Cheekye Fan Current Development Application

District of Squamish Presentation at Public Information Meeting

Nov 24, 2014
Background
Hazard Policies
Next Steps
Background
The Cheekye Fan

- Sediment deposits from upper parts of the basin (Mount Garibaldi)
- Recognized debris flow / flood hazard
Intergovernmental Cooperation Accord

• 2011: Squamish Nation may apply, with or without partner, to the Crown for ownership of ~200 acres of Cheekye Fan lands
• Development in hazard zones 3 and 4 requires:
  – Debris Flow Mgt. Plan
  – Area-wide mitigation measures.
Development Application
Development Application: BMS Cheekeye One Partnership

OCP Land Use Designations

Zoning
Hazard Policies
Hazard and Risk

Hazard: Debris flow volume and frequency
Risk: Probability X Consequences

Almost certain

Very unlikely

Incidental

Catastrophic

Probability

Consequences
History

1993
Thurber
Terrain Hazard and Land Use Study

Numerous Studies

2008
BGC
How big / how often?
Where will it go?
What are the consequences?

2013
Application

2014
Expert Panel

30+ years of Study
Expert Panel

- **How Big?**: volume of 5.5M m³
- **How frequent?**: 1:10,000 yr. return period or 0.01% chance each year
- Climate change likely to increase frequency of small events and to a lesser extent, large events.
- Risks to existing development should be mitigated whether or not there is future development.
- All forms of mitigation should be considered and carefully evaluated.
Hazard Policies

Expert Panel Recommendations

Current Application Review
- Mitigation Strategy
- OCP and Rezoning

Review OCP Policies and Hazard Zones
- Hazard and Risk
- Risk mitigation options
- Development Regs
• Debris flow mitigation works
  – *DoS staff and 3rd party reviewer:*
    • design standards, risk reduction, environmental impacts, operations and maintenance
  – *Province:*
    • Dike Maintenance Act (DMA), Water Act, etc.
  – *DoS Council:*
    • (DMA) Agree to “diking authority” → ownership, mtn., operation and rehabilitation.
• Concurrent review of OCP and zoning
  – Council readings including a Public Hearing
Current Application Review

We Are Here

- Inputs
- Mitigation Strategy
- Environmental Review
- Operations and Maintenance
- Design Concept

- Council

- OCP/Rezoning Application Review
- Intro to Council
- Staff Review
- Public Meeting

- District/Peer Review
- Provincial Review
Next Steps
Next Steps

- Continued review
- Begin to update policies
- Council update
- Further public comment
THANK YOU

http://www.squamish.ca/showcase

Development and Project Showcase – New Development Applications

District of Squamish Development Services
planning@squamish.ca
Cheekeye River Fan and its proposed residential development:

Public Meeting, Squamish November 24, 2014
Objectives

• Establish a reliable frequency-magnitude relationship of debris flows
• Estimate/model the hazard intensity on the fan
• Estimate the existing risk for loss of life on the fan
• Can portions of the fan be safely occupied? If so, what type and scale of mitigation is needed?
• What can be done to improve current resident’s safety and reduce hazard of future development to tolerable levels?
• In absence of legislated levels of risk tolerance, what levels are deemed reasonable by the DoS/the province?
### Current Elements at Risk

<table>
<thead>
<tr>
<th>First Nations Reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don Ross Secondary School</td>
</tr>
<tr>
<td>Brackendale Elementary School</td>
</tr>
<tr>
<td>Brackendale Residential</td>
</tr>
<tr>
<td>Highway 99 Users</td>
</tr>
<tr>
<td>Cheekeye Bridge</td>
</tr>
<tr>
<td>BC Railway</td>
</tr>
<tr>
<td>Squamish Airport</td>
</tr>
<tr>
<td>DOS Infrastructure</td>
</tr>
<tr>
<td>BC Hydro Substation</td>
</tr>
<tr>
<td>Ross Road</td>
</tr>
<tr>
<td>Saw Mill</td>
</tr>
<tr>
<td>Squamish Valley Road</td>
</tr>
<tr>
<td>Cheekeye Development</td>
</tr>
</tbody>
</table>
Brakendale Airport
Cheekeye Subdivision
Hwy. 99
Cheekeye Subdivision
Possible Development Area
BC Hydro Transmission Line
Schools
First Nation IR
BC Rail
Airport
First Nation IRs
Brakendale
Elements at Risk
The July 2010 rock avalanche and debris flow at Capricorn Creek, Mount Meager

Photos: courtesy Prof. John Clague
The Steps

Steps completed to date:

- Hazard Recognition
- Frequency-Magnitude Analysis
- Hazard Intensity Mapping
- Consequence Determination
- Risk Calculations
- Risk Evaluation
- Risk Reduction
- Development

