UPPER BOW RIVER HAZARD STUDY HYDRAULIC MODEL CREATION AND CALIBRATION

FINAL REPORT

Prepared for:

Alberta Government

Alberta Environment and Parks

6 June 2018

NHC Ref. No. 3001178

nhc
northwest hydraulic consultants
water resource specialists

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Prepared for:

Alberta Environment and Parks
Edmonton, Alberta

Prepared by:

Northwest Hydraulic Consultants Ltd.
North Vancouver, BC

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EXECUTIVE SUMMARY

Alberta Environment and Parks (AEP) retained Northwest Hydraulic Consultants Ltd. (NHC) in September 2015 to complete a river hazard study for the Bow River. The roughly 118 km long study reach extends from the Banff National Park boundary, located approximately 5 km upstream of the Town of Canmore, to Bearspaw Dam, near the City of Calgary western boundary. Within the Town of Canmore, the study area incorporates Policeman Creek, a channel roughly 6.5 km long situated on the Bow River floodplain and running parallel to the Bow River main channel. In addition, the study area includes three tributaries: the lower 1 km long reach of Exshaw Creek at the Hamlet of Exshaw; the lower 5 km of Bighill Creek at the Town of Cochrane; and the lower 5 km of Jumpingpound Creek at the Town of Cochrane.

The study is being conducted under the provincial Flood Hazard Identification Program (FHIP). Project stakeholders include the provincial government, local authorities, and the public.

The overall objectives of this project are to identify and assess river related hazards and enhance public safety along the Bow River and the three tributaries included in the study area. The intent is to reduce potential future flood damages and disaster assistance costs to the federal, provincial, and local governments, as well as First Nations. New floodplain maps will inform land use planning decisions, assist with developing flood mitigation options and facilitate emergency response planning.

The Upper Bow River Hazard Study has been structured into eight major project components. This report summarizes the work of the second component, Hydraulic Model Creation and Calibration. Pertinent flood history, a summary of available data, and description of physical features modelled are provided as background information. The water surface profiles for the open water flood frequency flows are the key deliverable for this project component and are included in this report.

Although the three largest historic floods occurred in the late 1800's, the largest recorded flood occurred in June 2013. During this event, the severity of flooding varied throughout the study reach but generally damages increased in the downstream direction. Some tributaries, such as Cougar Creek and Exshaw Creek, experienced severe debris flows. The 2013 flood was adopted for the hydraulic model calibration due to both its high magnitude and available highwater mark observations within the study reach. However, some calibration difficulties were encountered because of limited reliable 2013 peak flows for this highly regulated river system. Other flood events (2012, 2005, 1990, 1986) were relied upon for additional model calibration and validation. Simulated water levels agreed well with the observed highwater marks, with an average difference of 0.2 m. At the location of a number of Water Survey of Canada (WSC) hydrometric gauges, model calibration was further informed by comparing simulated stage-discharge rating curves to equivalent curves published by WSC. This comparison verified the ability of the model to simulate stages for a range of discharges.

Water surface profiles were prepared for the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1000-year open water flood frequency return period flows on the Bow River and the modelled tributaries. The crest of the flood control dikes in Canmore are generally 0.15 to 0.5 m above the 100-

year open water flood level but are expected to start overtopping at multiple locations at the 200-year to 350-year flood events. The exception to this is the lower 1.1 km of the Canmore Town Dike near the wastewater treatment plant, where the dike is overtopped between a 35 and 75-year flood event. Also, a short reach of the Canmore Town Dike, upstream of the Engine Bridge, has a lower crest elevation which results in flooding of parkland at a 2-year to 5-year flood; however, houses located north of the park are on higher ground and would not be affected until a 50-year event. Along Jumpingpound Creek in Cochrane, the short flood control dike is generally 0.1 m below the 100-year open water flood level and would be overtopped at the 100-year flood event.

The calibrated open water model includes all pertinent physical features, flood control structures, and the most up-to-date terrain data available for the study area. Based on the results of the model calibration and comparison to available data, the model presented is considered appropriate for the open water inundation mapping and flood hazard identification components of the Upper Bow River Hazard Study.

CREDITS AND ACKNOWLEDGEMENTS

Northwest Hydraulic Consultants Ltd. (NHC) would like to express appreciation to Alberta Environment and Parks (AEP) for initiating this project, making available extensive background information and providing advice and support throughout the survey and modelling work. Key AEP representatives were Jane Eaket, P.Eng. (Project Manager) and Peter Onyshko, P.Eng. (Alternate Project Manager).

Special thanks are expressed to individuals from Alberta Environment and Parks, the Town of Canmore, the Municipal District of Bighorn, and the Town of Cochrane for assisting with the site visits and for providing valuable data for this study. Thanks are also expressed to individuals from Alberta Transportation, TransAlta, and CP Rail for providing data and background information. We acknowledge the Stoney Nakoda First Nation for facilitating the survey of Bow River channel cross sections on its territorial lands, which were subsequently used for developing the hydraulic model for this reach of the river.

The following NHC personnel were part of the study team and participated in the creation and calibration of the hydraulic model component of the study. The numerical modelling was completed by Vanessa O'Connor, P.Eng., (Hydraulic Modeller), while Sarah North, GISP (GIS Analyst), was responsible for data management and documentation, and manipulation of spatial data for input to HEC-RAS. Technical modelling guidance was provided by Vaughn Collins, P.E., Todd Bennett, P.E., and Robyn Andrishak, P.Eng. Monica Mannerström, P.Eng. (Project Manager) ensured the overall direction of the project and modelling work. Technical assistance was provided by Vanessa Bennett, E.I.T., Josef Drechsler, GISP, Andromeda McIsaac, E.I.T., and Jasmine Kang, E.I.T.

This report was authored primarily by Vanessa O'Connor and Sarah North with contributions from other team members. Robyn Andrishak and Monica Mannerström reviewed the report.

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1 INTRODUCTION

1.1 Project Background

Alberta Environment and Parks (AEP) retained Northwest Hydraulic Consultants Ltd. (NHC) in September 2015 to complete a river hazard study for the Upper Bow River, along a reach defined between the Banff National Park boundary at the upstream end and Bearspaw Dam at the downstream end. The study is being conducted under the provincial Flood Hazard Identification Program (FHIP).

The Bow River has been exposed to severe flooding in the past, with three extreme events occurring from the late 1800s to early 1900s, two around 1930, and, more recently, in 2013.

For the Bow River reach within the current study limits, provincial flood hazard mapping was previously prepared for Cochrane (Alberta Environment, 1990), Canmore (W-E-R Agra, 1993), and Municipal District (M.D.) of Bighorn (Acres, 1996). The Cochrane study was completed by Alberta Environment in 1986 with an addendum issued in 1990. The study reach covered 21 km of the Bow River (from Bearspaw Dam to upstream of the Town of Cochrane boundary) and the lower 4.5 to 5 km reaches of Jumpingpound and Bighill Creeks (two tributaries discharging to the Bow River within the Town of Cochrane limits). The M.D. of Bighorn study, completed by Acres International Ltd., includes a 15 km reach of the Bow River from the west boundary of Bow Valley Provincial Park to Dead Man's Flats and includes the lower one kilometre reach of Exshaw Creek. The Canmore study completed by W-E-R Agra Ltd. covered a 20 km reach of Bow River from Dead Man's Flats, through the Town of Canmore (including Policeman Creek), to the Banff National Park boundary.

AEP identified a need to update and expand the coverage of this mapping following the 2013 floods. Stakeholders of the present project are the Government of Alberta, the Town of Canmore, the M.D. of Bighorn, Stoney Nakoda First Nation, Rocky View County, the Town of Cochrane, and the public.

1.2 Project Objectives

The overall objectives of this project are to identify and assess river related hazards and enhance public safety along the Bow River and three tributaries included in the study area. The intent is to reduce potential future flood damages and disaster assistance costs to the federal, provincial, and local governments, as well as First Nations. New floodplain maps will inform land use planning decisions, assist with developing flood mitigation options and facilitate emergency response planning.

Specific study components, as outlined in the AEP Upper Bow River Hazard Study Terms of Reference, are:

- survey and base data collection;
- hydraulic model development, calibration and validation;
- open water flood inundation map production;

- open water flood hazard identification;
- ice jam assessment and associated flood hazard identification;
- governing flood hazard map production;
- flood risk assessment and inventory; and
- channel stability investigation.

The results of each component will be summarized in individual stand-alone reports. The current report describes the results from the Hydraulic Model Creation and Calibration phase of the project and forms the second of the Upper Bow River Hazard Study reports.

The main goal of the current component is the development of a calibrated HEC-RAS hydraulic model for the study area. The primary tasks, services, and deliverables associated with this report are:

- documentation of historic floods;
- development, calibration, and validation of a HEC-RAS hydraulic model;
- simulation of selected return-period floods and creation of water surface profiles throughout the study reach; and
- a sensitivity analysis of the model inputs.

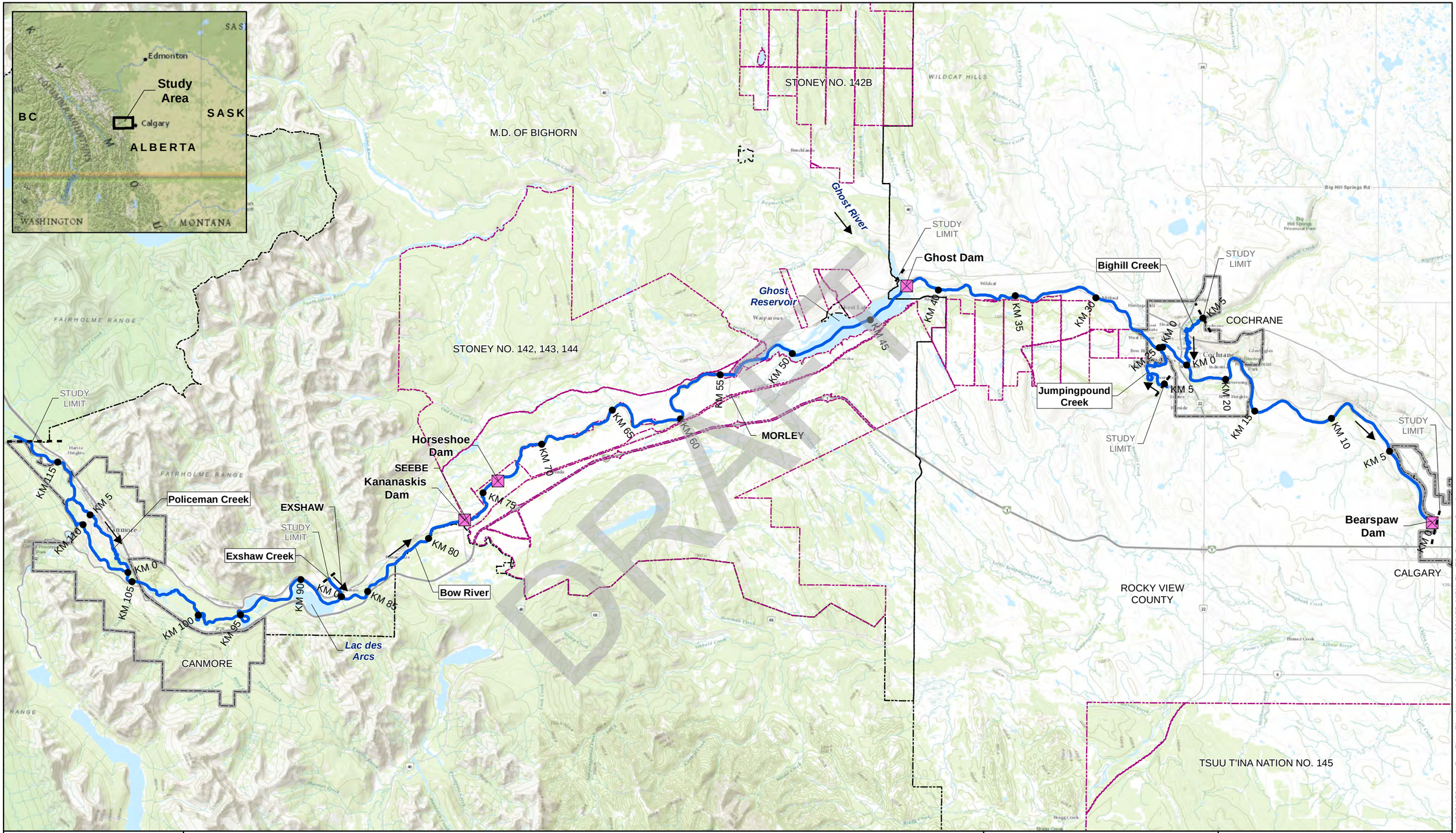
The hydraulic model development, calibration, and validation are foundational to the overall project. The hydraulic model described will be utilized for the open water and ice jam flood inundation mapping, as well as for the flood hazard identification components. These latter components are described under separate cover.

1.3 Study Area and Reach

From the Bow River headwaters at Bow Lake (Elev. 1940 m), just north of Lake Louise, the river flows in a south-easterly to easterly direction over nearly 600 km before draining into the South Saskatchewan River. The Upper Bow River study area comprises a roughly 118 km long reach, extending from the Banff National Park boundary, located approximately 5 km upstream of the Town of Canmore, to Bearspaw Dam, near the City of Calgary western boundary. Within the Town of Canmore, the study area incorporates Policeman Creek, an inlet controlled high water channel roughly 6.5 km long situated on the floodplain and running parallel to the Bow River main channel. In addition, the study area includes three tributaries:

- the lower 1 km long reach of Exshaw Creek at the Hamlet of Exshaw;
- the lower 5 km of Bighill Creek at the Town of Cochrane; and
- the lower 5 km of Jumpingpound Creek at the Town of Cochrane.

Flow is regulated both on the Bow River main stem and on several tributaries. In addition to the Bearspaw Dam at the downstream end, the Ghost, Horseshoe Falls, and Kananaskis Dams also impound the river. The study area is shown in Figure 1.



Alberta Government

nhc northwest hydraulic consultants

Model Stream Network (with stationing)

Dam

Summer Village

Town

City

First Nation Reserve

County or Municipal District

DATA SOURCES: Basemap from Esri & NRCAN.

SCALE - 1:200,000

0 1 2 3 4 5 6 7 8 KM

N

Coordinate System: NAD 1983 3TM 114
Units: METRES

Job: 3001178

Date: 17-NOV-2017

UPPER BOW RIVER HAZARD STUDY

STUDY AREA

FIGURE 1

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_StudyArea3.mxd

2 FLOODING HISTORY

2.1 General Information

A comprehensive review of past floods forms an important component of any flood hazard assessment. It provides an understanding of the weather conditions that lead to flooding, outlines potential inundation extents, and assists with selecting appropriate calibration and validation data. A distinction is made between historic and observed floods, defined as floods that occurred before the systematic record, and recent and recorded floods, which on the Bow River system began in 1909.

Along the 118 km long study reach, the Bow River drainage area doubles from approximately 3,730 km^2 at the upstream study limit to about 7,670 km^2 at the downstream end at Bearspaw Dam. Considering the extent of the study area and the number of tributaries, flooding may occur in some reaches of the river while not in others, depending on the particular characteristics of the flood event. During very large floods, most reaches are generally affected.

There are two separate flood regimes along the Bow River: open-water flooding and ice-affected flooding. The majority of open-water flooding throughout the study reach has occurred in late spring or early summer, as a result of either rain on snow events or high intensity rainfall. On the Bow River, in the vicinity of Cochrane, ice-affected flooding generally occurs during freeze-up and is a function of temperature and flow magnitude.

The study area includes four hydro-dams (from upstream to downstream): Kananaskis Dam built in 1913; Horseshoe Dam built in 1911; Ghost Dam built in 1929; and Bearspaw Dam built in 1954. The Kananaskis and Horseshoe dams have small head-ponds that provide negligible flow regulation, whereas the Ghost and Bearspaw dams are larger structures that provide significant regulation. Other anthropogenic features along the study reach include flood control dikes, berms, and road and railroad embankments.

An extensive data search was carried out, contacting various local, provincial and federal sources to obtain hydrometric data, relevant narratives, observations and photographs documenting significant floods (open water and ice-affected). Sources include:

- Water Survey of Canada (WSC);
- TransAlta Corporation (TransAlta);
- Alberta Transportation (AT);
- Provincial Archives of Alberta;
- community newspaper archives; and
- local libraries.

2.2 Open Water Floods

Based on the information reviewed, the following represents general characteristics of open water flooding in the study area.

- Flood events typically take place in late spring or early summer.
- Flooding often occurs following high intensity rain that may last several days or from rain on snow events. The rainfall is often concentrated in the area between Banff and Canmore.
- Flash floods and high runoff may occur anywhere in the study area but are often concentrated at tributary creeks. Debris floods can occur and have the potential to result in culvert washouts and damage to bridges and other low structures.
- Low-lying areas along the river are typically flooded directly by the Bow River and its tributaries, or by local surface runoff.

Estimated and recorded flood flows at key gauges in the Bow River basin are summarized in Table 1. The gauges are listed, starting on the left side of the table, from upstream to downstream. The flows at each gauge are shaded from the lowest flows (blue) to the highest flows (red). The shading highlights that some of the highest flows were recorded throughout the entire watershed during the 2013 flood, whereas other large floods were more localized.

The following points are worth noting when reviewing the values in Table 1:

- Reservoir operating regimes have changed over time and regulated flow records are non-homogenous.
- Although early flow records date back to 1909, some of the Water Survey Canada (WSC) gauges were discontinued or relocated and it is not possible to directly compare long-term peak flows.
- The annual maxima (estimated and recorded) for the Bow River at Calgary show a highly unusual distribution of peak flows, with all extreme peaks (>1,000 m^3/s), with the exception of the 2013 flood, occurring prior to 1933.
- High flows at Calgary are not necessarily correlated with high flows throughout the study area; similarly, high flows in the upper basin (e.g. Banff in 1918 and 1923) do not always result in high flows at Calgary.

Table 1 Estimated and recorded peak instantaneous flood flows at key gauges on the Bow River and tributaries

Year	Bow River at Lake Louise (05BA001)	Bow River at Banff (05BB001)	Spray River at Banff (05BC001)	Kananaskis River near Seebe (05BF001)	Bow River near Seebe (05BE004)	Ghost River near Cochrane (extended) (05BG001)	Bow River below Ghost Dam, Ghost Reservoir Outflow (05BE006)	Jumpingpound Creek at Township Road No. 252 (extended) (05BH015)	Bow River at Cochrane (05BH005)	Bow River at Bearspaw Reservoir Outflow (extended) (05BH008)	Bow River at Calgary (extended) (05BH004)
1879	-	-	-	-	-	-	-	-	-	-	2270
1884	-	-	-	-	-	-	-	-	-	-	-
1897	-	-	-	-	-	-	-	-	-	-	2265
1902	-	-	-	-	-	-	-	-	-	-	1557
1904	-	-	-	-	-	-	-	-	-	-	-
1909	-	329	-	-	-	-	-	21	-	-	-
1915	88	248	70	170	-	348	-	253	-	1138	1130
1916	112	324	137	234	-	154	-	168	895*	816	810
1918	128	362	121	105	-	28	-	15	-	604	599
1923	-	399	141	168	697	-	-	-	-	847	841
1929	-	233	75	161	699	374	-	-	-	1329	1320
1932	-	283	154	337	903	394	-	-	-	1531	1520
1933	-	328	168	118	705	35	606	16	-	677	686
1948	-	306	127	180	498	93	595	-	-	599	595
1972	-	320	181	-	-	70	476	15	-	428	425
1974	71	320	64	-	-	53	518	18	-	487	484
1986	71	317	21	76	482	57	426	14	-	428	427
1990	48	246	19	80	452	284	537*	55	-	523	530
2005	34	174	27	101	381	462	615*	213	-	919	791
2012	83	349	28	57	426	199	465*	62	468*	562	476
2013	66	506	87	353	818	670	1381*	214	1580*	1864	1840

Notes:

1. Flows obtained directly from WSC records or TransAlta plant logs marked with *.
2. All other flows from Golder (2017).
3. Colour shading for each gauge indicates lowest flow (blue) and highest flow (red).

2.2.1 Historic and Observed Floods

Historic floods refer to major floods that occurred prior to the period of hydrometric data collection and systematic recording of water level and discharge. In some cases, the magnitude of a historic flood can be estimated based on observations or even anecdotal information.

Appendix A (Table A-1) provides an overview level summary of historic and observed floods, focussing on the following information:

- weather conditions that led to the floods;
- information on observed or estimated flows and water levels; and
- damage caused by the floods.

Newspaper articles and local information on historic flooding date back to the flood of 1879, which is believed to be the largest observed flood on the Bow River at Calgary. Three very large floods occurred in 1879, 1884, and 1897, prior to official record keeping. Extensive damage was caused by these three floods, although the land was considerably less developed than now. In 1879, Canmore suffered severe damage, with destruction reported throughout the study area and in Calgary. The 1884 flood damaged the CPR line and two bridges were washed out. Again, Canmore suffered extensive damage and a number of bridges in Calgary were destroyed. Only 13 years later, in 1897, the third flood occurred causing yet more damage. The 1879 and 1897 flow estimates are roughly of the same magnitude. Additional large floods occurred in 1902 and 1904.

