LOCATIONS OF SELECTED MITIGATION SITES IN CANADA

Vancouver area (BC)
- Magnesia Creek
- Harvey Creek
- Charles Creek
- Upper MacKay Creek
- North Vancouver

Hope and Chilliwack area (BC)
- Hope
- Cheam View
- Ted Creek
- Patterson Creek

Whistler area (BC)
- Whistler
- Cheakamus Lake
- Creekside
- Whistler Creek

Canmore area (AB)
- Canmore
- Cougar Creek
CHARLES CREEK, Sea to Sky, British Columbia, Canada

Mitigation measures: Open check dam with decant structure; armoured channel; increased bridge conveyance

Process type (and basis): Debris flows

General notes: Refer to Couture and VanDine (2004) for additional information

Field notes: Concrete-faced rockfill dam. Downstream side is ungrouted rockfill; grouted around the spillway. There are several trees growing out of the downstream face. Debris high-mark observed on the upstream face. Lock blocks bolted in to spillway for energy dissipation. Small PVC pipe drains installed in the spillway sidewalls.

Dam geometry: Crest width of 4 m; spillway is 5.7 m deep in the middle of the dam. Upstream and downstream faces are 1.5H:1V (about 33°).

Spillway: 15 m wide. Initial gradient of about 4H:1V, steepening to 1.5H:1V.

Outlet structure: 6.23 m wide; beams are 5.93 m wide. The horizontal gap between the beams is 0.44 m. The top of the lower beam is about 5 cm above the bottom of the next beam. Beams are sitting on rubber pads. Outlet culvert gradient of about 4H:1V, 2.8 m high x 2.4 m wide.

From Google Earth Pro, dated 2009

Barrier with decant outlet structure

Site photographs by author, November 2015
**HARVEY CREEK, Sea to Sky, British Columbia, Canada**

Mitigation measures: Open check dam, armoured channel and increased bridge conveyance

Process type (and basis): Debris floods

General notes: Additional information available in Couture and VanDine (2004).

**Dam geometry**

Same general geometry as Charles, but two outlet structures. Large culvert for maintenance access. Rubber bumpers under the beams appear to be in better condition than the stoppers at Charles. Small wood and steel pipe outlet structure below one of the decant beams.

**Outlet**

Eleven horizontal beams, 12.1 m wide. Same spacing and beam size as Charles. Significant accumulation of wood debris in decant structure.

**Spillway**

Shallower spillway slope with low check dams below outlet culverts. Approximately 30% gradient (17°). Lower channel is grouted riprap.

Site photographs by author, November 2015

Satellite image from Google Earth Pro, dated 2004
MAGNESIA CREEK, Sea to Sky, British Columbia, Canada

Mitigation measures: Open check dam

Process type: Debris flows

General notes: Additional information available in Couture and VanDine (2004).

**Dam geometry**
Unlike Charles and Harvey, Magnesia is fully open and does not have a decant structure. The basin was excavated from rock, and rockfill dams were not required. Large wood beam present along the crest. Rubber dampers behind beams, similar to Charles and Harvey.

**Outlet structure**
Slope of the outlet is 45°. The outlet is tapered—narrower at the bottom than at the top. Eight horizontal beams. Top beam is 16.17 m long. Two openings at the base are 2.45 m wide and 1.5 m high. Gaps between the beams are about 0.3 m horizontally and 0.3 m vertically.

**Spillway and erosion protection**
Over the crest. No armouring of the concrete was observed. Barrier is on a concrete slab, but the slab was only observed to extend a few metres downstream.
UPPER MACKAY CREEK, North Vancouver, British Columbia, Canada

Mitigation measures: Open check dam (Austrian style) and riprapped channel

Process type (and basis): Debris flows

General notes: Refer to Murray et al. (1998) for additional information and layout specifications.
**HOPE CREEK, Hope, British Columbia, Canada**

- **Mitigation measures**: Diversion berm, armoured knickpoint (to protect pipeline) and a sediment basin
- **Process type (and basis)**: Debris flows, large event in 1995
- **General notes**: System constructed in the 1980s as part of the highway expansion

**TED CREEK, Chilliwack, British Columbia, Canada**

- **Mitigation measures**: Diversion berm, armoured channel and trash rack
- **Process type (and basis)**: Debris flows
- **General notes**: System constructed in the 1980s as part of the highway expansion
**PATTERSON CREEK, Chilliwack, British Columbia, Canada**

