COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE

Supplemental Information Request Round 2
Water Act File No. 00384210
NRCB Application No. 1601

SUBMITTED TO:
Alberta Environment and Parks
and Natural Resources Conservation Board

SUBMITTED BY:
Town of Canmore

December 2017

TABLE OF CONTENTS

FIGURES

TABLE OF ABBREVIATIONS

AEP	Alberta Environment and Parks
EIA	environmental impact assessment
LiDAR	Light Detection and Ranging
NRCB	Natural Resources Conservation Board
SIR	supplemental information requests
TOR	terms of reference

1 INTRODUCTION

The Town of Canmore submitted an environmental impact assessment (EIA) report and Natural Resources Conservation Board (NRCB) application summary for the Cougar Creek Debris Flood Retention Structure (the Structure) and Access Road (together, the Project) in July 2016 (NRCB Application No. 1601). The Town of Canmore has also submitted a *Water Act* application to the Dam Safety division of Alberta Environment and Parks (AEP) to obtain authorization to construct and operate the Project (*Water Act* File No. 00384210). A first round of supplemental information requests (SIRs) was received from AEP and the NRCB in December 2016 and a response was submitted in June 2017. A second round of SIRs was received from AEP on October 2, 2017.

This submission, dated December 12, 2017, provides responses to the second round of SIRs. The SIRs are presented and numbered in the following text boxes and correspond to the numbering used in the AEP letter dated October 2, 2017.

2 GENERAL

1	**Supplemental Information Request 1, SIR37, Page 3-9** The Town of Canmore indicated in the SIR response on page 3-9 that Piikani Nation and Tsuut'ina Nation were provided a summary of rare plant observations on the Project site. Upon review of the bi-monthly consultation reports, it appears that the Blood Tribe was also provided the summary document. This occurred on March 18, 2016. a. Were any other First Nations provided a summary of rare plant observations on the Project site?

Response:

a. No other First Nations were provided the summary of rare plant observations. The vegetation summary was only provided to those communities who expressed interest in the summary findings (Tsuut'ina Nation, Piikani Nation, and the Blood Tribe).

2	**Supplemental Information Request 1, SIR37, Page 3-9** The Town of Canmore indicated in the SIR response document on page 3-9 that *consultation meeting and site visits occurred before the completion of the environmental assessment*, therefore, information about the potential for direct loss of rare plants and traditionally used species was not explicitly communicated. The Town of Canmore has also agreed to provide each First Nation community with project updates *at key points during the EIA review process* (Section 3.2.1, Page 3-3). a. Explain whether any First Nation has brought up any questions or concerns regarding the potential direct loss of rare plants and traditionally used species since the submission of the environmental assessment. Will the mitigation measures be communicated to the First Nations who originally inquired about rare and traditionally used plant species?

Response:

a. As indicated in the bimonthly reports, two communities commented on vegetation during the site visits:

- An individual from the Blood Tribe requested that native species be used for reclamation but did not specify a concern or preference regarding loss of rare plants or traditionally used species. The Town of Canmore confirmed during the site visit that native species would be used for reclamation.

- Stoney Nakoda Nation participants expressed an interest in an opportunity to harvest usable medicinal or ceremonial plants before construction. The Town of Canmore has committed to providing an opportunity to harvest plants and hold a ceremony on the site before construction begins.

3 WATER

3.1 Hydrogeology

3	**Supplemental Information Request 1, SIR63, Page 5-5** a. Explain the rationale for considering river hydraulics in the assessment of the hydrology component. b. Confirm what methods were used in the hydrology, hydraulic and geomorphic analyses. In addition, provide more detailed information about the approaches, assumptions and results of the hydrology, hydraulics and geomorphic assessments to help gauge the impacts of the project.

Response:

a. River hydraulics (i.e., the behaviour of flowing water within a river with respect to velocity and water level) is a function of flow rates and depends on channel characteristics. The Structure will reduce peak flows and water levels, and the behaviour of the flowing water within the channel and these indicators were included in the EIA (page 6-2).