Of the three modelled tributaries, only Exshaw Creek has a reference to historic flooding. As detailed in the Bow River – M.D. of Bighorn Flood Risk Mapping Study (Acres, 1996), "*historic archives from the Glenbow Museum report of frequent flash flooding at Exshaw before construction of the cement plant in 1907".* The study also states that berms were built to confine Exshaw Creek to its original flow path and that little overbank flooding has occurred following the construction of the berm (Acres, 1996).

2.2.2 Recent and Recorded Floods

WSC started recording flow data on the Bow River at Banff in the spring of 1909. All flood events following 1909 are considered to be recent and/or recorded.

As indicated in Table A-2, Calgary forms the only point of comparison between recorded and historic floods. Following 1909, flows have not exceeded the estimated historic events. Although the 1929 and 1932 floods were relatively significant, corresponding peak flows at Calgary were less than 70% of the earlier floods. The magnitude of the 2013 flood, the largest recorded flood, was just over 80% of the 1879 and 1897 floods. It is interesting to note that although the 2013 flood was much larger than the 1932 flood at Calgary, 1932 flows at Seebe were higher than in 2013. Brief descriptions of the two largest recorded floods, 1932 and 2013, are provided below. Appendix A summarizes flood conditions and damage resulting from the 1909, 1915, 1916, 1918, 1923, 1929, 1932, 1948, 1974, 1986, 1990, 2005, 2012 and 2013 floods (Table A-2).

2 June 1932

The weather conditions leading up to the 1932 flood included heavy prolonged rainfall lasting for about one week. The peak instantaneous flow magnitude for Bow River at Calgary was reported by WSC to be 1,518 m^3/s, which is comparable to the peak flow estimate for the flood of 1902. Damage included inundation of 12 houses in Canmore and closure of several roads. In Exshaw, a bridge was washed out.

19-21 June 2013

The hydrologic conditions leading up to the 2013 flood are described by Golder (2016). An extreme rainfall event occurred in the headwaters of the Bow River and several other Alberta rivers. *"The June 18 to 22, 2013 rainfall event in southern Alberta had rainfall accumulations of up to 255 mm over a 24-hour period and 348 mm over the 72-hour storm duration. Of the 70 rain gauge stations analyzed, precipitation data recorded at 39 stations exceeded the 100-year short duration (1-hr, 2-hr, 6-hr, 12-hr and 24-hr) rainfall totals for at least one of the durations."*

The heavy rain coincided with saturated soil conditions and unusually high groundwater. Warming temperatures and the thermal effect of rainfall falling on snowpack further exacerbated runoff. The recorded snowpack was about 25% above normal for the time of year.

The flow at Banff reached a peak instantaneous discharge of 506 m^3/s on 21 June 2013, based on data published by WSC. The previous maximum recorded peak instantaneous discharge was 399 m^3/s in 1923.

The Bow River at Calgary (upstream of the Elbow River confluence) reached a record high peak instantaneous discharge of 1,840 m^3/s on 21 June 2013, based on data published by WSC. The previous maximum recorded peak instantaneous discharge was 1,520 m^3/s in 1932. The 2013 peak discharge for the Bow River at Calgary is estimated to have a return period of about 80 years, based on a frequency analysis by Golder (2016).

Flood damage in the Calgary area was extensive; however, relatively little flooding occurred along the Bow River within the study reach. Some of the tributaries, particularly Exshaw Creek, Jura Creek, and Cougar Creek (the latter two are not included in the study area), experienced severe flooding and debris flows.

2.3 Ice Jam Floods

The effect of ice on the flood hazards varies along the Bow River and tributaries within the study area. The Bow River upstream of Ghost Dam can experience water level increases during the winter months due to ice accumulation, but ice jams have been found to present little or no risk of flooding (W-E-R AGRA, 1993). A review of the historical flood record shows that ice-affected flooding upstream of Ghost Dam is rare and much less severe than open water flooding. Downstream of Ghost Dam, ice-affected flooding is of similar magnitude to the open water flooding. The Cochrane Floodplain Study (Alberta Environment, 1990) concluded that the ice regime on the Bow River at Cochrane is influenced by Ghost Dam upstream and Bearspaw Dam downstream. Continual releases of warm water from Ghost

Reservoir can result in long open water stretches downstream of the dam during the winter months, which can lead to the production of large volumes of frazil ice. Frazil particles flocculate and ultimately become frazil floes (ice pans) that are transported downstream on the water surface and accumulate in the Bearspaw Reservoir. This accumulation progresses upstream through Cochrane at rates and thicknesses that are governed by the ice supply and the local hydraulic characteristics. The relatively steep river slope contributes to the development of thick ice covers that can result in significant increases in water level.

Exshaw, Bighill, and Jumpingpound creeks are relatively narrow channels with low winter flows; therefore, these reaches are not susceptible to ice jams.

2.3.1 Historic and Observed Floods

Both historic and recorded floods were considered in this review. Historic floods refer to major floods that occurred prior to the period of hydrometric data collection and systematic recording of water level and discharge. In some cases, the magnitude of a historic flood can be estimated based on observations or even anecdotal information. Compared to a number of countries, the hydrometric record length is relatively short for most locations in Canada, with stream gauging on the Bow River beginning in 1909. Non-indigenous settlements were first established in the area towards the late 1800s and reported historic floods are limited to this time span, although indigenous anecdotal accounts date back much further.

A search of available sources found no record of historic floods along the Bow River and tributaries due to ice effects within the study reach. It is worth noting that prior to hydrometric record keeping, the study reach was not regulated for hydropower production.

2.3.2 Recent and Recorded Floods

The previous flood risk mapping study for Canmore (W-E-R AGRA, 1993) reported one uncorroborated occurrence of ice-related flooding at the Canmore school grounds in 1936 or 1937, resulting in about 0.6 m of inundation. That report concluded that ice related flooding at Canmore is rare due to typical characteristics of the ice regime of the Bow River in this reach and indicated by the lack of historical records of such events.

Ice-related flooding was reported in the Cochrane Floodplain Study (Alberta Environment, 1990). The following excerpts are quoted from the study:

> *"Winter flooding of some low terraces along the Bow River has occurred on a relatively frequent basis following installation of the Ghost Dam and Power Plant in the 1940's and the construction of the Bearspaw Reservoir in 1954. […] The most severe incident appears to have occurred in February, 1973, when a short-term loss in thermal generating capacity necessitated an increase in Ghost Plant output at a time when the ice pack accumulation was building*

through the Cochrane reach. TransAlta Utilities Corporation's records show that the ice pack water levels on this occasion reached a stage of approximately 4.5 m above normal summer water levels. This is high enough to cause flooding of low-lying areas bordering the river."

The 1973 peak stage recorded at River Avenue Bridge in TransAlta records is 1,119.36 m, which is the highest stage on record (Section 3.1). The next highest stage observed is 1,119.18 m in 1970-71, which suggests that the 1973 observation is not an outlier. Furthermore, there are several other observed stages within 1 m of the highest recorded stage.

Another quote from the Cochrane Floodplain Study (Alberta Environment, 1990) suggests localized flooding upstream of Highway 1A:

"Winter flooding in the vicinity of the Cochrane Ranch Historic Site, located just upstream of Highway 1A, is believed to be caused by ice dams (aufeis) which form in the spring fed creek, particularly in years with sudden and frequent temperature changes."

Aufeis can develop on top of the intact ice cover when runoff collects on top of the ice and freezes, rather than draining through the ice. The increased ice thickness from this additional freezing raises water levels locally. This localized flooding was not analysed in this report.

No evidence of recent and recorded ice jam flood activity was found for Exshaw, Bighill, or Jumpingpound creeks within the study area. Due to their physical characteristics and low winter flows, these reaches are not affected by ice processes that would lead to jamming and ice-related flood risks.

3 AVAILABLE DATA

Data pertinent to development of a calibrated hydraulic model include basin hydrology, current high-resolution terrain data representing the floodplain, surveyed channel cross sections, existing hydraulic models, highwater marks, gauge data, rating curves, and flood photographs. The data available for this study are summarized below. As discussed in Section 4, additional data include channel and floodplain roughness values, as well as geometric details for bridges and other structures.

3.1 Hydrology Summary

An open water hydrology assessment of the study area was completed by Golder (2017). The *Bow, Elbow, Highwood, and Sheep River Hydrology Assessment* includes a summary of the flood hydrology and provides estimates of naturalized and regulated flows at key locations. For the modelling described herein, natural and naturalized flood peaks were used when generating water surface profiles, in accordance with the terms of reference and FHIP guidelines. Details on the methods and distributions used to estimate the flood frequencies are provided by Golder (2017). Table 2 summarizes the final natural and naturalized flood flows relevant to the current hydraulic model. The location of the hydrometric stations listed in Table 2 are shown in Figure 2.

Table 2 Natural and naturalized flood frequency discharges

WSC Station Name or Location of Interest	Peak Instantaneous Flood Frequency Discharge Estimates (m^3/s)												
	1000-yr	750-yr	500-yr	350-yr	200-yr	100-yr	75-yr	50-yr	35-yr	20-yr	10-yr	5-yr	2-yr
Probability of Exceedance in Any Given Year (%)	0.1	0.13	0.2	0.29	0.5	1.0	1.3	2.0	2.9	5.0	10	20	50
Bow River at Canmore	1090	1050	993	940	861	770	734	684	642	577	499	425	323
Bow River above Kananaskis	1270	1210	1130	1060	957	843	798	738	689	614	527	446	338
Bow River below Kananaskis	1770	1660	1510	1400	1230	1050	983	894	822	719	606	505	380
Bow River near Seebe (05BE004)	1760	1650	1510	1400	1240	1060	994	906	834	731	616	513	384
Bow River Above Ghost Reservoir	1860	1750	1600	1480	1310	1120	1050	959	883	774	652	543	406
Bow River below Ghost Dam (Ghost Reservoir Outflow 05BE006)	2390	2230	2030	1850	1610	1350	1260	1130	1030	878	718	577	408
Bow River near Cochrane (05BH005)	3270	3020	2690	2420	2060	1680	1540	1360	1220	1010	800	619	413
Bearspaw Reservoir Inflow	3580	3290	2920	2620	2220	1790	1630	1440	1280	1060	829	634	415
Policeman Creek at Canmore	22.4	20.5	18.2	16.3	13.6	10.8	9.80	8.47	7.41	5.92	4.32	2.96	1.40
Exshaw Creek at Exshaw	67.9	62.1	54.9	48.9	40.6	31.9	28.7	24.7	21.4	16.9	21.1	8.18	3.82
Jumpingpound Creek at Cochrane	1030	936	815	711	568	425	374	310	260	193	127	76.8	30.0
Bighill Creek at Cochrane	48.4	45.6	41.8	38.4	33.3	27.4	25	21.8	19.1	15.1	10.5	6.55	2.29

TransAlta/WSC 05BD004
CASCADE POWER DIVERSION NEAR BANFF
1942 - Present
*Power Plant (1942 - 1976) and Recorder (1977 - 2016)

TransAlta Plant Log
HORSESHOE DAM
Reservoir WL and Q d/s from 2012 - Present

KANANASKIS DAM
Reservoir WL and Q d/s not available

TransAlta/WSC 05BE005
GHOST LAKE NEAR COCHRANE
1970 - Present
WL only

TransAlta Plant Log
GHOST DAM
Reservoir WL from 1985 - Present and gauge 05BE005

WSC 05BH005
BOW RIVER NEAR COCHRANE
1917 - 1930 (seasonal)
* gauge location was changed when gauge reinstalled in 2006

WSC 05BH005 (real-time)
BOW RIVER NEAR COCHRANE
2006 - Present (seasonal)
* gauge location was changed when gauge reinstalled in 2006

TransAlta Plant Log
BEARSPAW DAM
Reservoir WL and Q d/s from 1985 - Present

WSC 05BB001 (real-time)
BOW RIVER AT BANFF
1909 - Present

WSC 05BC001 (real-time)
SPRAY RIVER AT BANFF
1910 - Present

WSC 05BH009
JUMPINGPOUND CREEK NEAR THE MOUTH
1965 - 2006
* active gauge 05BH015 is approx. 9 km upstream

WSC 05BH015
JUMPINGPOUND AT TOWNSHIP ROAD No 252
2006 - Present
* discontinued gauge 05BH009 is approx. 9 km downstream

WSC 05BE008
BOW RIVER AT CANMORE
1976 - 1985

WSC 05BE006
BOW RIVER BELOW GHOST DAM
1933 - 1989
* discontinuous and/or seasonal coverage
* active gauge 05BE999 is approx. 8 km upstream

WSC 05BE003
BOW RIVER NEAR KANANASKIS
1912 - 1922

TransAlta/WSC 05BE999
GHOST TAILRACE
1988 - Present
* discontinued gauge 05BE006 is approx. 8 km downstream

TransAlta/WSC 05BE004
BOW RIVER NEAR SEEBE
1923 - Present
* some uncorrected data (1963 - 1977)

WSC 05BE001
BOW RIVER NEAR MORLEY
1910 - 1911

Headwaters Bow
Cascade
Ghost
Bighill
Bow River
Exshaw
Jumpingpound
Spray
Kananaskis

ALBERTA
Edmonton
Map Area
Calgary
SASK
BC

Hydrometric Station
- Active
- Discontinued
- Not Referenced in Study

Drainage Basin
- Within Study Area
- Outside Study Area

- Study Reach
- Stream
- Dam

DATA SOURCES: Basemap from Esri & NRCAN. Stream network from National Hydro Network (NHN). Watershed boundaries from NHN and NHC. Hydrometric stations from Water Survey of Canada.

SCALE - 1:650,000
0 5 10 15 20 25 KM
N

Coordinate System: NAD 1983 3TM 114
Units: METRES

Job: 3001178 | *Date: 14-AUG-2017*

UPPER BOW RIVER HAZARD STUDY

LOCATION MAP

FIGURE 2

Alberta Government

nhc northwest hydraulic consultants

MSN, \\192.168.100.12\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_LocationMap3.mxd

3.2 Digital Terrain Model Data

A digital terrain model (DTM) based on airborne LiDAR data was supplied by AEP for this study. The DTM was based on data collected for the study area by Airborne Imaging Inc. on September 10th and 11th and October 5th and 11th, 2015 (Airborne Imaging, 2016). The western portion of the study area was flown primarily on September 10th and 11th, while the eastern portion of the study area was flown on October 5th and 11th. A complete description of the DTM data and its comparison to the ground survey data is provided in the Survey and Base Data Collection Report (NHC, 2017) provided under separate cover.

3.3 Survey Data

The development of the hydraulic model required extensive surveys of the river cross sections, bridges, and flood control dikes. Control points were also established to validate the DTM and facilitate the extension of the river cross sections through the overbank beyond the expected flood inundation limits. The survey program, conducted in the fall of 2015 and in the spring of 2016, is documented in the Survey and Base Data Collection Report (NHC, 2017) submitted as part of this study.

A total of 587 cross sections were surveyed, with 184 of the cross sections being re-surveyed along the alignment of historical cross sections. The cross sections were located to obtain an appropriate hydraulic representation of the modelled streams. On average, sections are spaced every 320 m on the Bow River and every 50 to 100 m on Policeman, Exshaw, Jumpingpound, and Bighill creeks. The number and spacing of surveyed cross sections are summarized in Table 3. The Bow River was divided into three sub-reaches measuring roughly 40 km each. Values are also reported for the three sub-reaches.

Table 3 Summary of surveyed cross sections (Survey and Base Data Collection Report*)*

Description	Reach length (km)	Reach start stationing (km)	Reach end stationing (km)	Total number of sections	Number of historic sections resurveyed	Max spacing (m)	Min spacing (m)	Avg spacing (m)
Bow River - All	118.1	0	118.1	368	132	1703	15	321
Bearspaw Dam to Ghost Dam	42.1	0	42.1	157	54	973	27	266
Ghost Dam to Horseshoe Dam	31.8	42.1	73.9	71	n/a	1703	54	438
Horseshoe Dam to Banff Park Boundary	44.2	73.9	118.1	140	78	893	15	303
Policeman Creek	6.5	0	6.5	73	17	280	2	85
Exshaw Creek	1.3	0	1.3	22	3	168	9	64
Jumpingpound Creek	5.2	0	5.2	47	20	220	46	113
Bighill Creek	5.0	0	5.0	77	16	182	3	64

To accurately model road and rail bridges, cross sections were surveyed immediately upstream and downstream of the bridge faces. Additional cross sections were surveyed one channel width upstream and downstream of the bridge faces to measure the shape of the cross section beyond the hydraulic influence of the bridge structure. Bridge geometric details were derived both from survey data and information from available bridge design drawings.

Processed survey data are provided in 3-Degree Transverse Mercator (3TM) 114 Canadian Spatial Reference System North American Datum of 1983 (NAD83 CSRS) horizontal coordinates and HTv2.0 geoid. The vertical datum is the Canadian Vertical Datum of 1928 (CGVD28). Refer to Survey and Base Data Collection Report for additional details.

3.4 Existing Hydraulic Models

Several hydraulic models, primarily used as tools to generate flood hazard mapping, were previously developed for reaches of the Bow River, as well as Policeman, Exshaw, Jumpingpound, and Bighill creeks. Within the current study limits, hydraulic models are available for flood hazard studies completed in Canmore (W-E-R Agra ,1993), M.D. of Bighorn (Acres, 1996), and Cochrane (Alberta Environment, 1990).

The previous Canmore study includes a 20 km reach of the Bow River from the Banff National Park boundary, through the Town of Canmore (including Policeman Creek), to Dead Man's Flats. A HEC-2 model of the area was developed, based on cross sections surveyed in 1992.

The previous M.D. of Bighorn study includes a 15 km reach of the Bow River from Dead Man's Flats to Kananaskis and includes the lower one kilometre reach of Exshaw Creek. A HEC-2 model of the area was developed. The exact date of the cross section survey is unknown, but it pre-dates the 1993 Lac des Arcs dike construction.

The previous Cochrane study includes 21 km of the Bow River (from upstream of the Town of Cochrane boundary to Bearspaw Dam) and the lower approximately 5 km of Jumpingpound and Bighill creeks (Bow River tributaries within the Town of Cochrane limits). A HEC-2 model of the area was developed, based on cross sections surveyed in 1982.

3.5 Documented Highwater

Highwater mark observations provide documentation of the peak water levels that occurred at a given location for a particular flood of interest. These data are used for hydraulic model calibration and validation by comparing simulated water levels to the observed highwater mark elevations along the study reach.

3.5.1 Highwater Mark Elevations

For this study, open water highwater mark elevations were found in records from WSC and the Government of Alberta for the years 1986, 1990, 2005, 2012, and 2013. Government of Alberta records

include highwater marks from AEP and from AT. Details of highwater marks surveyed by AEP and AT after large floods are listed in Appendix A, Table A-3. The locations of the highwater marks are shown by year in Figures 3A to 3E.

The 2013 flood was selected as the preferred model calibration event based on the high flood flows, recent date, and large number of highwater marks. The other floods were used for validation.

3.5.2 Extents of High Water

After the 2013 flood, the Town of Cochrane surveyed the extents of high water along the banks of the Bow River and along the lower reaches of Jumpingpound Creek and Bighill Creek. These surveyed extents do not provide flood elevations but are useful for calibration since they depict the inundation extents. The extents of surveyed 2013 high water are compared with the modelled extents in Section 5.3.5.