Mitigation measures  
Riprap armoured basin, check dam with culvert outlets, armoured channel

Process type (and basis)  
Debris flows

General notes  
Possibly dates from the 1980s during the highway expansion project

**CHEAM VIEW, Chilliwack, British Columbia, Canada**

Mitigation measures  
Berm, basin, trash rack and riprapped channel

Process type (and basis)  
Debris flows

General notes  
System constructed in the 1980s as part of the highway expansion

Site photographs by author, February 2015

Site photograph by author, April 2015

Aerial image from Hungr (2009)
**FITZSIMMONS CREEK, Whistler, British Columbia, Canada**

<table>
<thead>
<tr>
<th>Mitigation measures</th>
<th>Open check dam with geosynthetic-reinforced soil (GRS) abutments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process type (and basis)</td>
<td>Debris floods</td>
</tr>
<tr>
<td>General notes</td>
<td>Additional information in Strouth et al. (2012), Roche (2010) and Currie (2010).</td>
</tr>
</tbody>
</table>

**Dimensions**
6.3 m tall and 13.5 m wide outlet. The smaller openings are 1.3 m wide. Horizontal steel beams are 0.85 x 0.61 m and vertical beams are about 0.3 x 0.3 m (1’ x 1’).

**Grid design**
The grid is designed to be flexible and to displace slightly upon impact. Similar to the Sea to Sky barriers, there are rubber dampers to cushion impact, and the grid is able to rotate. The components were custom designed for this barrier.

**Construction**

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6.3 m tall and 13.5 m wide outlet. The smaller openings are 1.3 m wide. Horizontal steel beams are 0.85 x 0.61 m and vertical beams are about 0.3 x 0.3 m (1’ x 1’).

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**Construction**

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**Site photographs by author, July 2016**

- **Upper open check dam and right abutment berm**
- **Hinge post to add flexibility**
- **Rubber damper**
- **Looking at the GRS left abutment (from right abutment)**
### WHISTLER CREEK, Whistler, British Columbia, Canada

**Mitigation measures**  
Large open check dam; smaller open check dam; armoured channel

**Process type (and basis)**  
Debris floods (watershed size)

**General notes**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper open check dam</td>
<td>Reinforced concrete barrier with steel outlet structure. Upstream height of 12 m and downstream height of 14 m. Outlet is 3 m wide at the base, widening to 9 m and then 13.5 m; top beam is 14 m long. Total crest length is 28 m. Horizontal beams are 0.66 x 0.66 m, vertical beams are i-beams, 0.3 x 0.3 m.</td>
</tr>
<tr>
<td>Lower open check dam</td>
<td>Top width of 10.8 m. Openings between horizontal beams are approximately 0.75 m high. Beams are 0.35 x 0.35 m. Downstream, the creek flows through and arch culvert under the ski hill.</td>
</tr>
<tr>
<td>Channel armouring</td>
<td>Grouted riprap and keyed-in/inset boulders.</td>
</tr>
<tr>
<td>Construction</td>
<td>Designed by KWL and built in 1998.</td>
</tr>
</tbody>
</table>

![Satellite image from Google Earth Pro, dated 2003](image1.jpg)

**Notes:**  
- Site photographs by author, July 2016
- Upper barrier
- Lower barrier
- Grouted riprap (below) and inset boulders (top right) for erosion protection
- Culvert below barriers

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**Upper barrier**

**Lower barrier**

**Culvert outlet**
**Mitigation measures**
Flexible debris net and articulated concrete mats

**Process type (and basis)**
Debris floods—major event in June 2013

**General notes**
Short-term mitigation system, to be replaced with a larger barrier

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**Flexible net**
Manufactured by Geobrugg (Switzerland). Capacity of 20,000 m³. 40 m wide and 6 m tall. Includes 74 anchor cables, each about 8 m in length. Low opening at base to allow the normal stream flow. Installed in spring 2014.

**Armoured channel**
Between 3,000 and 4,000 mats, each incorporating 72 blocks connected with cable. The mats cover 48,000 m² of the channel.

**Long-term mitigation**
Long-term mitigation design is being completed by alpinfra of Austria. The current proposed structure is an earthfill barrier with a culvert-type outlet structure, similar to the Sea to Sky barriers.

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Site photographs by A. Strouth, May 2017