The Terms of Reference (TOR) under the hydrology assessment requires an assessment of hydrology, river hydraulics, and geomorphic conditions of the watercourses that could occur as a result of the implementation of the Project.

To fulfill the requirements of the TOR; hydrologic, river hydraulics, and geomorphologic principles were used to assess the effect of the Project on various hydrologic, river hydraulics, and geomorphologic characteristics of the watercourses including the following:

- changes in flow magnitudes, timing, volume, peak and minimum flow rates, and river regime (hydrology);
- changes in water levels, flow velocities, and sediment transport (river hydraulics); and
- sediment transport yield and changes in geomorphic conditions such as river bed aggradation, degradation, and bank erosion (geomorphology).

Therefore, river hydraulics were considered in the hydrology assessment.

b. As noted in the response to part a) above, the Hydrology section of the EIA report captures each of the hydrology, hydraulics, and geomorphology disciplines as per the EIA TOR; therefore, the methods, approaches, assumptions, and results related to hydrology, hydraulics, and geomorphology are all included within Sections 6.5, 6.6, and 6.7 of the EIA report.

The overall method of the hydrology impact assessment was to review the extensive work for Cougar Creek already completed by various consultants over the past decade (mostly since the 2013 flood). References to relevant studies and reports considered in the baseline and application case assessments are provided in the Aquatic Environment section of the EIA report (Sections 6.5, 6.6, and 6.7).

The approach involved the following:

- performing a comprehensive review of the methods and assumptions used in the technical studies;
- performing a comprehensive and in-depth review of findings of such studies;
- assimilating relevant information from technical studies for use in our assessments; and
- deriving conclusions on potential impact of the Project, applying professional judgement based on previous studies, analysis, and predicted impacts.

4 TERRESTRIAL

4.1 Wildlife

4	**Supplemental Information Request 1, SIR 141, Page 6-60** a. Given the high degree of public recreational use of the area, describe the effects of human use on wildlife use amongst the Cougar Creek mitigation, and how those effects will be mitigated to allow wildlife use of the area?

Response:

a. Baseline information on wildlife and recreational use is being conducted by AEP as part of a camera survey and winter tracking program. Initial findings indicate high use of Cougar Creek by humans and low use by wildlife; therefore, the area is already affected by human use. The addition of the Project may increase the level of wildlife movement across Cougar Creek relative to current conditions. It is not within the scope of this Project to restrict recreational use of Cougar Creek. AEP has independently initiated work to stop use of non-designated trails around Cougar Creek.

The effects of recreational displacement of animals will be mitigated, within the scope of this Project, by increasing the opportunities for wildlife to move through the area. Mitigations have been put in place to reduce impacts to wildlife movement (Section 7.4.1.4 of the EIA report and discussed further in SIR Round 1 response 142). During operations, wildlife movement is expected to continue along Cougar Creek using the Structure, the Access Road, and existing trails. The Structure is sloped at 30° or 57%, and is fully grassed to allow for wildlife movement over the Structure. The Access Road is at a shallower angle than the Structure, with a maximum grade of 10%, and also allows for wildlife movement along Cougar Creek.

Additional mitigations to increase wildlife use of the wildlife corridor and movement across Cougar Creek include the following:

- Establishing signs in consultation with AEP to clearly mark intended trail use and prevent use of unmarked trails within the wildlife corridor and habitat patches.
- There will be no vehicular traffic along the Access Road aside from maintenance work for the Structure. No fencing will be added to the Access Road as that would inhibit wildlife movement; however, a locked and removable bollard or gate that is passable by hikers and wildlife will be installed to restrict vehicle access.
- The reclamation strategy in No Man's Land is expected to facilitate wildlife movement between the wildlife corridor and the Indian Flats Local Habitat Patch. Final placement of the reclaimed patches will be decided on by the Town of Canmore and the Parks Division of AEP after the results from the wildlife monitoring program are reviewed and understood. Once established, the reclaimed patches will provide cover from predators and habitat for potential foraging, nesting, and resting by wildlife.