CANMORE

TRANS-CANADA HWY

CP RAIL

Bow River

Policeman Creek

117,500 117,000 116,500 116,000 115,500 115,000 114,500 114,000 113,500 113,000 112,500 112,000 111,500 111,000 110,500 110,000 109,500 109,000 108,500 108,000 6,000 5,500 5,000 4,500 4,000 3,500 3,000 2,500

ENGINE BRIDGE

RS 109,981 RS 109,938 RS 109,921

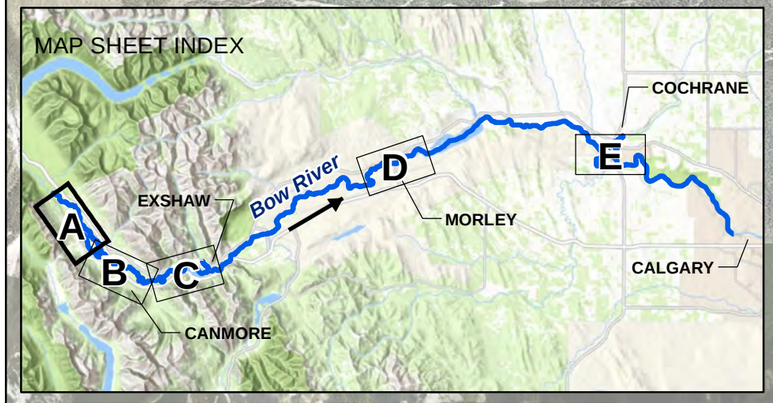
SCALE - 1:2,500
0 50 100 M

BRIDGE ROAD BRIDGE

RS 109,366 RS 109,235 RS 109,202 RS 109,114

SCALE - 1:2,500
0 50 100 M

MAP SHEET INDEX



DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

Alberta Government

nhc northwest hydraulic consultants

- Cross Section
- Model Stream Network (with stationing)
- Town
- County or Municipal District
- First Nation Reserve

HWMs 1986
- Alberta Environment and Parks
- Alberta Transportation

HWMs 1990
- Alberta Environment and Parks
- Alberta Transportation

HWMs 2012
- Alberta Environment and Parks

HWMs 2013
- Alberta Environment and Parks
- Alberta Transportation

SCALE - 1:20,000
0 200 400 600 800 M

N

Coordinate System: NAD 1983 3TM 114
Units: METRES

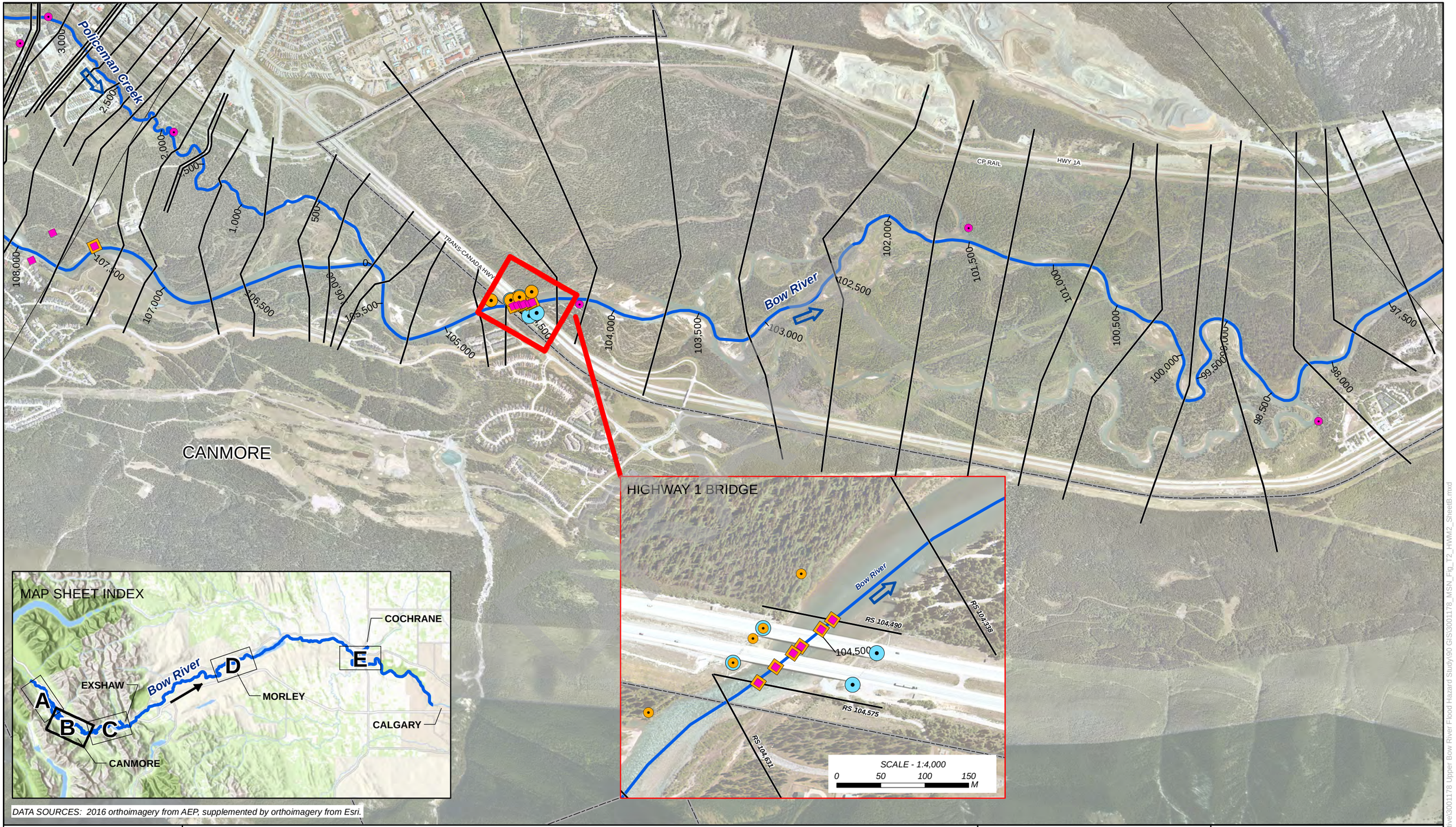
Job: 3001178 | Date: 17-NOV-2017

UPPER BOW RIVER HAZARD STUDY

HIGHWATER MARK LOCATIONS

FIGURE 3A

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_HWM2_SheetA.mxd



DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

Alberta Government

nhc northwest hydraulic consultants

- Cross Section
- Model Stream Network (with stationing)
- Town
- County or Municipal District
- First Nation Reserve

HWMs 1986
- Alberta Environment and Parks
- Alberta Transportation

HWMs 1990
- Alberta Environment and Parks
- Alberta Transportation

HWMs 2013
- Alberta Transportation

SCALE - 1:20,000
0 200 400 600 800 M

Coordinate System: NAD 1983 3TM 114
Units: METRES

Job: 3001178 | Date: 17-NOV-2017

UPPER BOW RIVER HAZARD STUDY

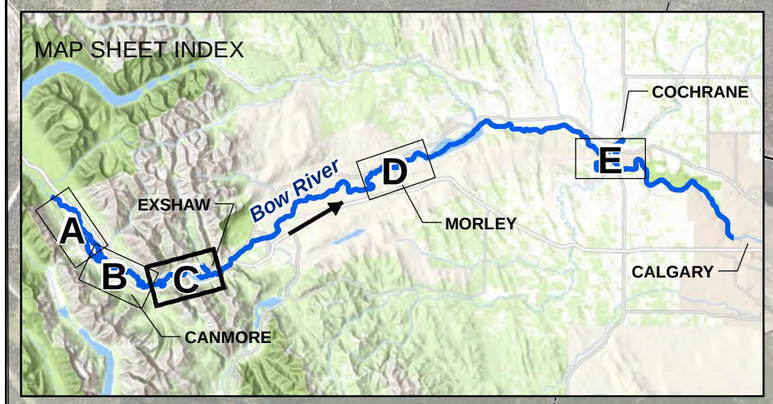
HIGHWATER MARK LOCATIONS

FIGURE 3B

\MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_HWM2_SheetB.mxd

Gap Lake
Bow River
Lac des Arcs
Exshaw Creek
HWY 1A
CP RAIL
TRANS-CANADA HWY
97,000
96,500
96,000
95,500
95,000
94,500
93,500
93,000
92,500
92,000
91,500
91,000
90,500
90,000
89,500
89,000
88,500
88,000
87,500
87,000
86,500
86,000
85,500
1,000
500

MAP SHEET INDEX



DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

Alberta Government

nhc northwest hydraulic consultants

- Cross Section
- Model Stream Network (with stationing)
- Town
- County or Municipal District
- First Nation Reserve

HWMs 1986
- Alberta Environment and Parks
- Alberta Transportation

HWMs 1990
- Alberta Environment and Parks

HWMs 2013
- Alberta Environment and Parks

SCALE - 1:20,000

0 200 400 600 800 M

N

Coordinate System: NAD 1983 3TM 114
Units: METRES

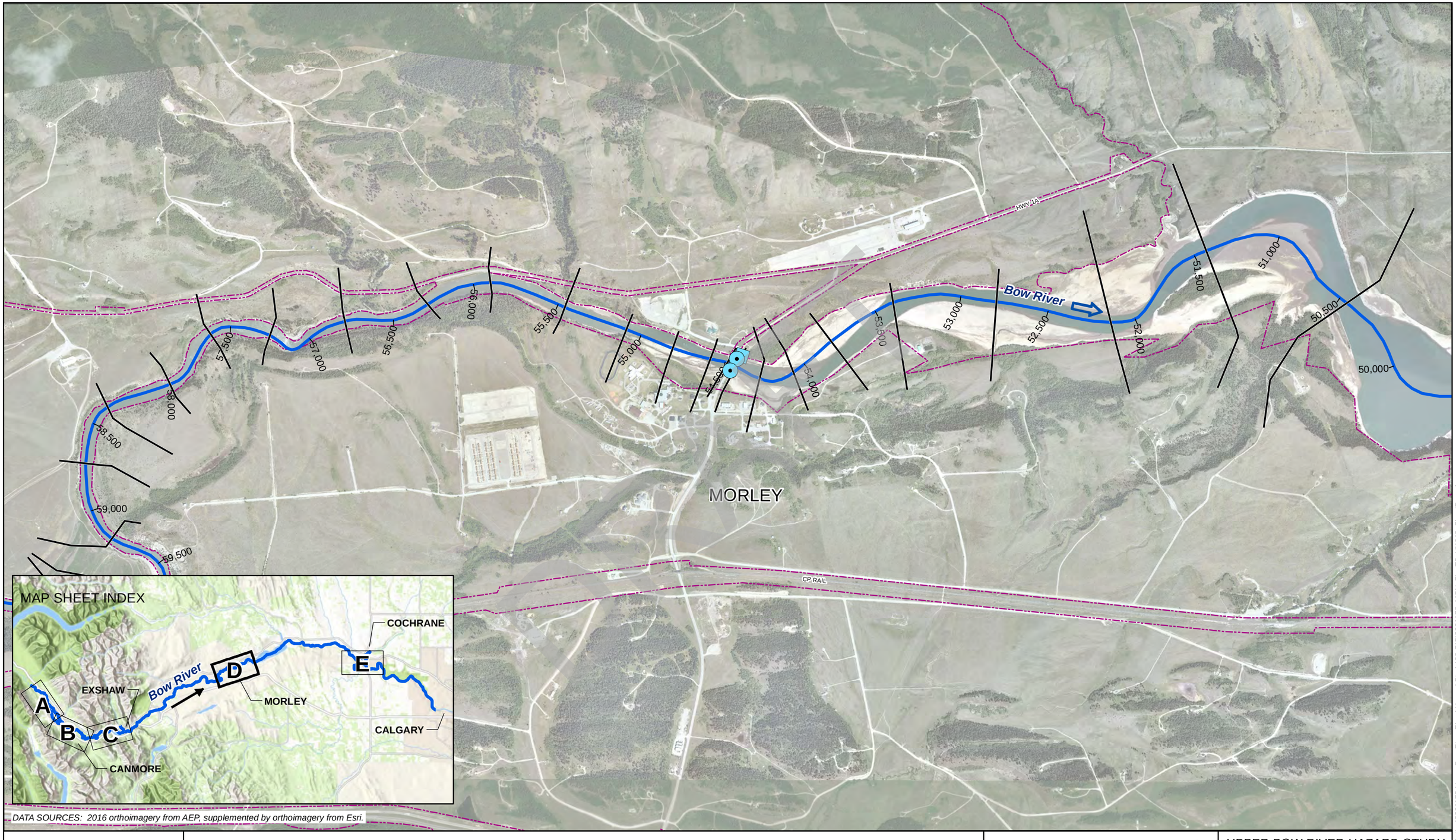
Job: 3001178 | Date: 17-NOV-2017

UPPER BOW RIVER HAZARD STUDY

HIGHWATER MARK LOCATIONS

FIGURE 3C

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_HWM2_SheetC.mxd



DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

Alberta Government

nhc northwest hydraulic consultants

- Cross Section
- Model Stream Network (with stationing)
- Town
- County or Municipal District
- First Nation Reserve

HWMs 2013
- Alberta Environment and Parks
- Alberta Transportation

SCALE - 1:20,000
0 200 400 600 800 M

N

Coordinate System: NAD 1983 3TM 114
Units: METRES

Job: 3001178 | *Date: 17-NOV-2017*

UPPER BOW RIVER HAZARD STUDY

HIGHWATER MARK LOCATIONS

FIGURE 3D

\MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_HWM2_SheetD.mxd

COWBOY TRAIL / HWY 22 BRIDGE

Bow River

RS 23,562

RS 23,415

RS 23,391

RS 23,317

23,500

SCALE - 1:2,500

0 50 100 M

Bighill Creek

HWY 1A

CP RAIL

HWY 22

Bow River

COCHRANE

Jumpingpound Creek

MAP SHEET INDEX

EXSHAW

MORLEY

CALGARY

CANMORE

A

B

C

D

E

DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

Alberta Government

nhc northwest hydraulic consultants

- Cross Section
- Model Stream Network (with stationing)
- Town
- County or Municipal District
- First Nation Reserve

HWMs 1990
- Alberta Transportation

HWMs 2005
- Alberta Transportation

HWMs 2013
- Alberta Environment and Parks
- Alberta Transportation

SCALE - 1:20,000

0 200 400 600 800 M

N

Coordinate System: NAD 1983 3TM 114
Units: METRES

Job: 3001178 | Date: 17-NOV-2017

UPPER BOW RIVER HAZARD STUDY

HIGHWATER MARK LOCATIONS

FIGURE 3E

MSN: \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_HWM2_SheetE.mxd

3.6 Gauge Data & Rating Curves

Water level (stage) and rating curves from hydrometric gauging stations located on the Bow River within the study area were obtained and used to support creation and calibration of the hydraulic model. The gauge names, locations, gauge operation, and other gauge details are shown in Figure 2.

TransAlta records reservoir levels and flows downstream of the Bearspaw, Ghost, and Horseshoe Dams. No data are available at Kananaskis Dam.

The measured data (water level and discharge pairs) were provided by WSC and TransAlta at gauges within the study reach. The details of the rating curves are summarised in Table 4.

Table 4 WSC rating curve details

Gauge Number	Gauge Name	Gauge Status	Period of Record				Conversion from assumed datum (m)
			Measurements		Curves		
05BE004	Bow River near Seebe	Active	1922	2015	1922	2015	1233.715
05BE999	Ghost Tailrace	Active	2013	2015	1979	2015	1155.192
05BH005	Bow River near Cochrane	Active	2006	2014	2006	2014	1098.309
05BE008	Bow River at Canmore	Discontinued	1976	1985	1976	1985	-
05BE003	Bow River near Kananaskis	Discontinued	1912	1922	1912	1922	1278.916
05BE001	Bow River near Morley	Discontinued	1910	1911	1910	1911	1191.800
05BE006	Bow River below Ghost Dam	Discontinued	1933	1989	1933	1973	1141.016

3.7 Flood Imagery

Details of flood imagery captured during or after the 2013 flood and provided by AEP are included in Table 5.

Table 5 2013 flood imagery

Date	Area	Source	Details	Comment
23-Jun-2013	Canmore	AEP – Pleiades Satellite Imagery	Resolution: 0.5 m Number of tiles: 2 Products: panchromatic (BW), full colour infrared, colour satellite imagery	**Flow at Banff:** 21-Jun-2013 = 466 m^3/s 22-Jun-2013 = 405 m^3/s 23-Jun-2013 = 286 m^3/s … 29-Jun-2013 = 167 m^3/s
29-Jun-2013	Downstream of Exshaw to Bearspaw Dam	AEP	Resolution: 0.14 m Products: orthorectified colour aerial photography Accessed via WMS (https://maps.alberta.ca/genesis/rest/services/RGB_Aerial_Southern_Alberta_Flood_2013)	**Flow at Cochrane:** 21-Jun-2013 = 1580 m^3/s 22-Jun-2013 = 1420 m^3/s ... 29-Jun-2013 = 442 m^3/s
21-Aug-2013	Entire study reach (Banff National Park Boundary to Bearspaw Dam)	AEP	Resolution: 0.2 m Products: orthorectified colour aerial photography Accessed via WMS (https://maps.alberta.ca/genesis/rest/services/RGB_Ortho_Southern_Alberta_Post_Flood_2013)	

4 RIVER & VALLEY FEATURES

4.1 General Description

The Bow River flows through three main physiographic regions in the study area (Pettapiece, 1986; Fenton et al., 2013):

- Front Range of the Rockies
- Southern Rocky Mountain Foothills
- Western Alberta Plains

The Front Range of the Rockies region extends from the upstream boundary of the study to near the Hamlet of Exshaw. In this region, the Bow River flows through a mountainous, U-shaped glaciated valley and the valley bottom is commonly covered by Quaternary glacial drift and post-glacial fluvial sediments.

The Southern Rocky Mountain Foothills Region extends approximately 50 km eastward from the mountain front and is underlain by folded and faulted Mesozoic rocks consisting mainly of sandstone and shale. The bedrock is overlain by deposits of Quaternary-age glacial till, fluvial-glacial outwash deposits of gravel and sand, and fine-grained glacial lake deposits. In this foothills region, the Bow River flows through a stream-cut valley, which is gorge-like in places due to outcrops of bedrock that confine the river.

The Western Alberta Plains region starts approximately 10 km west of Cochrane. The bedrock consists of Tertiary-age sandstone and shale and is overlain by Quaternary-age glacial till and glacial lake sediments. In this plains region, the Bow River is often entrenched and flows through a stream-cut valley, confined by high terraces of glacially-derived sediments.

The main population centres are located in Canmore, Exshaw and Cochrane.

4.2 Bow River

4.2.1 Channel Characteristics

The Bow River has been divided into nine sub-reaches on the basis of physiography (valley features), degree of channel confinement, channel pattern, and channel slope (refer to Upper Bow River Hazard Study – Channel Stability Investigation Report (NHC, 2018) for further information on the basis of the reach classification). The reaches are summarized in Table 6. The reference distances (in kilometres) are based on the river stationing that has been adopted for the hydraulic modelling.

Table 6 Bow River sub-reach boundaries

Reach	Upstream	Downstream	Reference River Station (km)	Main Features
R1	Park Boundary	Dead Man's Flats	118.0 – 95.0	Front Range, Canmore
R2	Dead Man's Flats	Exshaw	95.0 - 87.1	Lac des Arcs
R3	Exshaw	Kananaskis Dam	87.1 - 77.5	Start of Foothills
R4	Kananaskis Dam	Horseshoe Dam	77.5 - 73.8	Reservoir
R5	Horseshoe Dam	Morley Bridge	73.6 - 54.5	Bedrock gorge
R6	Morley Bridge	Ghost Dam	54.5 - 41.5	Ghost Reservoir
R7	Ghost Dam	Jumpingpound Creek	41.5 - 24.8	Start of Western Plains
R8	Jumpingpound Creek	Bearspaw Reservoir	24.8 – 7.0	Cochrane terraces
R9	Bearspaw Reservoir	Bearspaw Dam	7.0 – 0	Reservoir

Figure 4 shows a longitudinal bed profile and water surface profile (2-year flood).

Reach 1 of the Bow River, from the Banff National Park boundary to Dead Man's Flats, has an irregular, anabranching (wandering) channel pattern, characterized by one or two active gravel bed channels that are divided by wooded islands (Kellerhals, Neill and Bray, 1972). Other minor distributary channels dissect the active channel zone. These channels often represent former main branches that were abandoned or cut-off due to past channel shifting. Policeman Creek, which flows through the Town of Canmore, is an example of a distributary channel that has been isolated from the main river (further description of Policeman Creek is contained in Section 4.3. The slope of the Bow River averages 0.0014 through this reach. The top width and mean depth average 120 m and 2.1 m respectively at a 2-year flood condition.

Reach 2 extends from Dead Man's Flats to Exshaw and includes Lac des Arcs, a 3 km long lake that borders the south bank of the Bow River. The river flows in a sinuous, mainly single thread, gravel bed channel with alluvial banks. The alluvial floodplain is mainly continuous. The slope decreases rapidly through this reach (averaging 0.00015) due to backwater control from the Exshaw Creek and Heart Creek alluvial fans, which produce a local constriction in the Bow River. The top width and mean depth average 140 m and 3.6 m respectively in this reach at a 2-year flood condition.

Reach 3 extends from Exshaw to Kananaskis Dam. Below Exshaw Creek, the Bow River steepens (0.0019) and develops an irregular, meandering gravel bed channel pattern with occasional anabranched sections consisting of two or three sub-channels channels flowing around wooded islands. The river is frequently confined by steep valley walls and the alluvial floodplain is fragmentary and narrow. Approximately 4.7 km downstream of Exshaw, the river transitions into the reservoir behind Kananaskis Dam.

Downstream of Kananaskis Dam, the Bow River is frequently entrenched and confined by high terraces or valley walls. As a result, the alluvial floodplain is fragmentary and narrow. Bedrock outcrops in the valley walls and channel below Kananaskis Dam (Reach 4) and below Horseshoe Dam (Reach 5), creating narrow, gorge-like canyons with local rapids consisting of rockfall and boulders.

Below Horseshoe Dam to Bearspaw Dam, the slope of the river bed remains remarkably uniform at approximately 0.002 for a distance of approximately 75 km. This indicates the channel has become incised into relatively inerodible, non-alluvial materials and is flowing on a gradient that is imposed by the underlying geology rather than in a self-formed alluvial channel.