Not completed
Glacial History
Fan Evolution

12,000 - 10,200 yrs

10,200 - 6,900 yrs

6,900 yrs

6,000 to 2,000 yrs

present

Terrain Units
- Uplands
- Middle fan
- Lower fan
- Floodplain
- Debris flow units

C: 6.9 ka

D: 6 - 2 ka

Sound

Evolutionary Stages
I Rockslides, debris flows, and floods
II Debris flows and floods
III Debris flows, floods, incised channels
Dendrochronology

- ~60 wedges, cores, discs sampled along channel
- Cross-sections reconstituted along confined reaches
- Discharge back-calculated
Test Trenching Program

Objectives:
- Determine size of Garbage Dump debris flow
- Update frequency-magnitude analysis
Test Trenching Program

5 m

Fluvial Gravels

Southern part of airport

1 m

Garbage Dump event

Fluvial Gravels

Northern part of airport
Garbage Dump Debris Flow ~ 900 years ago

Cheakamus R.

BC Hydro Sub

Hwy. 99

Airport

2.1 M m$^3$ = 175,000 dump truck loads
Debris Flow Volume

<table>
<thead>
<tr>
<th>Return Period (years)</th>
<th>Total Debris Flow Volume (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 yr</td>
<td>0.2 Mm$^3$</td>
</tr>
<tr>
<td>50 yr</td>
<td>0.4 Mm$^3$</td>
</tr>
<tr>
<td>100 yr</td>
<td>0.6 Mm$^3$</td>
</tr>
<tr>
<td>200 yr</td>
<td>0.8 Mm$^3$</td>
</tr>
<tr>
<td>500 yr</td>
<td>1.4 Mm$^3$</td>
</tr>
<tr>
<td>1000 yr</td>
<td>2.8 Mm$^3$</td>
</tr>
<tr>
<td>2500 yr</td>
<td>2.4 Mm$^3$</td>
</tr>
<tr>
<td>10,000 yr</td>
<td>5.5 Mm$^3$</td>
</tr>
</tbody>
</table>

Design return period, debris flows
- Switzerland
- Austria

Former design return period, geohazards, Canada

National Building Code, Seismic Design, Canada

Upper Design Return Period, Cheekeye

Best Estimate

Worst Estimate

Design return period, debris flows

Best Estimate

Worst Estimate

Upper Design Return Period, Cheekeye
What does 5.5 Mm$^3$ debris mean?

5.5 million cubic metres is roughly twice the volume of BC Place Stadium.
Rock Avalanche Modeling

(e) Atwell Peak (4 Mm$^3$)

(b) Dalton Dome (57 Mm$^3$)

Maximum Velocity (m/s)

(c) Cheekye Ridge (25 Mm$^3$)

(d) Brohm Ridge (32 Mm$^3$)
20-year return period event, unmitigated
100-year return period event, unmitigated
2500-year return period event, unmitigated
10,000-year return period event, unmitigated
Preliminary mitigation concepts

~ 35 m high barrier

Sedimentation basin
Safety Risk

- In Safety Risk one differentiates between Individual Risk Safety and Group Risk Safety
- Individual Risk: Unacceptable for current development
- Group Risk: Unacceptable for current development
- Highway Users: Unacceptable Group Risk given risk tolerance standards practiced, for example, by the District of North Vancouver.

Therefore, mitigation required irrespective of new development (expert panel). New development does require higher mitigation standard than existing developments.
Safety Target Risk Criteria

- **New development individual residual risk**: 1 in 100,000 ($10^{-5}$).
- **Existing development individual residual risk**: 1 in 10,000 ($10^{-4}$).
- **Total group residual risk**: “ALARP” zone which means “As Low As Reasonably Practical”
Barrier Design

- Barrier to retain an “extreme” debris flow event – 5.5 Mm³
- Barrier to have a outlet to pass the Cheekeye River while maintaining the existing channel shape and sediment load downstream
- After an event, the outlet will maintain an outlet for the Cheekeye River and provide practical access for cleanout from the top
- Events that pass through the outlet are to be managed by risk reduction measures that could include earthworks on the banks of the Cheekeye River as well as debris basin upstream of Hwy 99.
Main Barrier
(preliminary design concept)

Downstream view

Squamish River

PRELIMINARY CONCEPT
Main Barrier
(preliminary design concept)
Main Barrier
(preliminary design concept)
Vision of Post-Mitigation Design

BC Hydro Sub

Brackendale

5.5 Mm³ debris
Principal retention basin
Sedimentation basin

Model Input Parameters
- H-1 = 200,000 m³
- H-2 discharge = 1,000,000 m³/s
Site Investigation