Wildlife movement will continue to be evaluated as part of a long-term monitoring project using cameras to record wildlife use in Cougar Creek. Additional mitigation will be considered if wildlife movement is shown to be affected.

5 INCIDENTS, MALFUNCTIONS AND RETENTION STRUCTURE SAFETY

5	**Supplemental Information Request 1, SIR155, Page 8-1** The Town of Canmore states that *There are only five parcels that are available for development in the Cougar Creek area… This increase in residential units in the area would increase the population… by less than 0.5%.* a. Clarify how many residences could be associated with the five "parcels". b. Clarify whether "the area" is the potentially inundated area, the town area, or the alluvial fan.

Response:

a. Three of the parcels could have two dwellings (main residence and a basement/garden suite) and the remaining two parcels could have only one dwelling. Therefore a maximum of eight dwellings could be associated with the five parcels.

b. The area refers to the alluvial fan extent and all parcels are also located within the potentially inundated area.

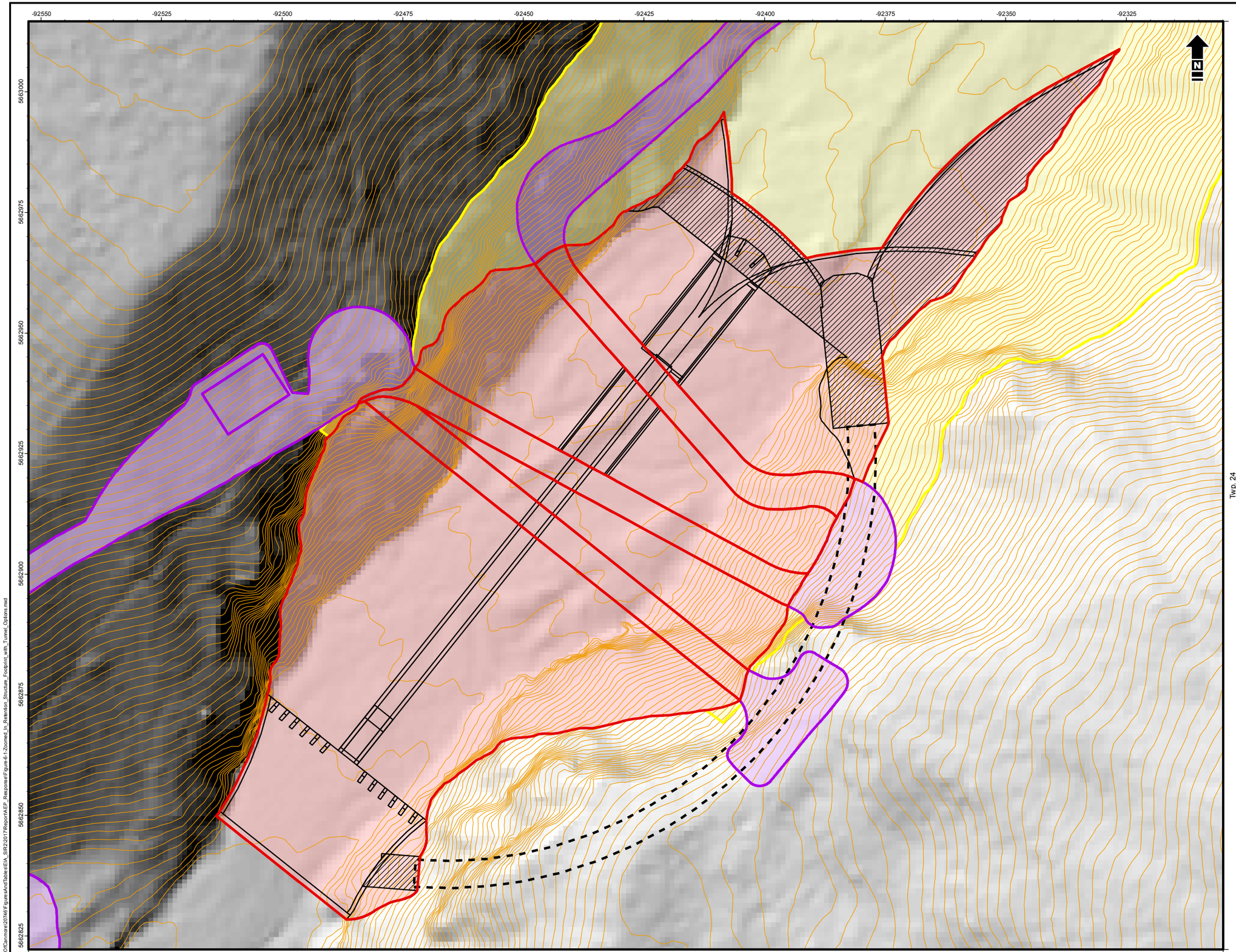
6	**Supplemental Information Request 1, SIR159, Page 8-6** The overall project footprint is shown on Figure 4.1-2. a. Was construction access of the tunnel option included in the project footprint? If so, explain where this information is located within the EIA. Explain how the project footprint of the tunnel option includes construction access, stockpile areas, and any other areas that will be disturbed. If the tunnel option was not included in the project footprint explain why this was left out.