Reach 6 is the reservoir behind Ghost Dam and extends from the Morley Bridge to the dam site. The top width of the reservoir averages 490 m and depth averages 7.2 m. The river is entrenched and continuously confined in this reach.

Reach 7 extends from Ghost Dam to Jumpingpound Creek at the Town of Cochrane and is situated near the start of the Western Plains. The river flows in a wide stream-cut valley and is frequently confined by high terraces of glacial and glacio-lacustrine material. The river has a single, irregular or sinuous channel pattern with no visible bars or islands, which is indicative of a stable channel with a low sediment transport rate. The average top width and mean depth of the channel in this reach are 110 m and 2.1 m respectively, at a 2-year flood condition.

Downstream of Jumpingpound Creek in Reach 8, the Bow River displays occasional side bars, point bars and islands, likely reflecting the local input of sediment from Jumpingpound Creek and Bighill Creek. However, the overall channel sinuosity and channel dimensions are similar to those in Reach 7.

Reach 9 has a length of approximately 7 km and corresponds to the reservoir behind Bearspaw Dam. The top width and mean depth of the reservoir average 300 m and 5.4 m, respectively. The reservoir has a sinuous alignment and is confined by high terraces.

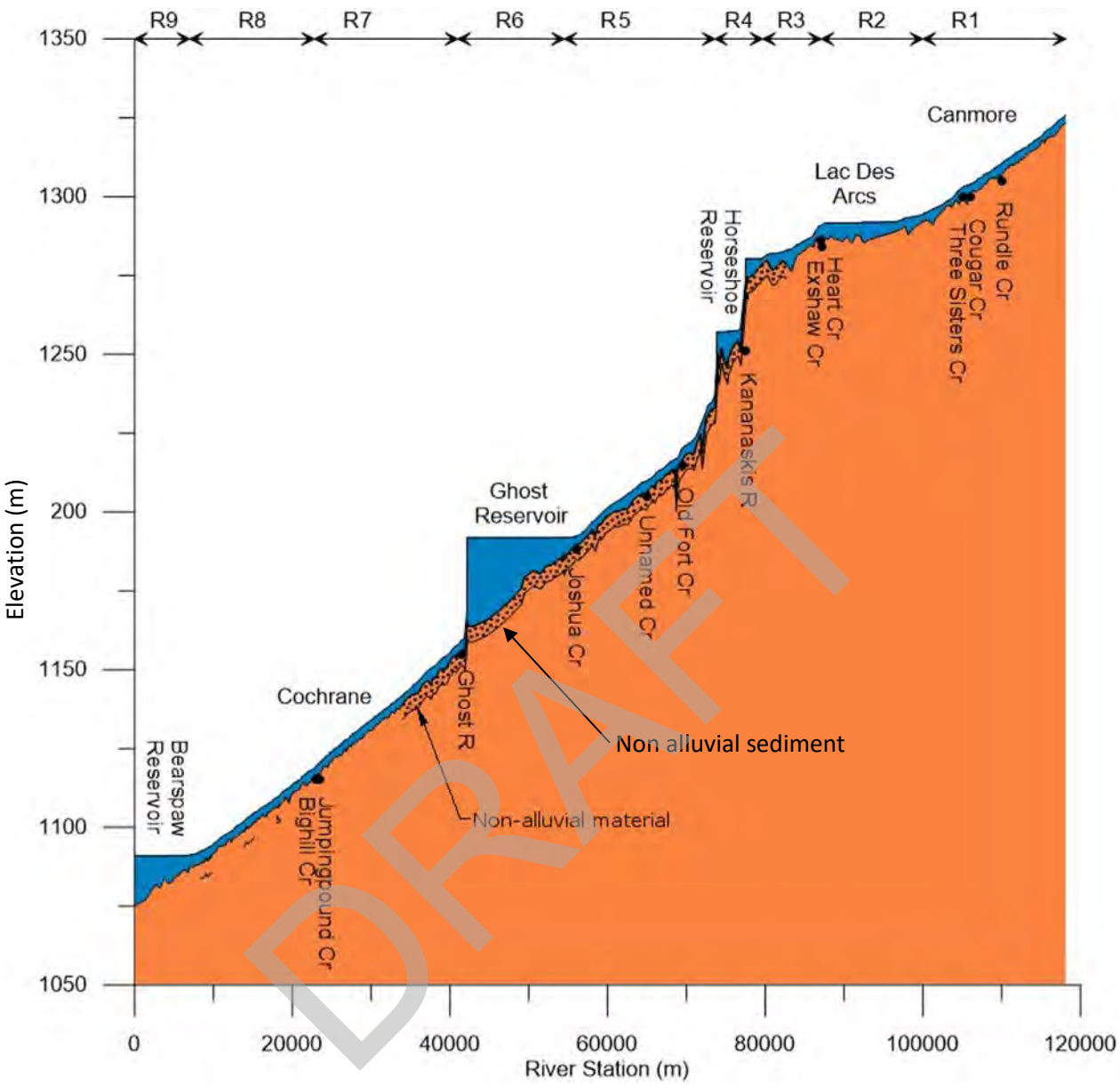


Figure 4 Longitudinal profile of Bow River, with sub-reach boundaries

4.2.2 Floodplain Characteristics

The alluvial floodplain is mainly continuous and wide between the Banff National Park boundary down to Exshaw (Reaches 1 and 2). The floodplain is urbanized on both banks at the Town of Canmore and is moderately forested in the remaining areas of these two reaches.

Downstream of Exshaw to Bearspaw Dam, the river is frequently entrenched and confined by valley walls or high terraces, resulting in a floodplain that is fragmentary and narrow. Due to the longterm incision that has occurred, the existing floodplain surface often corresponds to a low terrace that is

inundated relatively infrequently. The floodplain is generally uncultivated and covered with shrubs (Kellehals, Neill and Bray, 1972).

4.3 Significant Tributaries

Hydraulic modelling was conducted on portions of Exshaw Creek, Jumpingpound Creek and Bighill Creek. In addition, Policeman Creek was represented as a side channel as part of the Bow River model.

4.3.1 Policeman Creek

Policeman Creek branches from the Bow River just upstream of Canmore near the Canmore Golf and Curling Club. Inflows to the distributary channel are controlled by the Policeman Creek diversion structure, which was constructed between 1977 and 1982. The channel meanders through the town for a distance of approximately 5 km. Portions of the channel are modified by road and foot bridges and walking trails. The channel bed is mainly gravel and cobbles, with finer sediments and wetland vegetation encroaching into many sections. The banks are generally forested or covered with shrubs. The top width of the channel averages 25 to 30 m through the town. Spring Creek is a secondary branch channel that starts near 8th Street and meanders approximately 1.6 km before joining Policeman Creek.

Near its downstream end, the channel merges with outlet channels from Cougar Creek. The channel re-joins the Bow River approximately 1 km upstream from the Trans Canada Highway Bridge.

4.3.2 Exshaw Creek

Exshaw Creek is a steep mountain creek that forms an extensive alluvial fan on the north side of the Bow River near the eastern end of Lac des Arcs. The Lafarge Exshaw cement plant occupies the western side of the fan.

The headwaters of Exshaw Creek are subject to debris flows, which deliver large volumes of gravel and sand-sized sediment to the creek. Exshaw Creek has a uniform slope of 0.046 through most of the study reach, flattening to 0.015 as it approaches its confluence with the Bow River. Near the head of the fan, the channel consists of a heterogeneous range of sediment from boulders to sand, along with woody debris. The top width of the channel is typically 15 m near the fan head, widening to between 20 to 30 m downstream on the main fan. Near the head of the fan, the creek is confined on its west bank by a high berm of cobble and gravel material and by bedrock on its east bank. Further downstream riprap has been placed along portions of both banks.

The size of sediment in the channel decreases in the downstream direction due to selective deposition and aggradation that occurs during floods. At the confluence with the Bow River, the delta of the Exshaw Creek consists of well sorted, medium to coarse gravel. Rapid aggradation of coarse sediments during the 2013 flood triggered considerable lateral channel shifting and also resulted in rapid delta growth at the mouth of the Bow River. The aggradation and lateral channel shifting that is characteristic of this creek is not able to be represented in a fixed bed model such as HEC-RAS.

4.3.3 Jumpingpound Creek

Jumpingpound Creek is situated in a narrow stream-cut valley. The thalweg slope through the study reach averages 0.0053, and the profile consists of alternating pools and riffles. The channel has an irregular meandering pattern, with side bars and point bars. The average top width and bankfull depth are 32 m and 1.3 m, respectively. The bed consists of gravels, cobbles and occasional boulders, whereas the channel banks are predominantly alluvial gravels. Erodible glacial deposits (till or lacustrine) were observed to comprise the high terraced banks. The channel displays point bars and side bars through the reach, indicating a moderately high sediment transport rate. Sediment deposition has also occurred at the mouth.

Residential development along the creek is limited to approximately the lower 2 km of the channel length, with a significant portion occurring on high terraces. A 170 m long flood control dike is located on the right bank of the creek, immediately below the George Fox Trail crossing. A series of timber groynes are located along the base of the dike. A short distance downstream, a small side channel splits off to the east from the main channel, separated by a large vegetated island.

4.3.4 Bighill Creek

The headwaters of Bighill Creek are located in the foothills, northeast of Cochrane. The creek flows southwards, entering the study area just north of Cochrane town limits. The creek flows in a narrow, steep-sloping ravine, which leads onto the Bow River valley floor. The channel pattern is irregular, meandering, with pools and riffles present in the lower kilometre.

The thalweg slope steepens as the creek approaches the Bow River, varying from 0.0058 between 3 to 5 km upstream from the confluence to 0.01 in the lower kilometre. In the most downstream kilometre, the stream is relatively straight and is constrained by a high ravine walls along the right bank. The banks are generally low, vertical and made up of predominantly alluvial sands and gravels. The channel bed consists of gravels and cobbles. The average top width and mean depth are 8 m and 0.7 m, respectively.

4.4 Other Tributaries

There are a number of tributary streams that were not modelled in this study, including:

- Stoneworks Creek
- Cougar Creek
- Heart Creek
- Jura Creek
- Kananaskis River
- Ghost River

Stonework Creek, Cougar Creek, Heart Creek and Jura Creek all have alluvial fans that merge or cover portions of the floodplain of the Bow River. Floodwater and sediment from Jura Creek may coalesce with the Exshaw Creek fan, modifying the flooding extent on that fan.

4.5 Bridges, Culverts and Weirs

A total of 40 bridge crossings and 8 culverts were modelled within the study area. Information on bridges was collected either by survey or from design or record drawings and survey-verified. Design drawings were provided by AT and by the towns of Canmore and Cochrane. All structures are shown on the Model Overview Maps (Sheets 1 to 5) and Model Detail Maps (Sheets 1 to 4) included in the Maps and Drawings section of this report. Only structures located on the modelled streams and those considered to have a hydraulic impact on water levels were included in the model. These modelled structures are listed in Table 7 and Table 8. Detailed information concerning the bridge and culvert configurations can be found in Appendix B of the Survey and Base Data Collection Report (NHC, 2017) provided under separate cover.

Table 7 Modelled bridge crossings

Stream Name	River Station (m)	Location	Road/Trail	Owner	Owner ID
Bow River	21,225	Cochrane	River Avenue	Alberta Transportation	111
Bow River	23,403	Cochrane	Cowboy Trail/Hwy 22	Alberta Transportation	76609
Bow River	27,374	near Cochrane	CP Rail	CP Rail	Mile 25.7
Bow River	54,457	Morley	Morley Road	Alberta Transportation	611
Bow River	77,639	Seebe	Hwy 1X	Alberta Transportation	75111
Bow River	79,676	Seebe	CP Rail	CP Rail	Mile 53.1
Bow River	104,509	Canmore	Hwy 1 East	Alberta Transportation	74353
Bow River	104,549	Canmore	Hwy 1 West	Alberta Transportation	74353
Bow River	109,212	Canmore	Bow River Pedestrian Bridge	Canmore	BG03
Bow River	109,223	Canmore	Bridge Road	Alberta Transportation	00167 (BG02)
Bow River	109,929	Canmore	Spur Line Trail (Engine Bridge)	Canmore	81692 (BG20)
side channel (Bow River)	109,929	Canmore	Spur Line Trail	Canmore	81694 (BG18)
Bighill Creek	208	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	372	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	581	Cochrane	Walking Trail	Cochrane	-

Stream Name	River Station (m)	Location	Road/Trail	Owner	Owner ID
Bighill Creek	992	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	1,207	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	1,722	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	2,158	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	2,754	Cochrane	CP Rail	CP Rail	Mile 23.6
Bighill Creek	2,814	Cochrane	Bow Valley Trail/Hwy 1A	Alberta Transportation	521
Bighill Creek	3,385	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	3,794	Cochrane	Walking Trail	Cochrane	-
Bighill Creek	4,360	Cochrane	Walking Trail	Cochrane	-
Jumpingpound Creek	647	Cochrane	George Fox Trail	Alberta Transportation	283
Exshaw Creek	111	Exshaw	Diamond Drive	M.D. of Bighorn	-
Exshaw Creek	155	Exshaw	CP Rail	CP Rail	Mile 57.0
Exshaw Creek	451	Exshaw	Walking Trail	M.D. of Bighorn	-
Policeman Creek	1,552	Canmore	Wastewater Treatment Plant Road	Canmore	BG33
Policeman Creek	2,793	Canmore	Spring Creek Gate	Canmore	79434 (BG24)
Policeman Creek	3,147	Canmore	Walking Trail	Canmore	BG31
Policeman Creek	3,699	Canmore	8 Street	Alberta Transportation	71563 (BG06)
Policeman Creek	3,876	Canmore	10 Street	Alberta Transportation	80959 (BG07)
Policeman Creek	4,328	Canmore	Walking Trail	Canmore	81618 (BG08)
Policeman Creek	4,717	Canmore	Walking Trail	Canmore	BG09
Policeman Creek	4,853	Canmore	Walking Trail	Canmore	BG28
Policeman Creek	5,103	Canmore	Walking Trail	Canmore	BG10
Policeman Creek	5,252	Canmore	Walking Trail	Canmore	BG11
Policeman Creek	5,648	Canmore	Walking Trail	Canmore	-
Policeman Creek	5,668	Canmore	Golf Course	Canmore Golf Course	-

Table 8 Modelled culvert crossings

Stream Name	River Station (m)	Location	Road / Trail	Owner	Owner ID
Bighill Creek	480	Cochrane	Griffin Road West	Alberta Transportation	76989
Bighill Creek	1,519	Cochrane	Glenpatrick Road	Cochrane	-
Bighill Creek	2,498	Cochrane	Glenbow Drive	Alberta Transportation	81092
Exshaw Creek	206	Exshaw	Bow Valley Trail - Hwy 1A	Alberta Transportation	71734
Policeman Creek	4,923	Canmore	8 Avenue	Canmore	81617 (BG27)
Policeman Creek	5,003	Canmore	17 Street	Canmore	81616 (BG26)
Policeman Creek	5,957	Canmore	Golf course	Canmore Golf Course	BG25
Policeman Creek	6,435	Canmore	-	AEP	

The last culvert listed in Table 8 located at RS 6,435 on Policeman Creek is the inlet structure through the Canmore Town Dike. The diversion structure was re-constructed in 1992 to allow diversion of the Bow River's flow into Policeman Creek during low flow for fish management. The culvert is gated and, together with the Canmore Town Dike, was designed to prevent high flows from entering Policeman Creek during flood events.

4.6 Flood Control Structures

There are two flood control structures (dikes) located along the Bow River in Canmore, one along the Bow River in Cochrane, and one along Jumpingpound Creek in Cochrane (Table 9). The locations of the flood control structures are indicated on the Model Overview Maps (Sheets 1 to 5) and Model Detail Maps (Sheets 1 to 4) included in the Maps and Drawings section of this report.

In Canmore, the flood control dikes were constructed by Alberta Environment in 1977 in response to the flood of 1974. The Town Dike, located on the left (northeast) side of the river, protects a large portion of downtown Canmore, extending from the Canmore Golf and Curling Club to upstream of the wastewater treatment plant. The Mine Dike protects the area on the right (southwest) side of the river and extends from the TransAlta Rundle Plant outlet to West Canmore Park, near the intersection of Rummel Place and Three Sisters Drive.

In Cochrane, the Jumpingpound Creek Dike was constructed in 2015 and runs along the right (east) bank of the creek downstream of the George Fox Trail Bridge. The Riverfront Park nature playground berm is a ring dike surrounding the playground located on the north side of the Bow River downstream of the Highway 22 bridge.

Table 9 Flood control structures

Name	Owner	Length (m)	Description
Riverfront Park nature playground berm	Cochrane	220	North side of Bow River, downstream of Hwy. 22 bridge, surrounding playground
Jumpingpound Creek Dike	Cochrane	168	East side of Jumpingpound Creek downstream of George Fox Trail Bridge
Canmore Mine Dike	AEP	1109	Southwest side of Bow River through Canmore
Canmore Town Dike	AEP	5176	Northeast side of Bow River through Canmore

4.7 Other Features

The majority of major infrastructure and populated areas within the study area are found in Canmore, Cochrane, and Exshaw. Other features of note within the study area include:

- The CPR railway and Highway 1 and 1A parallel the river, and in some locations, the embankments and side slope armoring encroach on the river channel. There are many culverts through road or railway embankments.
- Four dams owned and operated by TransAlta are located within the study reach. Details of the dams are provided in Table 10.
- A 950 m long river training structure is located just upstream of the Highway 1 bridge near Canmore. It is tied into the highway embankment on the north. The structure includes a series of riprapped groynes and at least two culverts to allow conveyance of low flows through the structure. The structure was built to direct flows through the Highway 1 bridge opening.
- A number of river engineering training works, such as spurs for erosion control and bank protection have been constructed along the Bow River at the following locations: Canmore Golf Course, Trans-Canada Highway Bridge, Three Sister's Campground, and Bow River Campground.
- A berm along the right bank of Exshaw Creek restricts the creek away from the cement plant.
- Two dust control dikes in Lac des Arcs, built in 1994, control the Lac des Arcs water level during the winter to reduce the dust problem caused by blowing lake bed sediments when water levels are low.

- The Cochrane Riverfront Park berm is located on the left (north) bank of the Bow River downstream of the Highway 22 Bridge but is not a dedicated flood control structure.

Table 10 List of dams

Name	Stream	River Station (m)	Year Built
Bearspaw Dam	Bow River	0	1954
Ghost Dam	Bow River	42,150	1929
Horseshoe Dam	Bow River	73,850	1911
Kananaskis Dam	Bow River	77,490	1913

5 MODEL CONSTRUCTION

The hydraulic modelling is considered foundational to the overall project. Hydraulic modelling is required for the open water and ice jam flood inundation mapping, as well as the flood hazard identification components, which are described under separate cover. The model was run in steady-state mode for thirteen discharge scenarios ranging from the 2-year to the 1000-year flood flows.

5.1 HEC-RAS Program

HEC-RAS (River Analysis System) is a computer program developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC). Version 5.0.3 was released in September of 2016 and was used for this study. The program is designed to perform one-dimensional (1D), two-dimensional (2D), or combined 1D and 2D hydraulic calculations for a full network of channels. The basic inputs required by HEC-RAS are a series of cross sections spaced over known lengths of channel, roughness coefficients for the channel and overbank areas at each cross section, a specified water level or slope at the downstream model boundary, and a discharge at all upstream model boundaries.

5.1.1 Theoretical Aspects

In 1D models, HEC-RAS applies the Bernoulli equation between consecutive cross sections and is designed to determine subcritical and/or supercritical water surface profiles; assess the hydraulic effects of channel and floodplain adjustments, such as channel straightening, encroachment, enlargement, and flood control diking; and estimate energy losses due to in-channel structures such as culverts, bridges, weirs, and other obstructions. The analytical approach employed by HEC-RAS has the following assumptions and potential limitations:

- Flow is gradually varied, so that the boundary friction losses between cross sections can be estimated by Manning's equation using section-average parameters.
- Changes in the channel and floodplain geometry resulting from erosion or mobile bed processes that might arise during a flood cannot be directly accounted for or modelled.
- The water level is constant across each cross section, with three separate conveyance components representing the main channel and each of the left and right overbank zones.
- Flow is one-dimensional, therefore only velocity components in the principal direction of flow are accounted for in the equations and calculations.
- The pressure distribution through the depth of flow is hydrostatic.

Simulation of the overbank floodplain behind the Canmore Town Dike challenges the assumption that the flow patterns are one-dimensional within the study reach. Care was taken to address this when developing the model geometry, as discussed in Section 5.2 and Section 5.4.

5.1.2 General Model Setup

Esri ArcGIS was used to complete general model setup, which includes the following: defining the river centerline alignment; laying out cross section cut lines; locating dams, bridges, culverts, and flood control dikes; and, specifying ineffective flow areas. The model layout and details are shown on the Model Overview Maps (Sheets 1 to 5) and Model Detail Maps (Sheets 1 to 4) included in the Maps and Drawings section of this report.