- 5 boreholes have been completed at the Barrier site, 1 in the basin.
- Bedrock depth is variable. 5 to >80 m at the barrier.
- The rock is overlain by sand, gravel and cobbles from previous debris events.
- 15 Test pits have been dug to characterize the near-surface (<5m) soils.
- Geophysics is being done to interpolate the characterization between boreholes.
Conclusions

• Safety risk is currently unacceptable compared to, for example, DNV standards and mitigation is recommended irrespective of future developments
• Moderate and large sized debris flows, if unmitigated, would also result in significant economic loss
• The expert review panel recommended the structure(s) be designed for a 10,000-year return period event with a volume of 5.5 Mm$^3$
• The topography allows mitigation works to be technically feasible and would protect, amongst other elements at risk, the current and future development and the people of the Squamish Nation.
• Preliminary mitigation concept is to provide one primary barrier structures with auxiliary risk reduction measures and monitoring
Questions?
Risk Reduction Benefits

- The community of Brackendale (northern portions)
- The Cheekeye subdivision within Squamish
- I.R. 11
- The Cheekeye Substation (BC Hydro). Existing risk is already low due to a natural shelter by a large bedrock bluff and an existing perimeter berm
- Lower transmission towers (BC Hydro)
- Squamish Airport
- Squamish Garbage Dump
- CN Rail. Risk to track washout or bridge loss over Cheekeye River will be significantly reduced.
- Brackendale high school and primary school
- Users of Government Road and Squamish Valley Road
- Users of Highway 99
- Resort Municipality of Whistler and Village of Pemberton. Economic losses due to highway closure caused by bridge loss or highway erosion or sediment deposition will be significantly reduced
- Fortis Gas. Risk of pipeline exposure by erosion will be significantly reduced
- Aquatic habitat Cheekeye, Brohm, Cheakamus Rivers. The likelihood of extreme events destroying fish or spawning habitat will be significantly reduced
- District of Squamish. Rates of fluvial sediment transport and aggradation in the Squamish River floodplain near Squamish will be reduced
Stump Lake Sediment Coring

~ 6900 yrs BP

~ 11,600 yrs BP

Debris flow deposits

~ 6900 yrs BP

~ 11,600 yrs BP

Stump Lake

Cheeky River

V = 15-30 m/s
Proposed Cheekeye Development

PUBLIC INFORMATION MEETING
Monday November 24th
Request

Amendments to the District of Squamish’s official community plan and zoning bylaw to permit a new single family neighbourhood, educational/community uses, parks, greenways and trails.
Background

1970’s-80’s
- 241 manufactured home strata plan was registered on the property (still exists) and site servicing completed (existing paved road layout remains)
- Project halted due to the threat of a debris flow originating from the Cheekeye River
- Crown retained ownership of the lands

1993

2008
- Umbrella Agreement between Squamish Nation and District of Squamish recognizes further development potential of these lands

2011
- Accord between the Squamish Nation and the District of Squamish recognizing future development potential of the lands
Development Proposal

Complement Brackendale’s existing community by introducing affordable housing options close to existing schools, services while also extending the park and greenway system, trails and constructing the needed hazard debris barrier.
# Single Family Lots

<table>
<thead>
<tr>
<th>Single Family Lots</th>
<th>#</th>
<th>Approx. Size (sq. ft)</th>
<th>Approx. Frontage (ft)</th>
<th>% of Lots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Lots</td>
<td>79</td>
<td>2850</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>Medium Lots</td>
<td>591</td>
<td>4500</td>
<td>45</td>
<td>79</td>
</tr>
<tr>
<td>Large Lots</td>
<td>78</td>
<td>6000</td>
<td>60</td>
<td>10</td>
</tr>
</tbody>
</table>
Parks and Open Spaces

- 57 acres of parkland and greenways
- 51 acre community park (home of Brackendale Fall Fair)
- 6 acres of parkways including park improvements
Community/Educational Uses

- Proposed Education Facility (i.e. independent school, continuing education, etc.)
- Daycare Facility
Trails

- Retain, enhance and expand Ray Peters Trail by a further 1.3 km
- Introduce enhanced “through” and “connecting trails” by 1.6 km
- Net gain of trails by 2.2 km
- Opportunities to design unique, multi-ability trails for neighbourhood and community
Debris Barrier
Timing and Phasing

- Subject to development approval process and local real estate conditions
- Intent to develop in two phases, south to north due to efficiencies with servicing installation
- 20 year timeframe for build out (approximately 40 lots per year)
Technical Studies

- Geotechnical Engineering (Debris Flow Mitigation)
- Environmental Review (wildlife, terrestrial, and riparian)
- Site Servicing (conceptual civil design for utilities and roads)
- Traffic Study
Community Questions and Comments

Public Information Meeting is the initial step in the development approval process.