Response:

a. The EIA considered a maximum footprint with both options overlaid (Figure 4.1-2 of the EIA report). This approach was described in Section 4.4.4.3 of the EIA report:

> "The Town of Canmore intends to progress two outlet structure designs through the procurement process. Both options are technically feasible and serve the same function but input from experienced construction contractors was needed to confirm the relative costs of these options. For the purposes of this EIA, both options have been considered by each discipline to determine if there are any differences in potential Project effects. For the purpose of the terrestrial assessment, the Project footprint includes all potential areas disturbed by either of these two options."

To facilitate the review of this SIR response, a zoomed in view of Figure 4.1-1 of the EIA report is presented herein as Figure 6-1. The figure presents the Structure with both outlet structure design options.



Tunnel Components Above Ground
Below Ground Tunnel
Contour (Interval 1 m)
Debris Flood Retention Structure Detail

Proposed Footprint

Debris Flood Retention Structure
Access Road
Inundation Area

Reference: Data obtained from Alberta Parks (all rights reserved) used under license.

1:750

20 0 20

Metres

NAD 1983 3TM 114

Town of CANMORE

Cougar Creek Debris Flood Retention Structure

Zoomed In Retention Structure Footprint with Tunnel Options

Date: 07 Dec 2017		Project: 20746-514	
Technical: I. Trimble	Reviewer: I. Trimble		Drawn: C. Beaumont

Disclaimer: Prepared solely for the use of the Town of Canmore as specified in the accompanying report. No representation of any kind is made to other parties with which the Town of Canmore has not entered into contract.

Figure 6-1

I:\Town Of Canmore\20746\Figures And Tables\EIA_SIR 2\2017 Report\AEP_Response\Figure-6-1-Zoomed_In_Retention_Structure_Footprint_with_Tunnel_Options.mxd

7	**Supplemental Information Request 1, SIR164, Page 8-22** **Supplemental Information Request 1, SIR183, Page 8-50** The Town of Canmore states that there would be three effects of the sediment and debris conveyed during a dam breach event: higher impact forces, debris deposition, and increased potential blockage of culverts. The Town of Canmore states *the potential inaccuracy of the model [i.e., ignoring these effects] does not affect the classification.* a. Clarify whether the debris deposition and culvert blockage could also produce higher flood levels and greater inundation extents. If so, clarify whether those effects are considered in the consequence classification. Discuss whether application of a safety factor to the calculated depths or inundation limits may be appropriate to account for the potential inaccuracy of the model.

Response:

a. The dam breach analysis already assumes that the culverts will be blocked by sediment. All analysis and resulting flow depth, maps submitted in SIR Round 1, as well as maps included in response to SIR 9 below account for this. The flood levels and inundation extents provided do not need a further application of a safety factor. The discussed effects are also already considered in the consequence classification.