Geometric Layout

The total length of the modelled Bow River is just over 118 km and follows the established Bow River centerline. In addition, a 5 km reach of Jumpingpound Creek, a 5 km reach of Bighill Creek, and a 1 km reach of Exshaw Creek are included in the model. In Canmore, Policeman Creek is modelled as a separate branch and is connected to the Bow River at its upstream and downstream ends. The river stationing is assigned in metres with a station of 0 m specified at the downstream end of each stream (Bow River, Policeman Creek, Exshaw Creek, Bighill Creek, and Jumpingpound Creek), with stationing for each stream increasing in the upstream direction. The Bow River, within the study area, is divided into reaches at every modelled junction. Model sub-reaches within HEC-RAS were named (in kilometres) based on the downstream river station. A schematic model layout, shown in Figure 5, includes stream names, as well as the location of dams and junctions. The model sub-reach names (e.g. KM 112 and KM 106) are indicated at each junction and refer to the reach upstream of the junction.

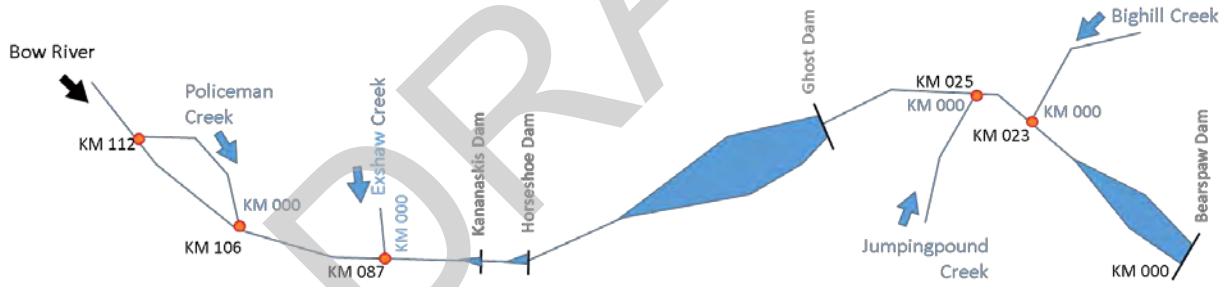


Figure 5 Schematic layout of model reaches (not to scale)

Channel and Overbank Roughness

Manning's roughness values were used to represent boundary roughness in the modelled reaches. At each cross section, roughness was varied horizontally across the channel, as required, to represent changes in river and floodplain characteristics. A minimum of three (one channel and two overbank) and a maximum of eighteen (in the braided reach downstream of Highway 1 in Canmore) roughness values were used within each cross section. The number of roughness values used was dependent on the complexity of the channel and the presence of distinct features, such as bars and islands.

Manning's roughness is used to account for an array of energy losses that may vary with respect to discharge. Due to the complexity and length of the model and the limited spatial distribution of calibration

data, roughness values were assumed to be constant with discharge. At the locations where rating curve data were available, using a single roughness value for all discharges provided reasonable results.

Expansion and Contraction Coefficients

To account for the effect of flow contraction or expansion on the energy balance between successive cross sections, HEC-RAS multiplies the absolute difference in velocity head by a coefficient. Coefficients range from 0.10 for gradual transitions to 0.80 (Brunner, 2016).

Boundary Conditions

Boundary conditions for the model included specified inflows at the upstream end of each modelled stream. The Bow River was divided into nine flow zones, which are defined as reaches with constant discharge; one flow zone was used for each of the modelled tributaries. The flow zone limits along the Bow River, developed in consultation with AEP, take into consideration the flow assessment locations employed by Golder (2017). The flow zones do not necessarily reflect additional inflow at tributary confluences. Additionally, where possible, it was AEP's preference to maintain a constant discharge through a community. The flow zone limits are shown in Model Overview Maps (Sheets 1 to 5) and Model Detail Maps (Sheets 1 to 4) included in the Maps and Drawings section of this report. The flow zones are summarized in Table 11.

Table 11 Flow zones

Stream Name	HEC-RAS Model Sub-Reach	Upstream River Station (m)	Flow Zone Name
Bow River	KM 112	118,148	Bow River at Canmore
Bow River	KM 087	104,338	Bow River above Kananaskis
Bow River	KM 025	77,488	Bow River below Kananaskis
Bow River	KM 025	73,845	Bow River near Seebe
Bow River	KM 025	50,452	Bow River upstream of Ghost Reservoir
Bow River	KM 025	42,132	Bow River downstream of Ghost Reservoir
Bow River	KM 023	24,684	Bow River between Bighill and Jumpingpound Creeks
Bow River	KM 000	22,894	Bow River at Cochrane
Bow River	KM 000	11,503	Bearspaw Reservoir Inflow
Bighill Creek	KM 000	5,030	Bighill Creek at Cochrane
Exshaw Creek	KM 000	1,319	Exshaw Creek at Exshaw
Jumpingpound Creek	KM 000	5,294	Jumpingpound Creek at Cochrane
Policeman Creek	KM 000	6,465	Policeman Creek

The full supply level (FSL) of Bearspaw Reservoir was used as the boundary condition at the downstream model boundary. At the other three dams along the study reach, the reservoir FSLs were applied as internal water level boundaries. The reservoir FSLs provided by TransAlta were used for all thirteen flood profiles.

Canmore Floodplain

The left Canmore floodplain covers the area bounded by the Bow River and the Trans-Canada Highway and extending from the Canmore Golf Course at the upstream end and extending downstream to the Trans-Canada Highway Bridge. The majority of this floodplain area is developed and protected by the Canmore Town Dike. The Canmore Town Dike ends near the sewage treatment plant and does not protect the areas downstream from surface flooding.

At higher flows, it was determined that the Canmore Town Dike would be overtopped and that flow would spill across the floodplain in a south east direction until merging with Policeman Creek flood flows. A two-dimensional hydraulic model of the left Canmore floodplain was developed to guide the creation of the one-dimensional hydraulic model. The two-dimensional model results provided guidance on the spill locations and flow paths under various flood events.

In the hydraulic model, the Canmore floodplain was divided between the Bow River influenced portion of the floodplain and the Policeman Creek influenced portion of the floodplain. The location of the boundary line, which follows the alignment of roads or other physical features, was drawn in consultation with AEP based on the floodplain topography and results of the two-dimensional modelling. To represent the transfer of flow from the Bow River to Policeman Creek, four rating curves relating the flow in the Bow River to the magnitude of flow to be transferred to Policeman Creek were generated. The rating curves were based on the two-dimensional model results.

5.2 Geometric Database

The geometric database provides all of the components of the HEC-RAS model geometry developed using the geospatial analysis tool within ArcGIS. The HEC-GeoRAS toolbox facilitated the development of the model geometry. Further processing of the data was performed using the HEC-RAS geometry editor. The following describes the content of the geometric database and methods for model geometry development. The geometry data are shown on the Model Overview Maps (Sheets 1 to 5) and the Model Detail Maps (Sheets 1 to 4) included in the Maps and Drawings section of this report. The resulting geometric database is provided as part of the electronic deliverables of the study.

5.2.1 Cross Section Data

Cross section alignments were established in ArcGIS following the general path of the topographic and hydrographic survey points for each of the cross sections surveyed within the study area (refer to Section 3.3). Each cross section extends through the left and right overbanks to an elevation beyond the anticipated 1,000-year flood level. Cross section elevations were derived from a combination of the DTM data, the topographic survey data, and the hydrographic survey data as follows:

1) The cross section alignments were defined to pass through the surveyed point data and extended into the overbank above the anticipated 1,000-year flood level.
2) Two separate station-elevation data sets were created for each cross section.

- The first was developed from elevation data extracted from the DTM using the GeoRAS ArcGIS extension tool.
- The second was based on the survey data and was developed by projecting the topographic and hydrographic survey points onto the cross section line in a direction perpendicular to alignment of the cross section line using the GeoRAS ArcGIS extension tool.

3) Both station-elevation data sets were exported from ArcGIS to a HEC-RAS geometry format.
4) The DTM-based and survey-based cross sections were combined in HEC-RAS using the Graphical Cross Section Editor. The number of elevation points in the combined cross sections were reduced to less than 500 using the minimize area change point filter option.

Distances between each cross section along the channel centerline and along the central flow path of the left and right overbank areas were measured in ArcGIS and exported with other cross section data to the HEC-RAS model. Cross section details based on NHC's surveys are provided in Appendix C.

5.2.2 Bridges & Culverts

The modelled reach includes 40 bridge crossings and 8 culverts. Table 7 and Table 8 provide a summary of bridges and culverts included in the analysis, and key design information incorporated into the model is tabulated in Table B-2 and Table B-3, found in Appendix B. Any culverts in the study area that service local drainage only or were not relevant to the hydraulic model computations were not modelled.

The alignment and location of each bridge structure was established in ArcGIS midway between surveyed cross sections bracketing the bridge. The bridge cross section line was assigned the same length as the bracketing cross sections to ensure that the stationing of the bridge cross section was consistent with the bracketing cross sections. At some bridges, it was not possible to assign the same length to the bridge cross section line as the bracketing sections. Adjustments were made to the bridge data to ensure the bridge was represented properly. The bridge cross section included the approach roadway on both banks, abutments, high and low chord defining the bridge structure, and the piers. The approach roadway was extracted from the DTM in ArcGIS, while the bridge abutments, high and low chords, and piers were extracted from the surveyed data. Bridge details were checked against design drawings, the full feature LiDAR points, details from available AT bridge file records, and other sources, where available.

For the railway bridges, safe access to the structures could not be obtained to collect direct survey measurements. Bridge geometry was derived from the available general bridge layout and elevation drawings, the supplied DTM data, field photos, and orthorectified imagery. Some limited survey validation of the bridge structure elevations, and pier spacing dimensions was obtained using a total station.

For each of the modelled bridges and culverts, the standard energy solution method was used.

5.2.3 Flood Control Structures

The profiles of flood control dike crests were surveyed during the field program. These data, in conjunction with the DTM, were used to inform the specification of levees in the HEC-RAS model. Levees in HEC-RAS restrict the wetted portion of the channel to the area inside the levees until the simulated water level exceeds a specified elevation. Generally, the levee elevation corresponds to the crest elevation of the flood control dike, above which overtopping occurs. However, consideration was given to overtopping points at adjacent upstream and downstream cross sections to ensure that, where appropriate, when a levee is overtopped and water appears in the model behind the levee, connected areas also appear wet for the same simulated water surface profile. This process involved determining an effective levee elevation at some cross sections that is below the actual crest of the flood control dike. The surveyed crest elevations and effective levee elevations for flood control dikes are provided in Table 12.

Table 12 Modelled flood control structure details

Name (Location)	River Station (m)	Surveyed crest elevation (m)	Effective levee elevation (m)
Canmore Town Dike (Bow River)	113,065	1316.87	1316.42
	112,898	1316.49	1316.20
	112,726	1316.01	1315.99
	112,580	1315.97	1315.75
	112,416	1315.85	1315.54
	112,279	1315.65	1315.40
	112,071	1315.61	1315.16
	111,915	1315.48	1314.89
	111,823	1315.33	1314.78
	111,706	1314.77	1314.67
	111,305	1314.91	1313.98
	111,132	1314.47	1313.64
	110,887	1312.83	1313.01
	110,734	1313.65	1312.76
	110,352	1313.56	1312.29
	110,148	1313.16	1312.15
	109,981	1312.93	1311.93
	109,938	1312.02	1311.92
	109,921	1312.20	1312.20
	109,727	1311.79	1311.79
	109,501	1311.50	1311.50
	109,366	1311.79	1311.79

Name (Location)	River Station (m)	Surveyed crest elevation (m)	Effective levee elevation (m)
	109,235	1311.55	1311.55
	109,202	1311.65	1311.65
	109,114	1310.25	1310.28
	108,998	1310.15	1310.15
	108,757	1309.90	1309.90
	108,586	1309.38	1309.38
	108,458	1308.71	1308.68
	108,052	1308.44	1308.05
	107,747	1307.66	1307.55
	107,333	1306.73	1306.72
Canmore Mine Dike (Bow River)	109,727	1311.73	1311.73
	109,501	1311.55	1311.55
	109,366	1311.11	1311.11
	109,235	1310.88	1310.88
	109,202	1310.78	1310.78
	109,114	1310.31	1310.31
	108,998	1310.22	1310.22
	108,757	1310.00	1310.00
Jumpingpound Creek Dike (Jumpingpound Creek)	625	1128.86	1128.86
	562	1128.62	1128.62
	501	1127.98	1127.98
Riverfront Park nature playground berm (Bow River)	23,317	1123.76	n/a

5.2.4 Road and Railway Embankments

Geometric details of roads and railway embankments which may impact hydraulics (without being considered dedicated flood control structures) were extracted from the DTM when the cross sections were generated. The CPR railway and Highway 1 and 1A parallel the river and in some locations, the railway or road ballast and side slope armoring encroach on the river channel. The embankments were assumed to be permeable and where they were within the flood extents, the area on the land side was tagged with a permanent ineffective flow area marker (set at the elevation of the embankment crest). If it was reasonable to expect that flow would be conveyed in the downstream direction once the embankment was overtopped, the ineffective flow area marker was tagged as temporary.

Other structures that do not actively convey flow from the Bow River, Policeman Creek, Exshaw Creek, Jumpingpound Creek or Bighill Creek, were not surveyed but many have been identified in GIS based on imagery and a combination of drawings and files received from AT, Town of Canmore, M.D. Bighorn,

Town of Cochrane and CPR. These structures consist mainly of culverts through road or railway embankments that will allow backwater flooding from the river side to the land side. These are not included in the model but were considered when producing the floodplain maps.

5.2.5 Berms

The area behind the two dust control dikes on Lac Des Arcs was modelled as not actively conveying flow (permanent ineffective flow area) below the elevation of the dust control dikes.

A berm along the right bank of Exshaw Creek restricts the creek away from the cement plant (first built around 1907). This embankment was included in the cross section geometry from RS 593 to RS 1,319.

5.2.6 Dams

The geometry of the four dams (Table 10) was not included in the model. However, the hydraulic effect of the dams was included in the model by specifying the FLS reservoir elevations upstream of each dam in the flow data file.

5.2.7 Other Features

As per the requirements of this study, backwater flood inundation near the mouth of the Ghost River and other tributaries was considered, using simulated water levels from the Bow River. In accordance with the AEP terms of reference, no hydraulic modelling of the Ghost River or tributaries other than those described, was required and were therefore not represented in the hydraulic model.

5.3 Model Calibration

Model calibration forms a critical step of hydraulic model development. It involves gradually fine-tuning initially selected channel and overbank Manning's roughness coefficients and other model parameters to ensure simulated water levels match observed levels for a particular flood event. Other model parameters adjusted during calibration include specification of ineffective flow areas and selection of expansion and contraction coefficients. Once the coefficients have been fine-tuned, the model is typically used for simulating a second independent flood event with known flows and observed water levels to validate that the model is also accurate for a different magnitude event.

5.3.1 Methodology

For the present HEC-RAS model, this procedure was modified slightly to make use of the available pairs of inflows and highwater marks from historic flood events. Of the model parameters available for adjustment during the calibration, the primary calibration parameters were the Manning's roughness coefficients for the river channel and floodplain, expansion and contraction coefficients between cross sections, and the specification of ineffective flow areas. These were selected for each cross section using judgement and, where available, by comparing the simulated water surface profile elevations to observed water levels and highwater marks.

The challenges or limitations that are typical to the calibration process include:

- The accuracy of the highwater mark elevations.
- Improper identification of highwater marks.
- Uncertainties in estimates of the flood peak discharge.
- Insufficient channel geometry data.
- Updates to flood protection infrastructure since the flood event or the presence of temporary/emergency flood protection measures during a flood.
- Mobile channel bed conditions.
- Debris blockages.

For this study, the major factor affecting the calibration efforts was the uncertainty in discharge estimates associated with the magnitude and timing of flood peaks and the limited quantity of reliable highwater marks in many of the study reaches.

As a first pass in the model calibration process, roughness within the model domain was defined in ArcGIS based on the land cover as shown in the aerial imagery. The channel roughness values were assigned by reach based on the channel slope and channel pattern. The land cover types considered in defining roughness regions are defined in Table 13. Further refinement of lateral roughness variations to represent each land cover type was completed on a cross section by cross section basis within the HEC-RAS geometry editor, using the DTM and survey information as a guide.

Table 13 Description of land cover types within the study reach

Land cover type	Description
River channel	Includes the wetted channel area and low lying bars with light vegetation that would be easily eroded away by high flow velocity during large flow events. The river channel was divided into reaches based on the channel slope and channel pattern.
Grass	Agricultural crops or pasture land within the overbank or on islands with grasses with a general height of one metre or less
Brush and shrubs	Brush and shrubs within the overbank or on islands.
Trees with little undergrowth	Forest cover either in the overbank or on islands with moderate stands of timber, few down trees, little undergrowth, and flow generally below branches.
Trees with dense undergrowth	Forest cover either in the overbank or on islands with heavy stands of timber with dense undergrowth and flow into branches.
Urban	Development within the wetted width of the design flood, possibly behind a flood control dike, with buildings taller than the maximum expected flow depth with transportation corridors comprised of either asphalt or gravel between the buildings.

Calibration of Manning's roughness coefficients was done from the most downstream end of the model to the upstream end. While it may be possible to precisely match the simulated water surface profile elevations to the observed values at each location, this generally requires section to section adjustments in channel roughness values that are implausible and not physically-representative of the channel morphology. Instead, channel roughness coefficients were varied on a reach basis, with constant overbank roughness values selected for each land cover type (see Section 5.4.1).

Changes in the Manning's roughness coefficient typically coincide with variations in flow or sediment regime, often indicated by changes in channel slope or planform that can be identified from aerial imagery. The rivers were divided into reaches with similar channel bed material, average sectional geometry, and planform. Each reach was then assigned a roughness value for the in-channel portion of the cross section. Initial roughness values were assigned based on values provided in reference literature (Brunner 2016, Chow 1959, USGS 1967, and Hicks & Mason 1998) and based on values used in previous modelling of reaches of the Bow River and tributaries.

The hydraulic model was calibrated for both low and high flow conditions using available data. These data included surveyed water levels, water surface elevations extracted from LiDAR data, highwater marks provided by AEP and AT, and WSC hydrometric gauge data, measurements, and rating curves.

5.3.2 Low Flow Calibration

NHC completed the bathymetric surveys during low flow conditions. Corresponding water surface elevations were surveyed from October 7th to October 31st, 2015, and April 26th to May 27th, 2016.

Because of the long survey duration and the variation in discharge over the course of the survey, the surveyed water surface elevations were not used for the low flow calibration. The low flow calibration utilized the LiDAR water surface elevations, which were collected over a total period of 18 hours. This approach was simpler than attempting to correlate flow estimates with the surveyed water surface elevations collected during the ground surveys over a period of roughly two months.

The LiDAR data set was collected by Airborne Imaging Inc. for AEP on September 10th and 11th and October 5th and 11th, 2015 (Airborne Imaging, 2016). The reaches captured on each of the LiDAR acquisition flights are shown in Figure 6.

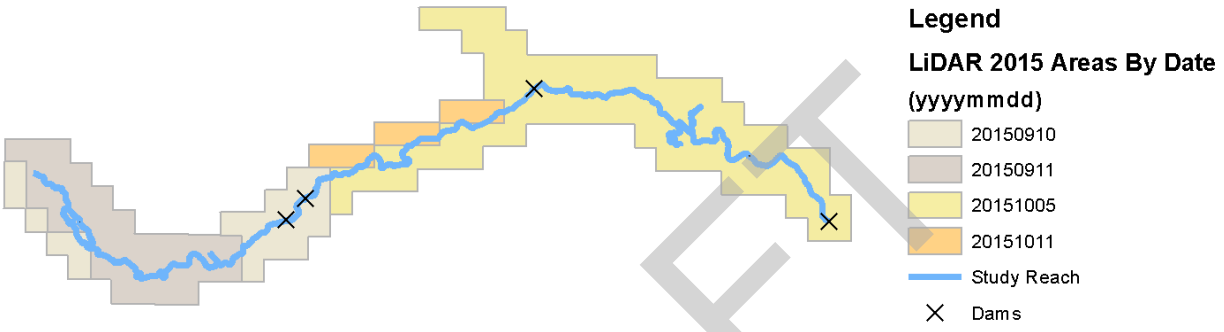


Figure 6 LiDAR flight reaches

Available flow and water level measurements were used as boundary conditions to the HEC-RAS model for the low flow calibration. These were obtained primarily from WSC gauges and from TransAlta plant logs. Discharges were available at the following gauges:

- WSC 05BH001 Bow River at Banff
- WSC 05BC001 Spray River at Banff
- TransAlta 05BD004 Cascade Power Diversion near Banff
- WSC 05BE007 Spray Power Diversion at Canmore
- TransAlta 05BE004 Bow River near Seebe
- TransAlta 05BE999 Ghost Tailrace
- WSC 05BH005 Bow River near Cochrane

With the operation of the dams, the daily discharge fluctuations in the Bow River are significant, especially downstream of the Ghost Reservoir, as shown in Figure 7.

