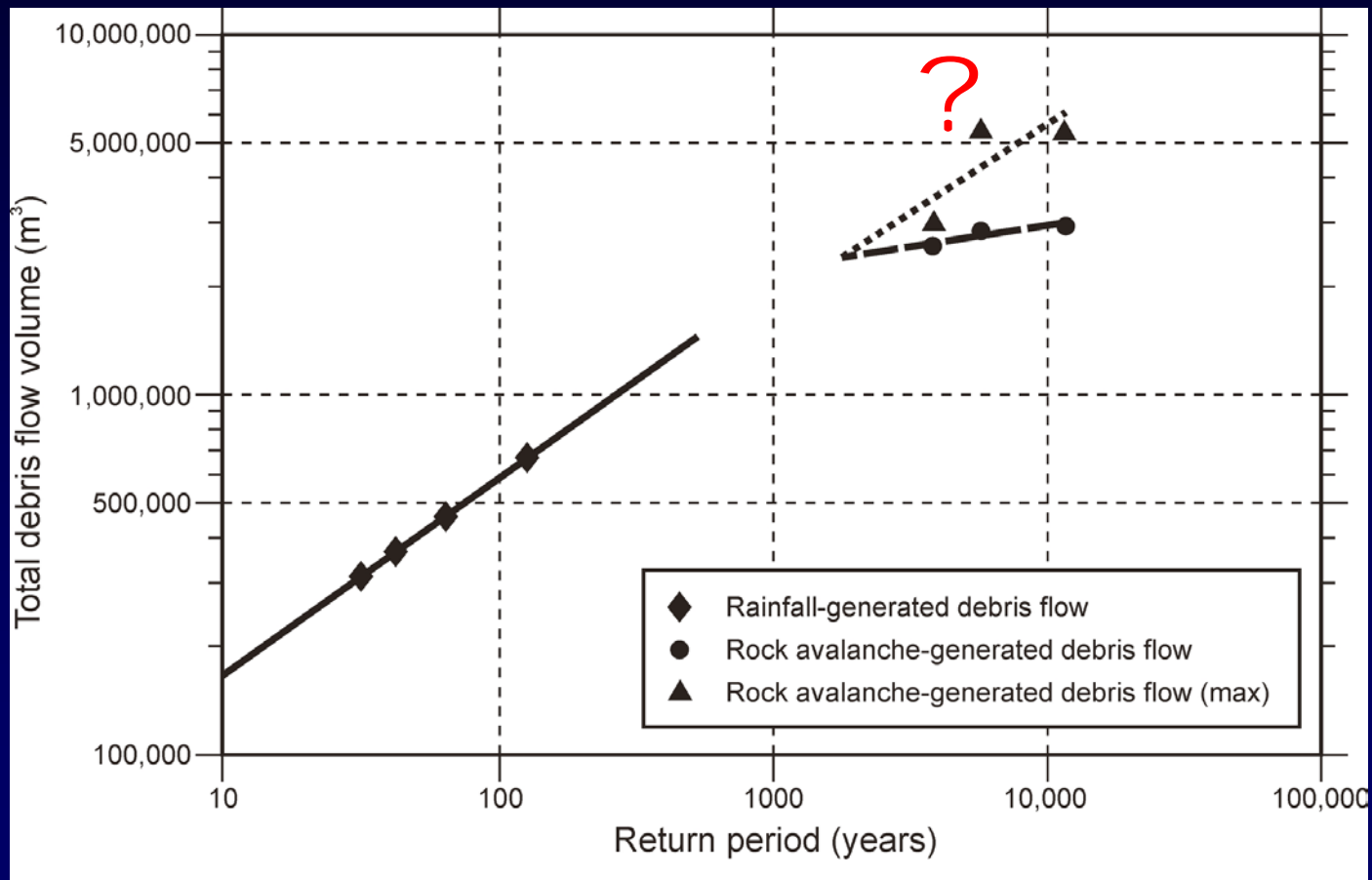
## Panel Terms of Reference

- Consider the potential effects of changes to climate and geomorphic developments that could affect the scientific data and assumptions used in the proposed magnitude-cumulative frequency relationship and the design of landslide risk reduction measures

- The Panel's opinion is that climate change might increase the frequency of smaller rainfall/water runoff-generated debris flows and debris floods, consistent with the conclusion of BGC (2008). This expectation would shift the solid line on the left side of the BGC MCF plot to the left, although by how much is unknown



- The Panel's opinion is that climate change **might** increase the frequency of major rock slide-generated debris flows, shifting the lines on the right side of the BGC MCF plot to the left. This shift would have the effect of increasing the volume of the 10,000-year event. This outcome, however, is uncertain