8	**Supplemental Information Request 1, SIR167, Page 8-29** The preparation of the Geotechnical Design Basis Memorandum (90% Design Stage) preceded the tunnel option therefore it does not make any reference to the tunnel. There are horizontal drill holes however these are limited in number and do not appear to intercept the tunnel alignment. a. Confirm whether the review board, who suggested the tunnel option, concurs that the existing data and information is sufficient for design purposes.

Response:

a. A response to this question has been prepared by Dr. Norbert Morgenstern: "The general geology and ground conditions are relatively well-known from existing borings and surface mapping. The tunnel designer is well-experienced in designing for residual uncertainty as reflected in the design approach. The design methodology proposed is appropriate to result in the acceptable safety and performance of a short shallow tunnel like the one proposed."

John Sobkowicz of Thurber Engineering Ltd. was not available for comments due to personal circumstances. However, colleagues at Thurber are in agreement with the assessment of Dr. Norbert Morgenstern as described above. They added that, to reduce uncertainties, more boreholes before a design is undertaken is always better. However, the design of different support classes based on existing information, as is currently being done on this Project, is acceptable and defensible, as long as a design engineer (or other representative of the engineering firm) is present onsite during construction. This is to ensure that the proper support class is being used and that conditions are similar to the design basis. Moreover, changes to the design could be made based on field conditions.

The Town of Canmore will have an engineer present onsite during the construction of the tunnel.

9	**Final Terms of Reference, Incidents, Malfunctions and Retention Structure Safety, 7[G]** a. Provide information on the potential downstream effects of a dam failure beyond the Town of Canmore. Potential effects to downstream municipalities and additional stakeholders, such as the Stoney Nakoda Nation and the Bow River Basin Council, should be added to cover off their concerns. If no concerns are expected, make the statement.

Response:

a. A new two dimensional dam breach analysis has been performed for the Structure. The extent of the analysis is from the Town of Canmore to the TransAlta Corporation-operated Kananaskis Dam, 31.7 km downstream of the Structure. The Town of Canmore does not have bathymetric data for the Bow River that covers the full reach of the study. The analysis was therefore performed using Light Detection and Ranging (LiDAR) data from September 2015. The water surface of the Bow River during the LiDAR flight has been estimated by AEP River Forecasting to be 37 m^3/s in Canmore. The Bow River baseflow used for the analysis is 180 m^3/s, which represents the upper bound of the normal peak flow in the Bow Valley during spring freshet. A further 143 m^3/s was therefore added to the model to recreate that required baseflow. By comparison, a similar baseflow has been used by TransAlta for modelling of all dam breach analyses in the Bow River basin in the Canmore area.

   Dam breach analyses are regularly conducted downstream of dams until the incremental flood water rise is less than 30 cm. This approach ensures better consistency between different analyses instead of using a fixed distance downstream of a dam breach. The Cougar Creek dam breach analysis has been conducted well past that standard threshold to ensure that the Kananaskis Dam would not fail due to cascading effect (refer to the updated dam breach maps on Figures 9-1 to 9-7). The peak flow of the dam breach is calculated to be 376.5 m^3/s at the Structure.

   The potential effects of a dam failure on downstream communities and stakeholders are expected to be minimal. The closest downstream community is Dead Man's Flats, part of the Municipal District of Bighorn, approximately 7 km downstream of Cougar Creek. The increase water level in the Bow River in that area is expected to be 40 cm with a peak flow of 283 m^3/s. This calculated peak flow is well below the capacity of the river in that area. For reference, during the spring of 2017, flows in Canmore exceeded 300 m^3/s with no issues reported in any Bow Valley communities. This flow rate is well below a 100-year return period flow rate and according to the online Flood Hazard Map by AEP, the Dead Man's Flats community is outside of the Floodway for a 100-year return period. Finally, according to the dam breach analysis, the extra flow is contained within the existing bed and shore of the river. Therefore, a dam breach would most likely not affect the existing bank protection or the community and no concerns are expected.