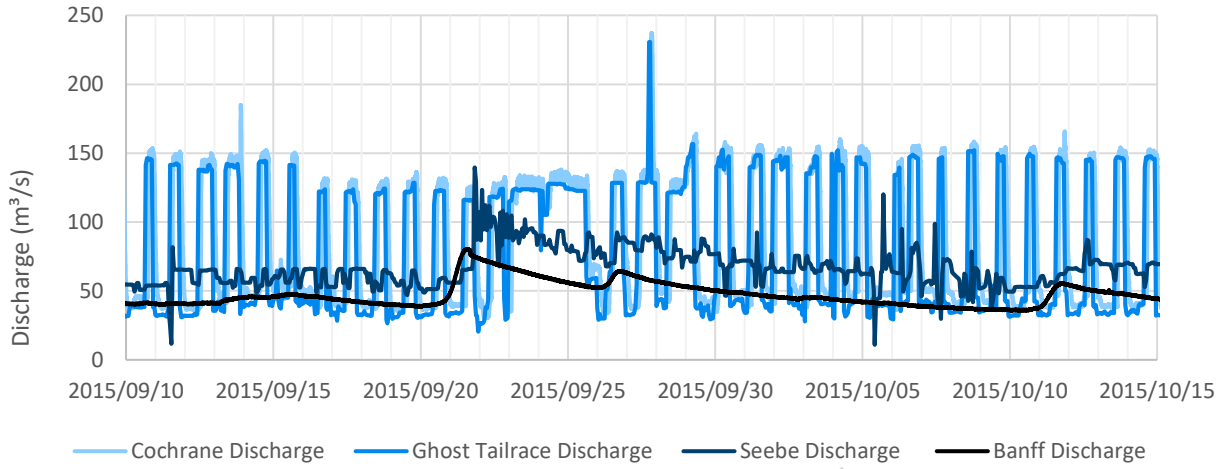


Figure 7 Discharges in the Bow River during 2015 LiDAR acquisition flights and field surveys

The boundary conditions used for the low flow calibration are summarized in Table 14. Where no flow records were available, flows were estimated based on upstream inflows.

Table 14 Boundary conditions for low flow calibration (September and October 2015)

Flow Zones	Reaches u/s of reservoirs	LiDAR WSE	Flow (m^3/s)		Reservoir level (m)	
Bow River at Canmore		Yes	40-56	c		
Policeman Creek		No				
Exshaw Creek at Exshaw		No				
Bow River above Kananaskis	Yes	Yes	40-56	d	1279.25	e
Bow River below Kananaskis	Yes	Yes	40-56	d	1256.60	e
Bow River near Seebe (05BE004)		Yes	50-56	a		
Bow River upstream of Ghost Reservoir	Yes	Yes		d	1191.06	e
Bow River downstream of Ghost Reservoir (05BE999)		Yes	38-40	a		
Jumpingpound Creek at Cochrane		No				
Bow River between Bighill and Jumpingpound Creeks		Yes	38-52	d		
Bighill Creek at Cochrane		No				
Bow River at Cochrane (05BH005)		Yes	39-52	b		
Bearspaw Reservoir Inflow	Yes	Yes	47.5	d	1090.31	e

Notes:

a. TransAlta plant logs (hourly)
b. WSC (hourly)
c. Sum of Bow River flow and tributary flow
d. Estimated based on upstream flows
e. LiDAR water surface elevation

No low flow calibration was completed for the tributaries due to:

- the lack of gauged flows on the tributaries
- the nearly dry conditions in Exshaw Creek, Policeman Creek and Bighill Creek
- difficulties in extracting a water surface from the LiDAR in small vegetated channels

Minimal emphasis was placed on the low flow calibration when determining the calibrated roughness coefficients, since flow conditions at the time of survey were significantly less than the 2-year flood discharge estimate. Results of the low flow calibration are provided in Section 5.3.5. In many locations on the Bow River, the low flow water levels are governed by hydraulic control features (e.g. rock outcrops, rapids, gravel bars, etc.) located between surveyed cross sections and therefore are not captured in the HEC-RAS model.

5.3.3 High Flow Calibration

As previously stated, the 2013 flood was selected as the preferred model calibration event based on the high flood flows and large number of highwater marks. The 2012, 2005, 1990 and 1986 floods were used for validation. The high flow calibration was completed using highwater marks provided by AEP and AT, as well as WSC hydrometric gauge data and measurements. The number and location of highwater marks are described in Section 3.5. The majority of the highwater marks are located along the Bow River in developed areas, such as Canmore, Exshaw, Morley, and Cochrane. Limited highwater marks are available along Exshaw Creek, Jumpingpound Creek, Bighill Creek, and undeveloped reaches of the Bow River.

The boundary conditions used for the high flow calibration and validation are summarized in Table 15. Results of the high flow calibration are provided in Section 5.3.5.

The computed 2013 flood water levels were also validated by comparing the modelled extents with the edge of highwater points surveyed by the Town of Cochrane (see Section 3.5.2). Results are provided in Section 5.3.5.

Table 15 Boundary conditions for high flow calibration (2013) and validation (2012, 2005, 1990, 1986)

Flow Zones	Reaches u/s of reservoir	2013				2012				2005				1990				1986			
		No. of HWMs	Flow (m^3/s)		Reservoir level (m)	No. of HWMs	Flow (m^3/s)		Reservoir level (m)	No. of HWMs	Flow (m^3/s)		Reservoir level (m)	No. of HWMs	Flow (m^3/s)		Reservoir level (m)	No. of HWMs	Flow (m^3/s)		Reservoir level (m)
Bow River at Banff (05BH001)			506	b			349	b			174	b			246	b			317	b	
Spray River at Banff (05BC001)			49	bb			15	bb			20	bb			18	bb			15	bb	
Cascade Power Diversion near Banff (05BD004)			28	bb			1	bb			16	bb			9	bb			1	bb	
Spray Power Diversion at Canmore (05BE007)			15	bb			12	bb			15	bb			12	bb			0	bb	
Bow River at Canmore			598	g			377	g			225	g			285	g			333	g	
Bow River at Canmore			683-1076	i&j			386-550	i&j			281-341	i&j			360-405	i&j			353-521	i&j	
Bow River at Canmore		13	598-780	g&i		4	377-386	g&i			225-281	g&i		12	270-360	gio		28	313-353	e&i	
Policeman Creek						1	-											24	-		
Exshaw Creek at Exshaw			~70	c											5	d			5	d	
Bow River above Kananaskis	*	1	-		-				-				-	2	310-315	d	-	4	298-302	d	-
Bow River below Kananaskis	*				1258.18	a			1257.14	a			-				-				-
Bow River near Seebe (05BE004)		3	818	a			427	a			381	j			452	j			482	j	
Bow River upstream of Ghost Reservoir	*				1192.01	a			1191.72	a			1191.86	a			1191.76	a			1191.16	a
Bow River downstream of Ghost Reservoir (05BE999)			1381	a			465	a			615	a			537	a			339	a	
Jumpingpound Creek at Cochrane			214	j			62	j		1	213	b			55	b			14	b	
Bow River between Bighill and Jumpingpound Creeks		2	1595-1635	g			527	g		1	828	g		1	592	g			352	g	
Bighill Creek at Cochrane		1	6.5-19	n																	
Bow River at Cochrane (05BH005)		3	1650	b			481	b		1	-				-				-		
Bearspaw Reservoir Inflow	*				1090.2	a			1090.82	a			1091.1	a			1090.66	a			1090.92	a
Total HWMs		**23**				**5**				**3**				**15**				**56**			
Total HWMs with estimated inflows		**22**				**4**				**2**				**15**				**32**			

Notes:

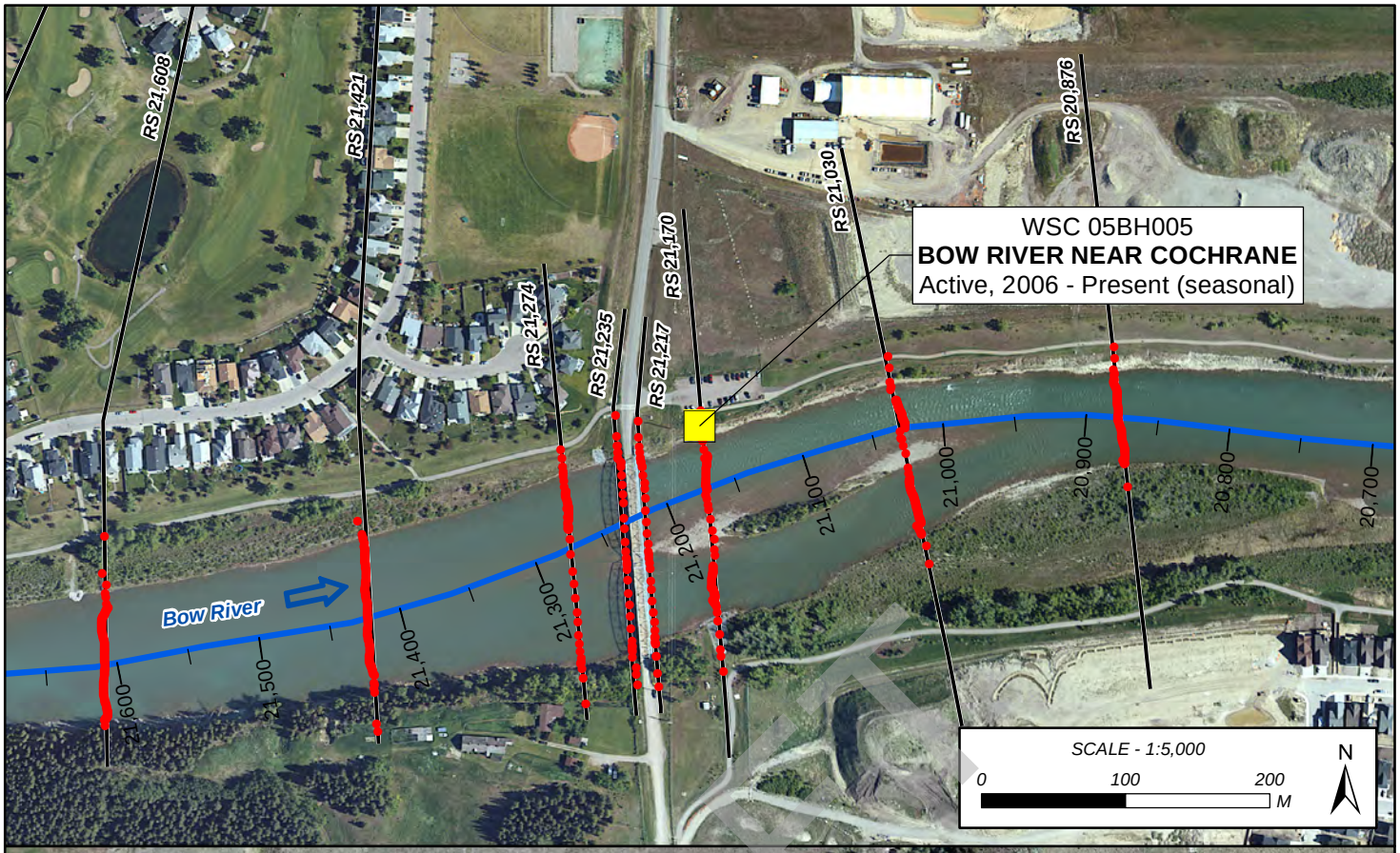
a. TransAlta plant logs (annual max from hourly data)
b. WSC (max instantaneous)
bb. WSC/TransAlta (daily when peak Q at Banff)
c. Golder, 2017.
d. Acres, 1996. (values provided for Bow River u/s and d/s of Exshaw Creek)
e. W-E-R Agra, 1993. (values provided for Bow River u/s and d/s of Cougar Creek)
f. Alberta Environment, 1986 . (values provided for 1981 only)
g. sum of Bow River flow and tributary flow
h. difference of Bow River flow u/s and d/s of tributary
i. Golder, 2016 (regulated flow estimates, excel file received 02Sept2016)
j. Golder, 2016 (recorded flow estimates, excel file received 02Sept2016)
k. Golder, 2016 (naturalized flow estimates, excel file received 02Sept2016)
l. LiDAR water surface elevation
m. estimated based on upstream flows
n. estimated based on Golder (2017) empirical relationship using nearby gauged foothill basins and observed 2013 flows
o. Alberta Transportation 1990 flood memo

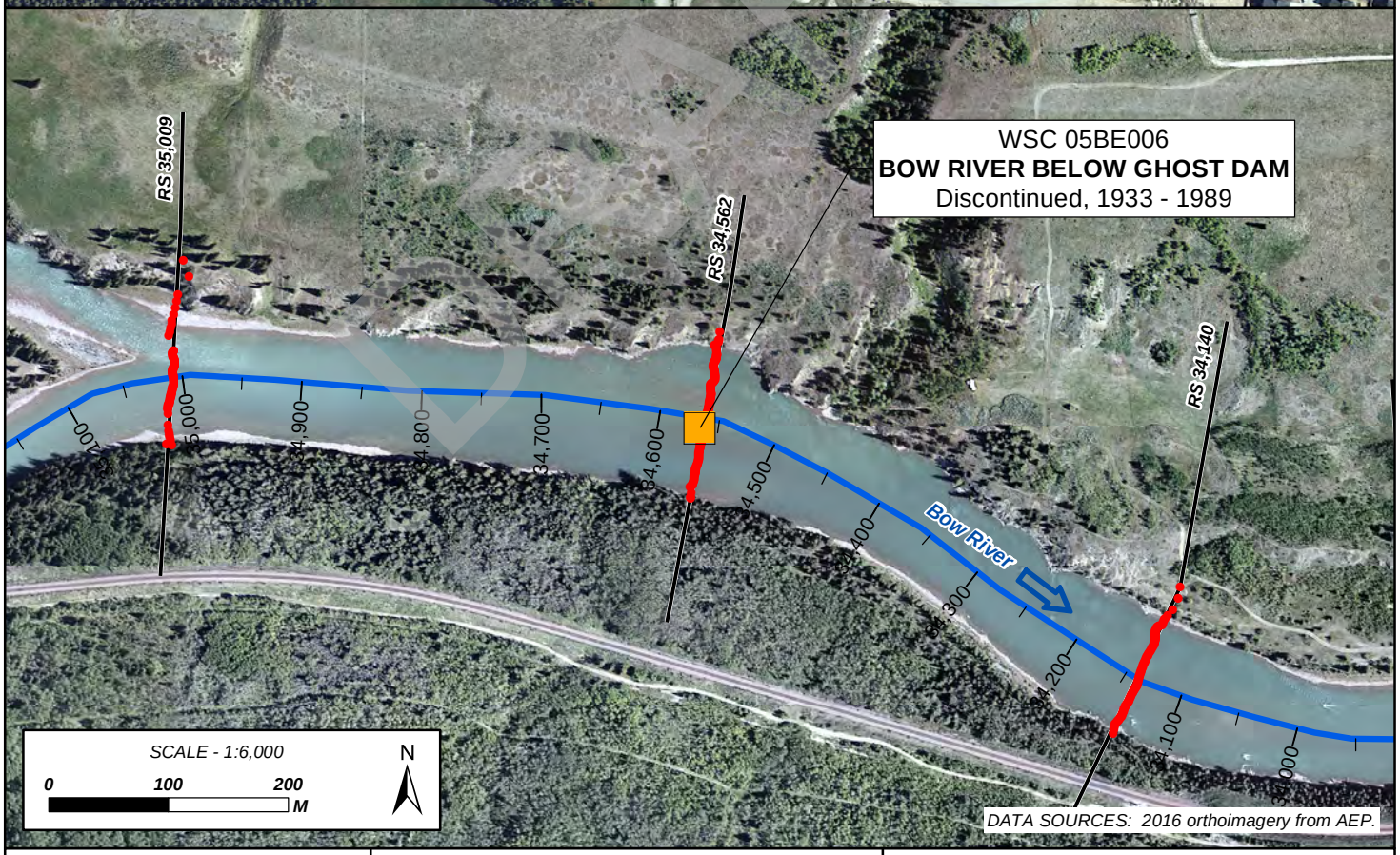
5.3.4 Gauge Data and Rating Curves

To verify the model calibration over a range of flows, synthetic stage-discharge curves based on hydraulic model output were computed at four WSC gauge locations (refer to Figure 8 and Figure 9). The gauge rating curves were used to verify the Manning's roughness factors over a range of discharges. The simulated rating curves from the calibrated model compared to the WSC gauge rating curves are shown in Figure 10 to Figure 13.

The two gauges shown in Figure 9 are located between model cross sections; therefore, synthetic stage-discharge curves were interpolated at the gauge location. The computed rating curves encompass the range of flows from low flows conditions experienced during the surveys to a flow of 1,000 m^3/s to cover the range of WSC measurements.

Very good agreement was obtained between the synthetic and WSC gauge rating curves. The comparison at the Cochrane gauge provides confidence in the ability of the model to simulate water levels over a range of flows in a developed reach of the study area.





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Active Hydrometric Station
Discontinued Hydrometric Station
Survey Point
Cross Section — — Interpolated Section
Model Stream Network