- Possible climate change effects must be dealt with by selecting suitably conservative parameters during the design of any mitigation measures, and by selecting solutions that are flexible with respect to the magnitude of potential effects

## Other considerations

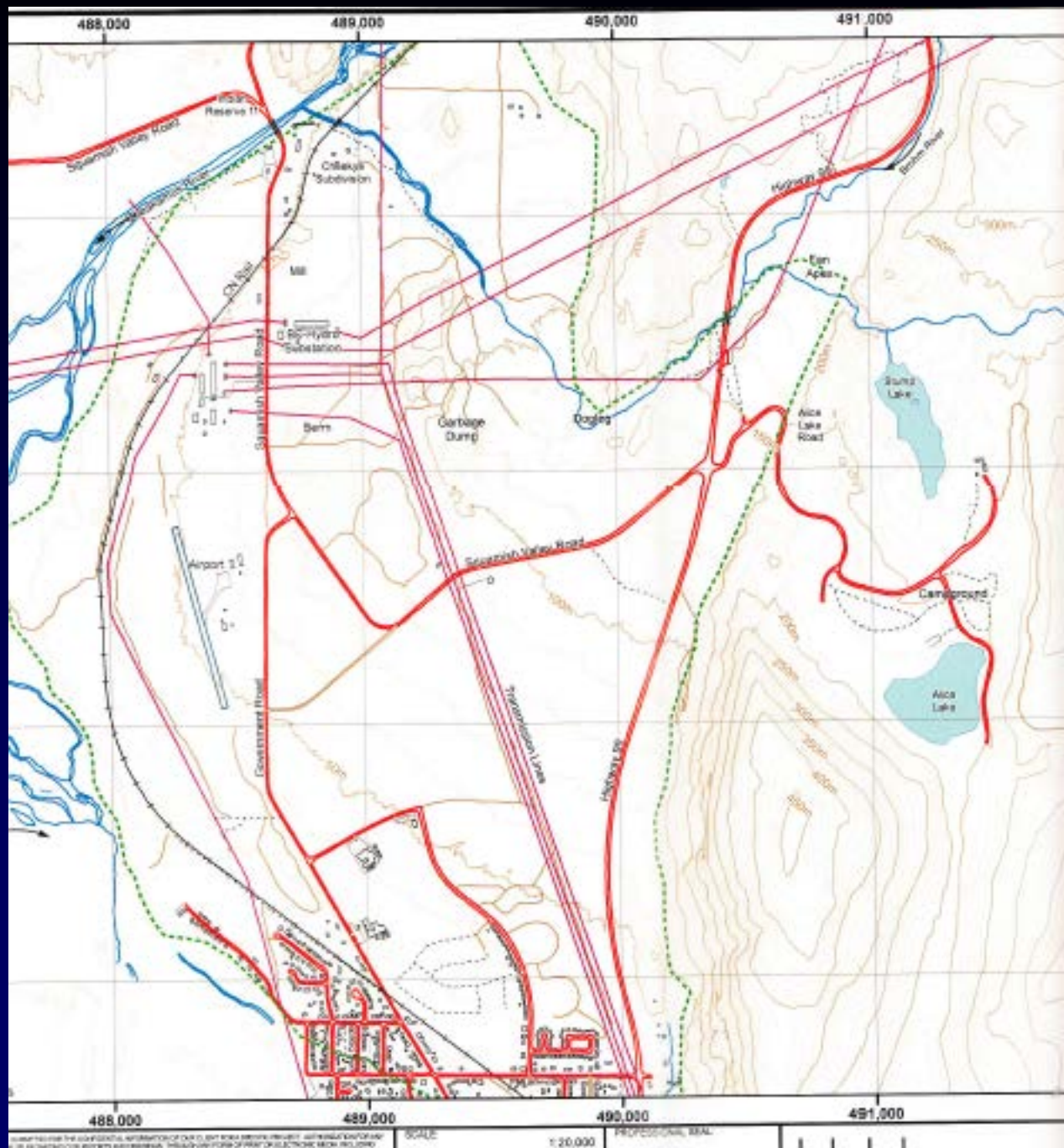
- Existing development on Cheekye Fan, including Squamish Nations communities, are at risk from both large and small debris flows, as well as from stream floods that may or may not be associated with debris flows or debris floods.
- It is the Panel's opinion that the risks to existing development should be mitigated whether or not there is any future development on Cheekye Fan. Any future protective scheme must be capable of mitigating both large and small magnitude events

## Other considerations

- Mitigation of debris flows can be achieved in many ways. It is the Panel's opinion that all forms of mitigation should be carefully considered and evaluated for existing and any future development on Cheekye Fan and on the west side of Cheakamus River across from Cheekye Fan. A combination of retention basins, channeling of streams, dyking, and judicious placement of new development on the fan should be considered







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