   The next communities to the east and downstream of Dead Man's Flats are Exshaw and Lac des Arcs, a further 7 to 12 km downstream. The increased water level in that area is expected to be between 12 and 30 cm, depending on the exact location, and to be contained within the existing bed and shore of the Bow River. Lac des Arcs acts as a very

large reservoir that can absorb a large quantity of water. Therefore, no issues or concerns are expected.

At the TransAlta Kananaskis Dam the resulting peak inflow is 217 m^3/s (representing an increase of only 37 m^3/s over the baseflow) and the input hydrograph does not look like a flood wave anymore. Moreover, the time to flood peak is 14 hours, which gives a significant amount of time for the Emergency Plans of both the Cougar Creek and the Kananaskis Dam facilities to be enacted. The Kananaskis Dam can absorb this peak inflow easily without reaching its operational limits. Therefore, only minimal operational impacts are expected at the TransAlta facility.

The Stoney Nakoda Nation and other communities further east are not expected to be impacted by a dam breach on Cougar Creek as they are located downstream of the Kananaskis Dam.

The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 1
- Distance to Retention Structure (km): 3.5
- Floodwave arrival time (hh:mm): 00:30
- Time to flood peak (hh:mm): 01:55
- Peak Water Surface Elevation (MASL): 1303.6
- Incremental rise due to floodwave (m): 0.14
- Peak Flow (m³/s): 212
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 32

POINT OF INTEREST 2
- Distance to Retention Structure (km): 4.65
- Floodwave arrival time (hh:mm): 00:40
- Time to flood peak (hh:mm): 02:10
- Peak Water Surface Elevation (MASL): 1302.39
- Incremental rise due to floodwave (m): 0.29
- Peak Flow (m³/s): 218
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 38

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swis User Community

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REV.	DATE	REVISION NOTES	DRAWN	REVIEW	APPROVED
01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/13
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: **CANADIAN HYDROTECH CORPORATION**

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
ISSUED FOR PERMITTING

Figure 9-1 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [1/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-030 R01	01

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The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 3
- Distance to Retention Structure (km): 7.76
- Floodwave arrival time (hh:mm): 01:20
- Time to flood peak (hh:mm): 03:25
- Peak Water Surface Elevation (MASL): 1296.7
- Incremental rise due to floodwave (m): 0.56
- Peak Flow (m³/s): 308
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 128

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

N

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swis User Community

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REV.	DATE	REVISION NOTES	DRAWN	REVIEW	APPROVED
01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/13
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: **CANADIAN HYDROTECH CORPORATION**

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
ISSUED FOR PERMITTING

Figure 9-2 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [2/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-031 R01	01

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The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 5
- Distance to Retention Structure (km): 15.19
- Floodwave arrival time (hh:mm): 03:00
- Time to flood peak (hh:mm): 07:20
- Peak Water Surface Elevation (MASL): 1292.64
- Incremental rise due to floodwave (m): 0.24
- Peak Flow (m³/s): 255
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 75

POINT OF INTEREST 4
- Distance to Retention Structure (km): 10.97
- Floodwave arrival time (hh:mm): 01:45
- Time to flood peak (hh:mm): 04:45
- Peak Water Surface Elevation (MASL): 1294.22
- Incremental rise due to floodwave (m): 0.40
- Peak Flow (m³/s): 283
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 103

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

N

Source: Esri, DigitalGlobe, GeoEye, User Community

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01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/24
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: CANADIAN HYDROTECH CORPORATION

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
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Figure 9-3 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [3/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-032 R01	01

The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 6
- Distance to Retention Structure (km): 20.65
- Floodwave arrival time (hh:mm): 04:00
- Time to flood peak (hh:mm): 09:20
- Peak Water Surface Elevation (MASL): 1292.26
- Incremental rise due to floodwave (m): 0.30
- Peak Flow (m³/s): 227
- Increase of Peak Flow due to Dam Breach/ floowave (m³/s): 47

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

N

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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REV.	DATE	REVISION NOTES	DRAWN	REVIEW	APPROVED
01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/24
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: CANADIAN HYDROTECH CORPORATION