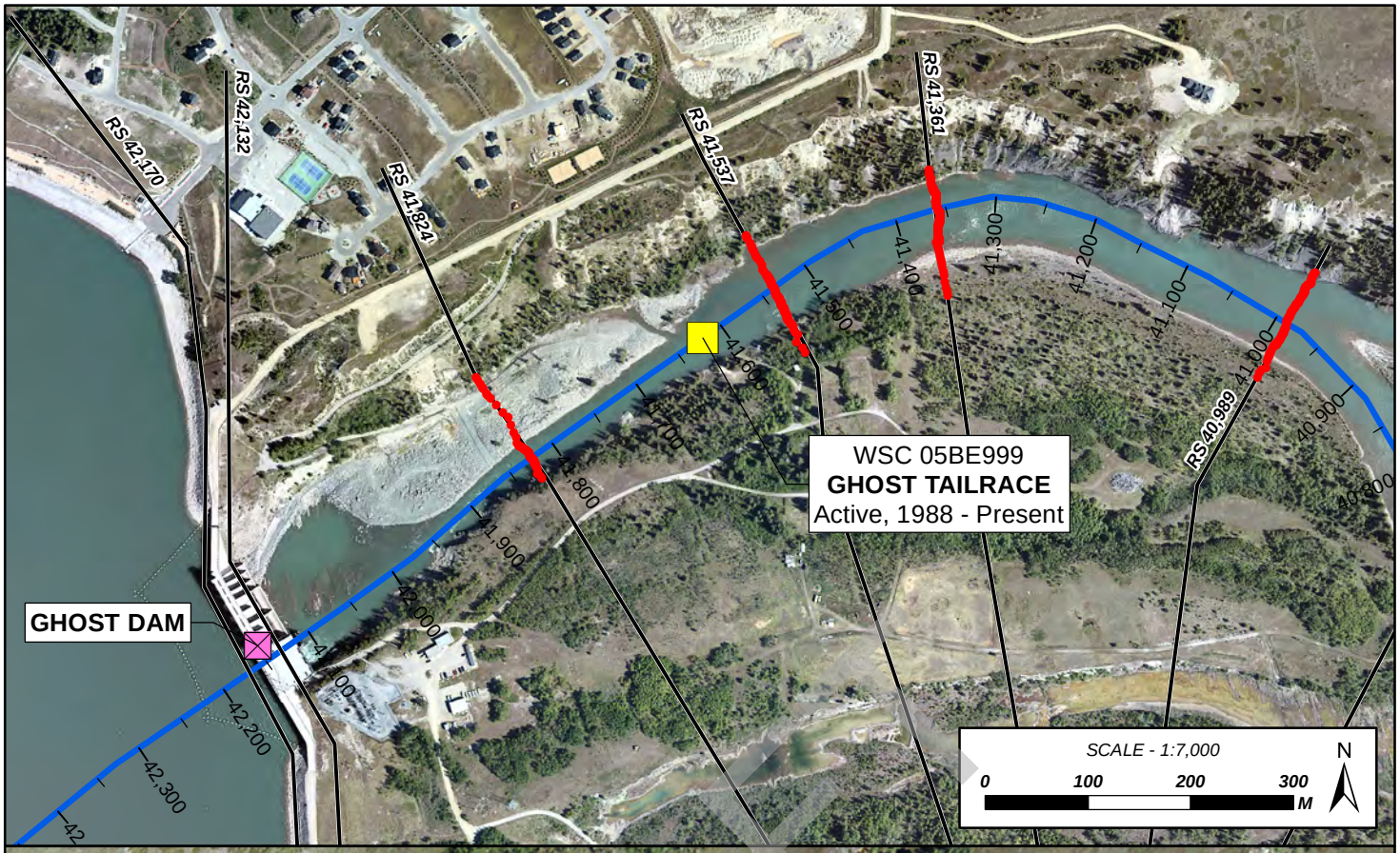
Job: 3001178 | Date: 13-FEB-2018

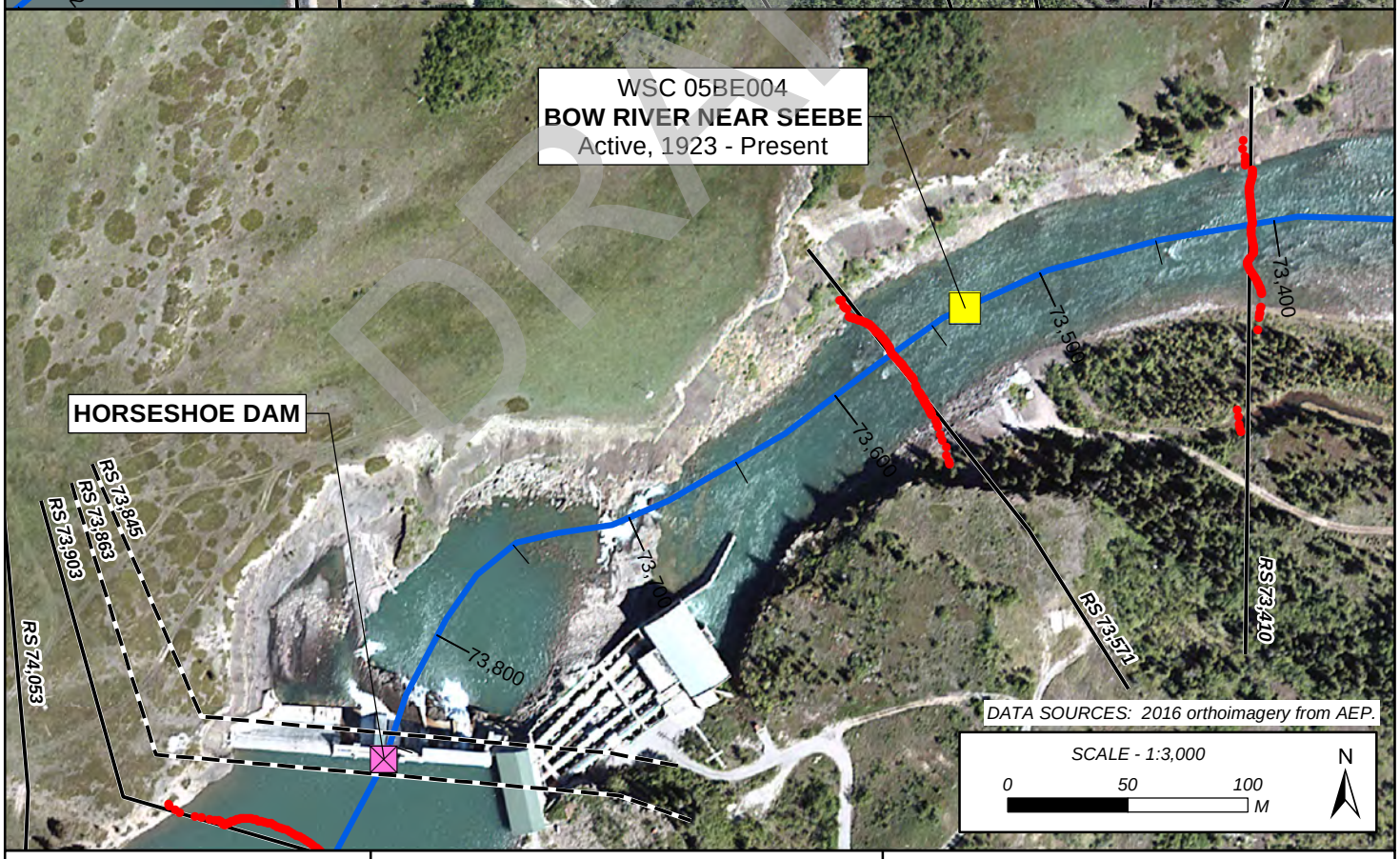
UPPER BOW RIVER HAZARD STUDY

HYDROMETRIC GAUGE LOCATIONS WITH ADJACENT SECTIONS

FIGURE 8

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_RatingCurveSections1_4.mxd





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Model Stream Network (with stationing)

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UPPER BOW RIVER HAZARD STUDY

HYDROMETRIC GAUGE LOCATIONS WITH ADJACENT SECTIONS

FIGURE 9

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_RatingCurveSections2_3.mxd

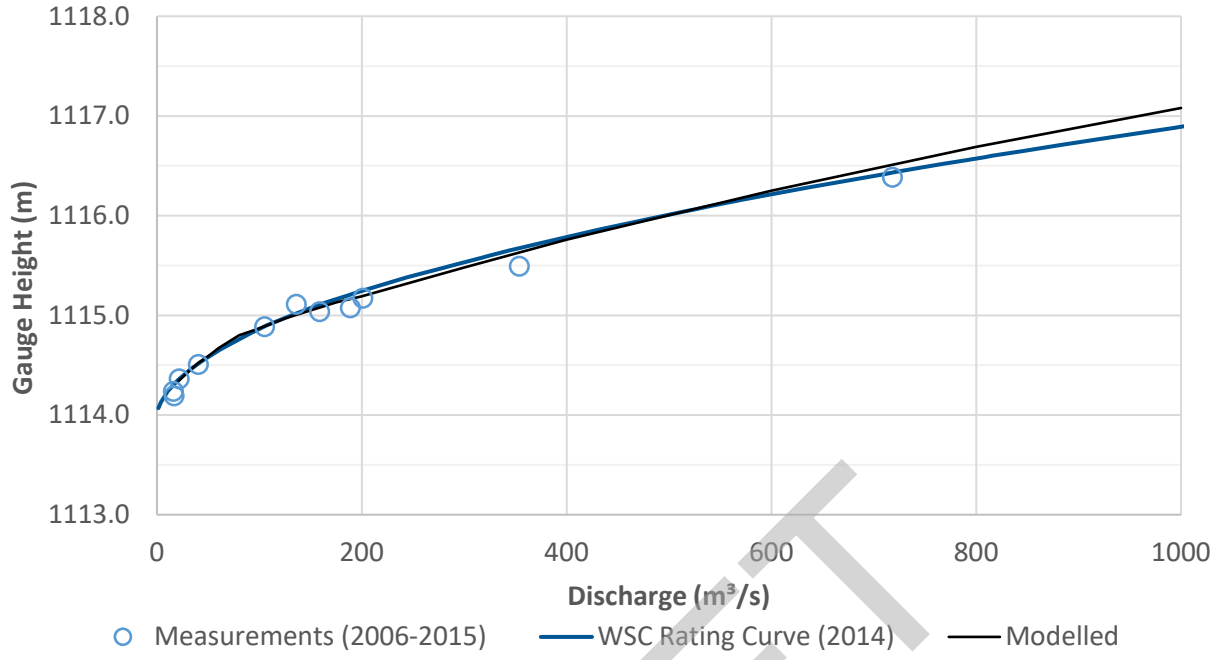


Figure 10 Comparison of simulated and WSC gauge rating curves at Bow River near Cochrane (05BH005)

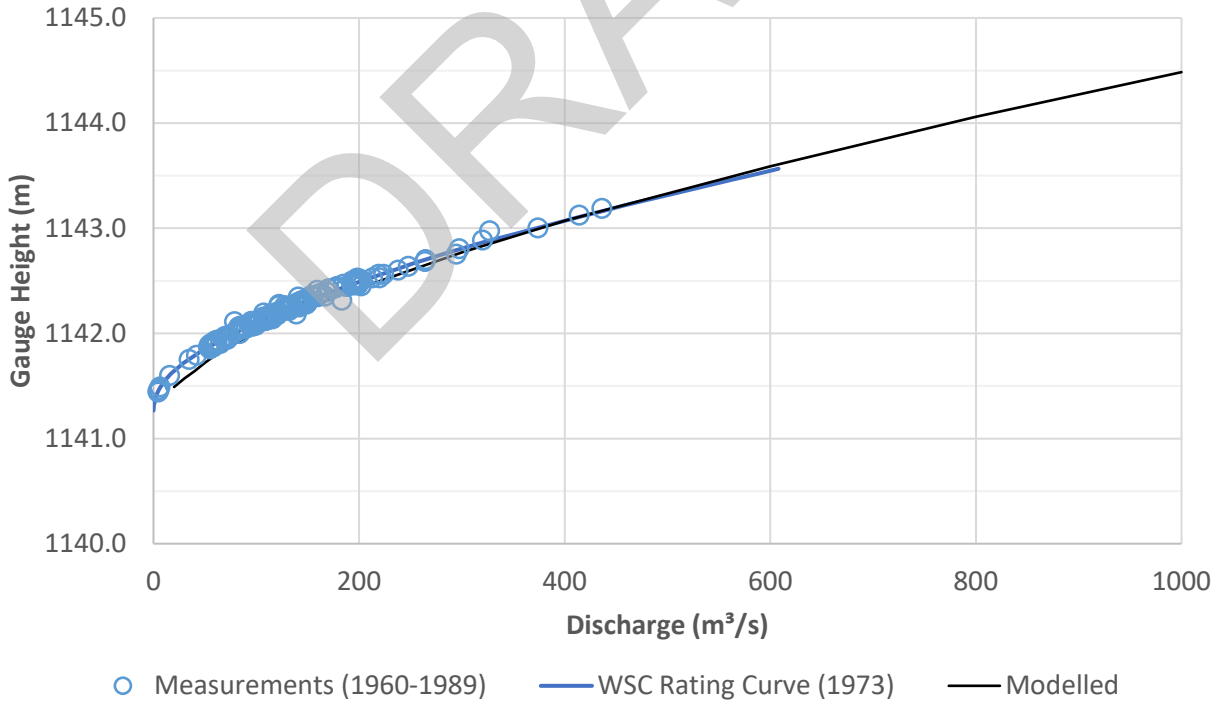


Figure 11 Comparison of simulated and WSC rating curve at Bow River below Ghost Dam (05BE006)

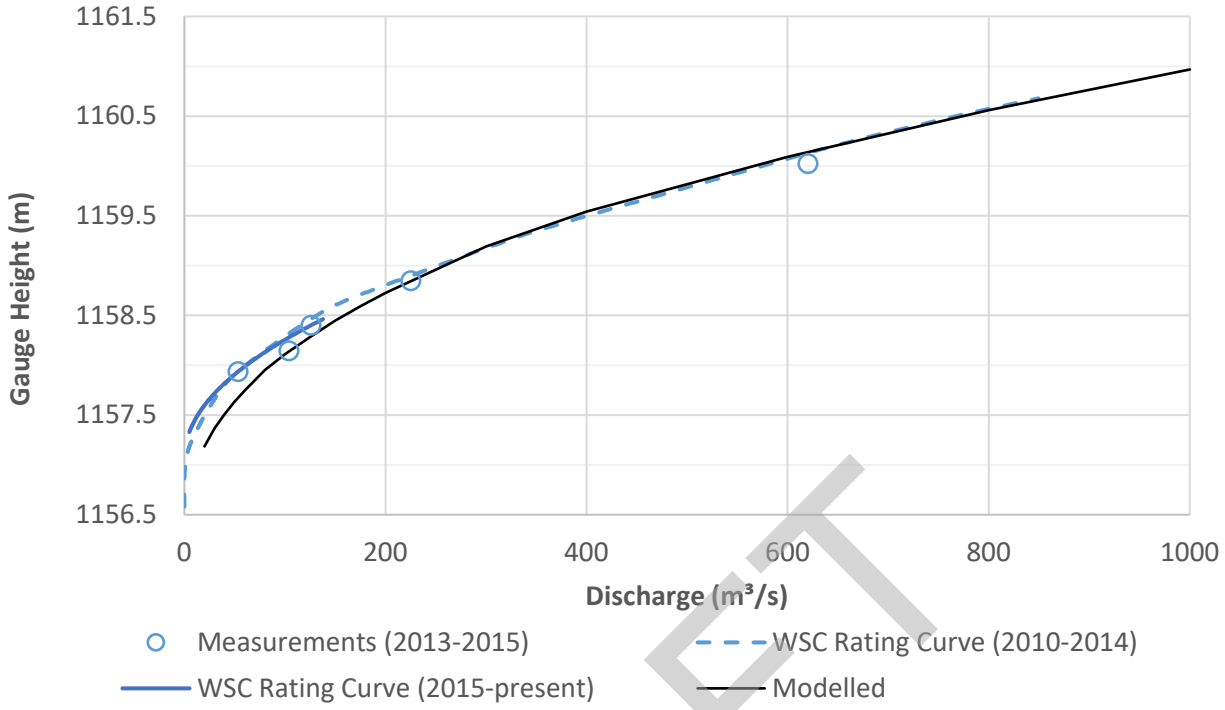


Figure 12 Comparison of simulated and WSC rating curve at Ghost Tailrace (05BE999)

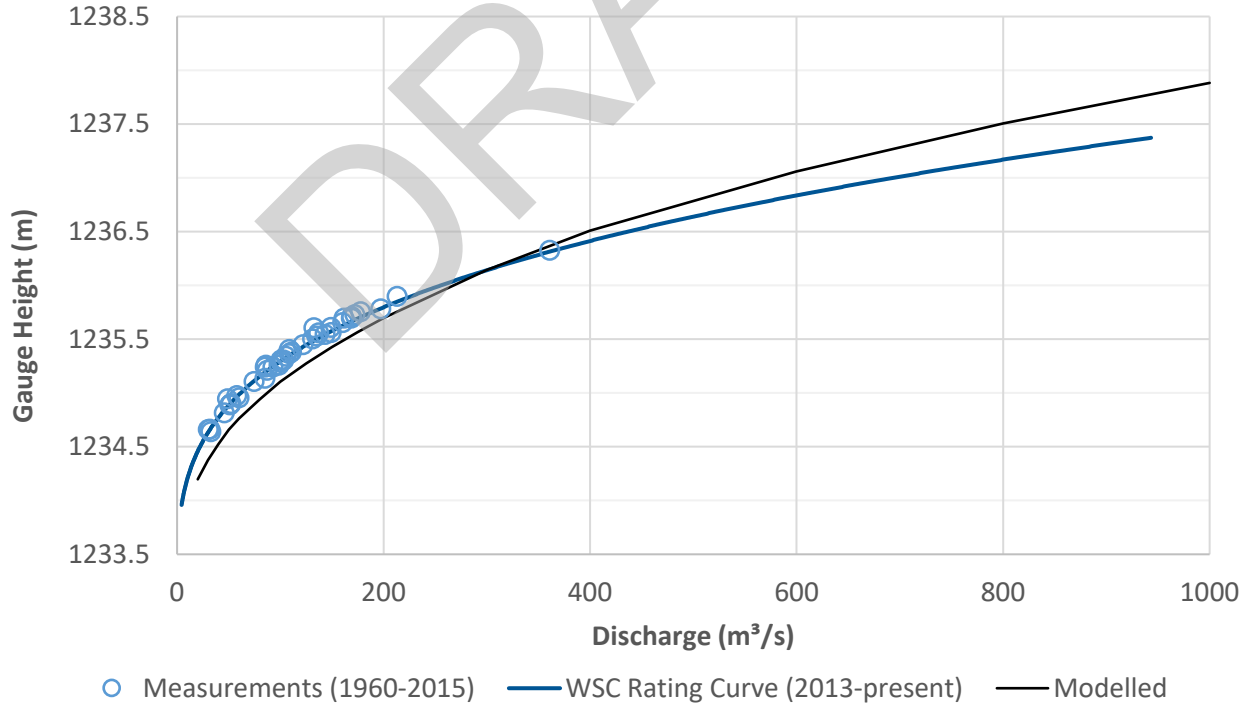


Figure 13 Comparison of simulated and WSC rating curve at Bow River near Seebe (05BE004)

5.3.5 Calibration and Validation Results

The results of the model calibration consist of a comparison between observed highwater marks and simulated water surface profiles for both low and high flow conditions.

Surveyed water levels and highwater marks (also referred to as observed water levels) that are spatially distributed over the study area can provide a measure of the distributed model performance. The comparison of model results with observed water levels was done using the mean absolute error (MAE) equation:

$$MAE = \frac{\sum_{x=1}^{N} |Z_s(x) - Z_o(x)|}{N}$$

where $Z_s(x)$ and $Z_o(x)$ are the simulated and observed water levels at river station x, and N is the number of points where observed water levels are available. The MAE is reported below as a measure of calibration agreement between simulated and observed water levels.

The Water Surface Profile Calibration, Low Flow (Sheets 1 to 10) and Water Surface Profile Calibration, 2013 Flood (Sheets 1 to 10) included in the Maps and Drawings section of this report contains the longitudinal profiles that present the comparison between simulated water surface profiles and the surveyed highwater marks for low and high flow calibration events. No simulated water levels are shown on the profiles for the reaches with no available discharge estimates. Tables with the differences between simulated water levels and surveyed highwater marks are included in Appendix B (Table B-4). A summary of the comparison statistics is included in Table 16. In the tables, the differences between simulated water levels and surveyed high water marks are only provided for the average flow profile for reaches where a range of flows were estimated.

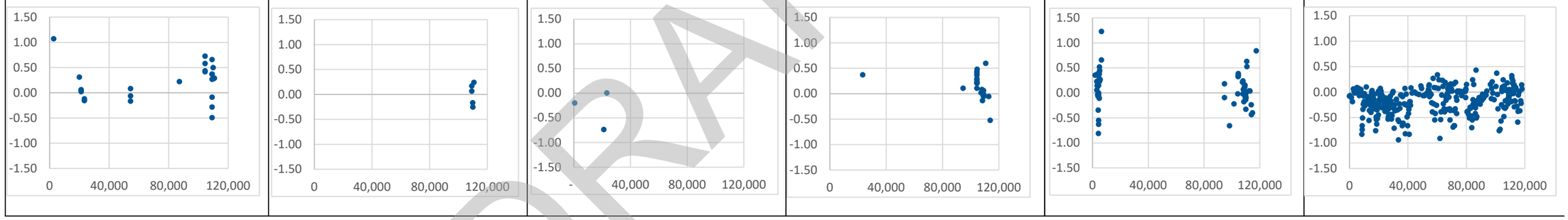
Overall, the MEA ranges between 0.2 m and 0.3 m. The differences are primarily due to the lack of reliable inflows along most of the reaches where highwater marks were surveyed (refer to Table 15). Furthermore, the model simulations were done using a constant discharge applied to large flow zones, which may not be representative of the conditions during the flood event. The model simulations do not take into account any debris flows, log jams, or channel changes that may have occurred and influenced the highwater levels. For the older flood events, such as 1986 and 1990, larger differences can be attributed to changes to the channels, flood control structures, and floodplain development. Very limited inflows and highwater marks were available for the calibration and validation floods on Jumpingpound, Bighill, Exshaw, and Policeman creeks.

The comparison of the computed 2013 inundation extents with the highwater extents surveyed by the Town of Cochrane is shown in Figure 14. The agreement between computed and surveyed extents is generally very good.

Table 16 Summary statistics from difference in highwater marks and simulated water levels for high and low flow calibration and validation events.