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
ISSUED FOR PERMITTING

Figure 9-4 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [4/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-033 R01	01

The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 7
- Distance to Retention Structure (km): 23.29
- Floodwave arrival time (hh:mm): 04:55
- Time to flood peak (hh:mm): 11:40
- Peak Water Surface Elevation (MASL): 1287.35
- Incremental rise due to floodwave (m): 0.12
- Peak Flow (m³/s): 220
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 40

POINT OF INTEREST 8
- Distance to Retention Structure (km): 25.99
- Floodwave arrival time (hh:mm): 05:35
- Time to flood peak (hh:mm): 12:25
- Peak Water Surface Elevation (MASL): 1283.62
- Incremental rise due to floodwave (m): 0.19
- Peak Flow (m³/s): 220
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 40

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

Source: Esri, DigitalGlobe, GeoEye, E
User Community

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01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/27
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: CANADIAN HYDROTECH CORPORATION

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
ISSUED FOR PERMITTING

Figure 9-5 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [5/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-034 R01	01

The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 9
- Distance to Retention Structure (km): 29.53
- Floodwave arrival time (hh:mm): 06:25
- Time to flood peak (hh:mm): 13:40
- Peak Water Surface Elevation (MASL): 1281.09
- Incremental rise due to floodwave (m): 0.22
- Peak Flow (m³/s): 220
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 40

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

Source: Esri, DigitalGlobe, GeoEye, E
User Community

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REV.	DATE	REVISION NOTES	DRAWN	REVIEW	APPROVED
01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/27
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: CANADIAN HYDROTECH CORPORATION

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
ISSUED FOR PERMITTING

Figure 9-6 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [6/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-035 R01	01

The floodwave calculation is based on a LiDAR terrain model that was recorded on September 10, and 11, 2015.
Water bodies and rivers do not feature bathymetric information.

Model Inflow:
a) Bow River: steady state180m³/s, starting 48h prior to superimposed dam breach scenario
b) Cougar Creek Debris Flood Retention Structure breach scenario (peak: 376.5 m³/s)

POINT OF INTEREST 9
- Distance to Retention Structure (km): 29.53
- Floodwave arrival time (hh:mm): 06:25
- Time to flood peak (hh:mm): 13:40
- Peak Water Surface Elevation (MASL): 1281.09
- Incremental rise due to floodwave (m): 0.22
- Peak Flow (m³/s): 220
- Increase of Peak Flow due to Dam Breach/ floodwave (m³/s): 40

POINT OF INTEREST 10
- Distance to Retention Structure (km): 31.69
- Floodwave arrival time (hh:mm): 06:45
- Time to flood peak (hh:mm): 14:20
- Peak Water Surface Elevation(MASL): 1280.07
- Incremental rise due to floodwave (m): 0.12
- Peak Flow (m³/s): 217
- Increase of Peak Flow due to Dam Breach/ floowave (m³/s): 37

INUNDATION AREAS
- SUPERIMPOSED BREACH SCENARIO FLOODWAVE
- BOW RIVER REFERENCE FLOW (180 m³/s)

Source: Esri, DigitalGlobe, GeoEye, E
User Community

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REV.	DATE	REVISION NOTES	DRAWN	REVIEW	APPROVED
01	2017/11/06	ADAPTION OF MODEL INPUT PARAMETERS	DPo	AHe	

SCALE: 1:10,000
DATE: 2017/11/27
MAP: DPo
ANALYSIS - CONTENT: DPo
REVIEW: AHe
APPROVED:

PROFESSIONAL SEAL:

APEGA PERMIT NUMBER: 13440

CLIENT: Town of CANMORE

ENGINEERING: CANADIAN HYDROTECH CORPORATION

PROJECT:
COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE
ISSUED FOR PERMITTING

Figure 9-7 Dam Breach Floodwave Calculation
FLOOD PROPAGATION BOW VALLEY: CANMORE - SEEBE DAM [7/7]

PROJECT No.:	DRAWING No.:	REV:
16568	LTMM CC-EIA-RES-036 R01	01