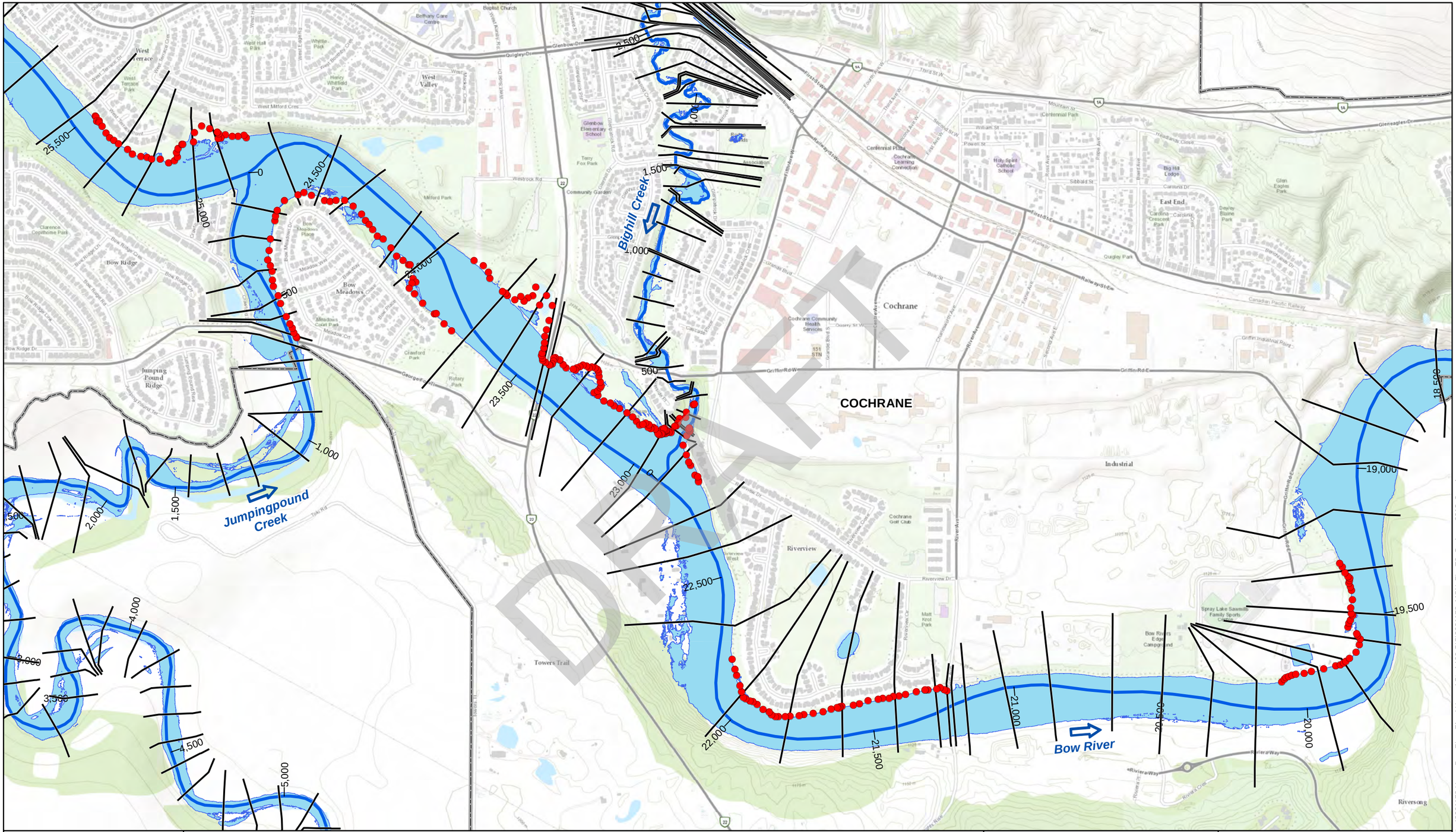
Statistics (Simulated WL – HWM)	2013 Flood		2012 Flood		2005 Flood		1990 Flood		1986 Flood		Low Flow	
	All AEP	All AEP & AT	All AEP	All AEP & AT	All AEP	All AEP & AT	All AEP	All AEP & AT	All AEP	All AEP & AT	-	LiDAR WSE Points
Number of HWMs	12	24	5	5	0	3	15	26	31	63		362
Minimum Difference	-0.12	-0.49	-0.26	-0.26		-0.74	-0.53	-0.53	-0.43	-0.81		-0.94
Lower Quartile	0.08	-0.07	-0.17	-0.17		-0.47	-0.04	-0.04	-0.06	-0.09		-0.30
Mean Difference	0.22	0.22	0.01	0.01		-0.31	0.08	0.13	0.16	0.09		-0.16
Median Difference	0.27	0.27	0.07	0.07		-0.20	0.11	0.11	0.15	0.12		-0.12
Upper Quartile	0.32	0.42	0.17	0.17		-0.10	0.21	0.29	0.34	0.33		0.01
Maximum Difference	0.50	1.07	0.24	0.24		0.00	0.60	0.60	1.23	1.23		0.43
Standard Deviation	0.18	0.36	0.21	0.21		0.38	0.25	0.24	0.35	0.35		0.24
MAE	**0.24**	**0.33**	**0.18**	**0.18**		**0.31**	**0.21**	**0.21**	**0.28**	**0.27**		**0.21**

Plot



Notes:

1. Statistics are provided for the average flow estimates only.
2. All differences are simulated water levels minus the observed water levels such that the model overpredicting a water level is shown as a positive difference value.
3. All HWMs are located on Bow River except for one on Bighill Creek in 2013, one on Jumpingpound Creek in 2005, and 26 on Policeman Creek in 1986.
4. Description of column headings:
   - All AEP = All available HWMs provided by Alberta Environment and Parks
   - All AEP & AT = All available HWMs provided by Alberta Environment and Parks and Alberta Transportation



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— Cross Section
— Model Stream Network (with stationing)
▭ Town
● 2013 Edge of Highwater
▭ Modelled 2013 Flood Extents

SCALE - 1:12,000
0 100 200 300 400 500 M
N

Coordinate System: NAD 1983 3TM 114
Units: METRES

DATA SOURCES: 2013 edge of highwater collected by Town of Cochrane in July 2013 (exact date of collection unavailable). Basemap from Esri & NRCAN.

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UPPER BOW RIVER HAZARD STUDY

COMPARISON OF MODELLED AND SURVEYED 2013 FLOOD EXTENTS IN COCHRANE

FIGURE 14

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_Cochrane2013_3.mxd

5.4 Model Parameters and Options

The following sections describe the key model parameters and options adopted in the calibrated HEC-RAS model. These include Manning's roughness coefficients for the channel and overbank areas, contraction and expansion loss coefficients, and ineffective areas.

5.4.1 Manning Roughness Values

Channel Roughness

In general, insufficient calibration data were available to justify significant variations in the Bow River channel roughness values. The channel roughness values for the tributaries were higher than for the Bow River which is consistent with the relative size of the channels and geomorphic characteristics of the tributaries. The channel roughness value for Exshaw Creek was calculated using an equation developed for high gradient streams with slopes greater than 0.002 (Jarrett, 1984). Table 17 summarizes the calibrated channel roughness in each reach.

Table 17 Adopted Manning's roughness values for the channel based on high flow calibration

Roughness Reach	Reach Description	Channel Roughness
Bow River		
118 km to 96 km	highly braided reaches near Canmore	0.035
110 km to 104 km	straight reach through Canmore	0.030
96 km to 87 km	backwater through Dead Man's Flats and Lac des Arcs	0.035
87 km to 84 km	steep reach d/s of Exshaw	0.035
84 km to 80 km	deep single channel reach	0.035
80 km to 77 km	backwater reach from Kananaskis Dam	0.035
77 km to 74 km	backwater reach from Horseshoe Dam	0.035
74 km to 69 km	steep reach through Stoney FN	0.045
69 km to 57 km	less steep reach through Stoney FN	0.035
57 km to 42 km	Ghost Reservoir backwater reach	0.030
42 km to 8 km	steeper reach between Ghost and Bearspaw	0.035
8 km to 0 km	Bearspaw Reservoir backwater reach	0.035
Tributaries		
Exshaw Creek	entire reach	0.090
Jumpingpound Creek	entire reach	0.040
Bighill Creek	entire reach	0.060
Policeman Creek	entire reach	0.045

The sensitivity of the hydraulic model results to changes in channel roughness are described in Section 5.6.2.

Overbank Roughness

Overbank roughness values were selected based on landcover composition, professional judgement, and literature guidance (e.g. Chow, 1959). Table 18 shows the adopted roughness values for the landcover types identified within the study area.

Table 18 Adopted Manning's roughness values for overbank areas

Overbank Landcover Types	Overbank Roughness
Grass (cultivated or pasture)	0.040
Light brush or shrubs	0.070
Trees with little undergrowth	0.080
Trees with dense undergrowth	0.10
Lake or ponded water	0.025
Residential development	0.040
Industrial development	0.040

Section 5.6.2 describes the sensitivity of the hydraulic model results to changes in overbank roughness.

5.4.2 Expansion and Contraction Coefficients

To account for the effect of flow contraction or expansion on the energy balance between successive cross sections, HEC-RAS multiplies the absolute difference in velocity head by a coefficient. Coefficients range from 0.10 for gradual transitions to 0.80 (Brunner, 2016).

For bridges and culverts with abutments constricting the flow, the contraction and expansion loss coefficients at the cross sections immediately adjacent to these structures were set to 0.3 and 0.5, respectively, to represent the mild flow area obstruction associated with the bridge piers and abutments. The default values of 0.1 and 0.3 for contraction and expansion loss coefficients were used at all other cross sections including those adjacent to pedestrian bridges and other structures that would not result in the contraction and expansion of the flow.

5.4.3 Bend Losses

Within the study reach, the Bow River channel has several large bends. The energy losses through these large bends were accounted for by adding minor losses in the geometry file. Minor losses are computed by entering a loss coefficient (*K*) at a specific cross section. To compute the minor energy loss, *K* (varying from 0.0 to 1.0) is multiplied by the velocity head and is added to the energy equation for steady flow computations. The energy loss is assumed to act as a force in the upstream direction to reduce the velocity (Brunner, 2016).

As no specific direction is provided in the HEC-RAS manual on determining appropriate loss coefficients for large bends, *K* values were estimated based on the bend performance chart (Miller, 1996) shown in

Figure 15, which was developed for pipeflow but is believed to be a reasonable approximation for open channel flow. The estimated *K* values are included in HEC-RAS as minor losses.

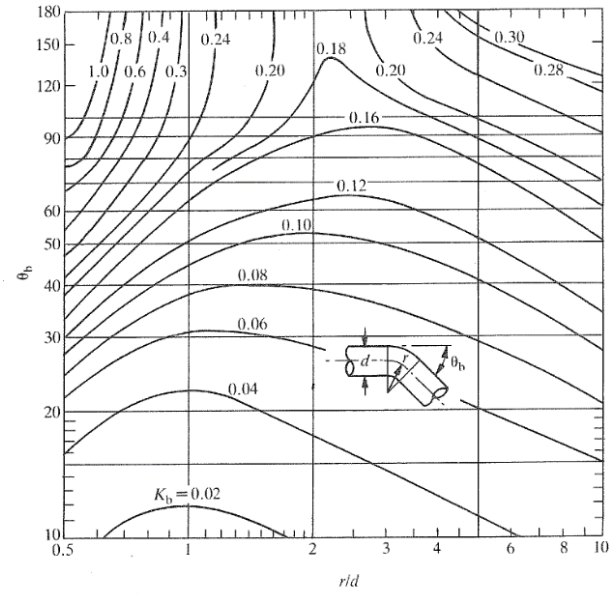

Figure 15 Bend losses (source: Miller, 1996)

In estimating the *K* values, the diameter (*d*) was assumed to be the channel width and the radius (*r*) was estimated as the channel bend radius for approximately the 100-year flood. The *K* values were distributed over one or more cross sections, as shown in Table 19. The largest bends, and consequently the largest *K* values, are found on the Bow River downstream of Cochrane.

Table 19 Bend loss coefficients

River	Reach	River Station (m)	*K*	*r* (m)	*d* (m)	*r/d*	Angle (degree)
Bow River	KM 087	86,899	0.22	68	54	1.26	100
Bow River	KM 025	71,322	0.12	149	103	1.44	60
Bow River	KM 025	69,341	0.16	223	118	1.89	90
Bow River	KM 025	64,302	0.17	333	107	3.11	110
Bow River	KM 025	62,736	0.20	143	90	1.59	115
Bow River	KM 025	59,664	0.19	230	110	2.09	180
Bow River	KM 025	38,248	0.16	207	105	1.97	90
Bow River	KM 000	22,028	0.18	168	102	1.64	90
Bow River	KM 000	19,933	0.05	265	156	1.70	25
Bow River	KM 000	19,798	0.05	265	156	1.70	25
Bow River	KM 000	19,603	0.05	265	156	1.70	25
Bow River	KM 000	19,507	0.05	265	156	1.70	25

River	Reach	River Station (m)	*K*	*r* (m)	*d* (m)	*r/d*	Angle (degree)
Bow River	KM 000	18,984	0.06	264	112	2.35	28
Bow River	KM 000	18,840	0.06	264	112	2.35	28
Bow River	KM 000	18,709	0.06	264	112	2.35	28
Bow River	KM 000	18,500	0.06	264	112	2.35	28
Bow River	KM 000	18,270	0.06	264	112	2.35	28
Bow River	KM 000	15,224	0.09	441	118	3.74	40
Bow River	KM 000	14,981	0.09	441	118	3.74	40
Bow River	KM 000	14,763	0.09	441	118	3.74	40
Bow River	KM 000	8,729	0.16	198	98	2.02	90
Jumpingpound Creek	KM 000	5101	0.16	124	35	3.54	90
Jumpingpound Creek	KM 000	3672	0.19	60	33	1.80	130
Jumpingpound Creek	KM 000	3363	0.17	117	46	2.55	100
Jumpingpound Creek	KM 000	2410	0.10	77	40	1.91	53
Jumpingpound Creek	KM 000	1861	0.24	24	36	0.65	70
Jumpingpound Creek	KM 000	1733	0.28	28	28	1.00	160

5.4.4 Ineffective Flow Areas and Obstructions

Ineffective Flow Areas

Ineffective flow areas were specified at cross sections in the HEC-RAS model, based on a detailed review of the local terrain and floodplain features both at and between cross sections. Ineffective flow areas can be specified within portions of cross sections where water is expected to pond, but where the velocity of that water, in the downstream direction, is also expected to be close to or equal to zero (Brunner, 2016). The downstream direction is taken relative to the cross section lines defined in the model, so the orientation of cross sections was considered when specifying ineffective flow areas.

Ineffective flow areas in the model may be specified as either permanent or non-permanent. Permanent ineffective flow areas apply regardless of the water surface elevation, whereas temporary ineffective flow areas become effective above a defined elevation. The configuration of permanent and non-permanent ineffective flow areas were specified depending on site-specific circumstances and engineering judgement.

General Criteria Used to Define Ineffective Areas

The general principles for determining ineffective flow areas were as follows:

- Non-permanent ineffective flow areas were used to “fill” local depressions on the floodplain that are obstructed by higher ground upstream or downstream. These areas were assumed to

become engaged in the active flow area once the water level exceeded the elevation of the adjacent ground.

- Permanent ineffective flow areas were used to "fill" relic channels, tributary channels or excavated holes that would otherwise have incorrectly added flow area to the cross section. For example, on the Bow River at RS 106,497, the Cougar Creek channel was set to be permanently ineffective; on Policeman Creek at RS 3002, a large excavated hole was set to be permanently ineffective.
- Permanent ineffective flow areas were defined where flow patterns were likely to be influenced by nearby bridge abutments and roadway embankments crossing the floodplain. These types of obstructions tend to direct flows towards the bridge opening. Several site-specific factors were taken into account when configuring ineffective flow areas at bridges and culverts in the study area, including: distance from the cross section to the bridge, terrain features, bridge geometry, and skew of the bridge opening relative to the river.
- Ineffective flow areas behind railroad and highway embankments were assessed on a case by case basis. Aerial imagery, LiDAR, and historic information was consulted to determine if there were indications of flow based on the overbank gradient, channels, or other evidence of discernible velocities behind the rail embankments. If not, permanent ineffective flow areas were set to the top of embankment elevation. This allowed areas behind embankments (assumed permeable) to be shown as wet and isolated but not conveying flow. Areas above embankments generally conveyed flow once the embankment was overtopped, unless an upstream or downstream obstruction was present causing local ponding or dead zones with limited flow. Areas below the height of the embankment were modelled as effective flow only if there was no downstream obstruction or if there was an indication of flow moving in the downstream direction.
- Permanent ineffective flow areas were also defined behind flood control structures such that they worked in combination with specified levees to represent realistic floodplain conveyance in the overbank areas across the full range of flood discharges.

Ineffective Areas Behind Flood Control Structures

For the Canmore Mine Dike, which ties into high ground at both the upstream and downstream ends, the top elevation of the ineffective areas was typically set at or below the existing flood control dike crest elevation, taking into consideration upstream and downstream flow-limiting elevations through connected floodplain areas. For floods that overtop this flood control structure, the above configuration was appropriate to ensure that those flood levels were not under-predicted, relative to floods of a lesser magnitude that did not overtop the flood control structures. In addition, the discharge apportioned to the overbank areas by the model was a consideration in determining representative ineffective flow areas, when flood control structures were overtopped.

For the Canmore floodplain (Bow River and Policeman Creek), which is the area behind the Canmore Town Dike, permanent ineffective flow areas were defined to limit the overbank flow to spill paths computed in the 2D model. Limiting the floodplain flow to these spill paths also ensured consistent

overbank conveyance from cross section to cross section, which otherwise would have varied significantly due to the location of the boundary between the Bow River and Policeman Creek. It should be noted that the presence of ineffective flow areas in the Canmore floodplain does not necessarily indicate that the flow would be ineffective during a flood event. The ineffective flow areas were primarily utilized as a means to improve model performance.

For flood flows exceeding the 200-year event, it was necessary to include additional ineffective flow areas at cross sections near the Bridge Road Bridge in Canmore to ensure model stability. It is expected that the flow in these areas would be effective during a flood event.

Ineffective flow areas were added at specific locations on the floodplain where high banks or other types of embankments (Lac des Arcs dikes) would cause water to pond. In these areas, once the threshold water level is exceeded, water may be actively conveyed.

Blocked Obstructions

Blocked obstructions in the floodplain, such as buildings, walls, storage tanks, or elevated foundations were not specified in the HEC-RAS model. Obstructions associated with bridge piers and structural members were modelled using the standard bridge editor specifications in HEC-RAS.

5.4.5 Flow Splits, Islands, and Diversions

In Canmore, when the Town Dike is overtopped, flood flows from the Bow River are expected to spill across the floodplain in a south east direction until they join the Policeman Creek flood flows. During the model development stage, a boundary line was defined between the Bow River influenced portion of the floodplain and the Policeman Creek influenced portion of the floodplain. This boundary line was delineated following roads and considering other physical features in Canmore. To represent the transfer of flow from the Bow River to Policeman Creek, four rating curves relating the flow in the Bow River to the magnitude of flow to be transferred to Policeman Creek were generated. The rating curves were based on the 2D model results.

No islands or diversions were modelled in the study reach.

5.5 Open Water Flood Frequency Profiles

The calibrated hydraulic model was used to generate flood frequency profiles for the thirteen open water floods, from the 2-year to the 1000-year, listed in Table 2. The computed flood frequency water levels at each surveyed cross section on the Bow River and tributaries are provided in Table B-5 in Appendix B. These results are plotted in the Open Water Frequency Profiles (Sheets 1 to 10).

At some hydraulic structures on Bighill Creek and Policeman Creek, the computed flood frequency water levels cross, that is the profile for a lower magnitude event is higher than that for a higher magnitude event. This typically occurs when the water level is near the low chord or embankment elevation of the structure. The difference in elevation between crossing profiles is generally less than 0.1m.

The crest elevations of the flood control dikes in Canmore are generally 0.15 to 0.5 m above the 100-year open water flood level and would be expected to start overtopping at multiple locations at the 200-year to 350-year flood events. The exception to this is the lower 1.1 km of the Canmore Town Dike near the Canmore WWTP, where the dike is overtopped between a 35 and 75-year flood event. Also, a short reach of the Canmore Town Dike, upstream of the Engine Bridge, has a lower crest elevation which results in flooding of parkland at a 2-year to 5-year flood; however, houses located north of the park are on higher ground and would not be affected until a 50-year event.

The crest of the short Jumpingpound Creek flood control dike in Cochrane is generally 0.1 m below the 100-year open water flood level and would be expected to be overtopped at the 100-year flood event.

5.6 Model Sensitivity

The sensitivity of the calibrated open water hydraulic model to adjustments in boundary conditions and Manning's roughness values was evaluated. These parameters affect the computed water surface profiles, and by direct result, predicted flood depths and inundation limits. The sensitivity analysis provides an indication of the plausible range of error in the calibrated model results and identifies the relative importance of each parameter to the overall error. When selecting the range of plausible parameters to test during the model sensitivity analyses, consideration was given to the variability of the factors with season and discharge. The 100-year flood was used as the baseline for the sensitivity analyses.

A summary of the sensitivity analysis results are provided below. All of the Sensitivity Analysis Profiles are presented in the Maps and Drawings section of this report, while tabular results are presented in Appendix B.

5.6.1 Boundary Conditions

The hydraulic model requires a downstream water level and an upstream discharge as boundary conditions for each river reach. The adopted downstream boundary condition in the calibrated model is the Bearspaw Reservoir FSL. The FSLs at the Ghost, Horseshoe, and Kananaskis reservoirs were set as internal boundary conditions. A plausible range of uncertainty in reservoir water levels is ± 1 m. The tabular results for the reaches impacted by the reservoir levels are presented in Appendix B and plotted on the Model Sensitivity Profiles – Sensitivity to Reservoir Levels (Sheets 1 to 10) included in the Maps and Drawings section of this report.

A summary of the results is included in Table 20 and shows that the reaches influenced by changing the imposed reservoir level range in length from 2.2 km to 14.6 km. None of the tributaries are impacted by changes to the reservoir levels.

Table 20 Summary of sensitivity analysis results to reservoir water level boundary condition

			Location where deviation from baseline profile falls below 0.1 m			
			River Station (m)		Distance from Dam (km)	
Reservoir	River Station (m)	Baseline FSL (m)	FSL - 1 m	FSL + 1 m	FSL - 1 m	FSL + 1 m
Bearspaw	0	1090.9	7,027	7,916	7.0	7.9
Ghost	42,150	1191.8	56,284	56,775	14.1	14.6
Horseshoe	73,850	1257.1	77,488	77,488	3.6	3.6
Kananaskis	77,490	1280.2	79,688	80,511	2.2	3.0

5.6.2 Manning Roughness Values

The sensitivity of the calibrated model to Manning's roughness was evaluated. Channel roughness, was examined independently of overbank roughness. The results of the sensitivity analysis are discussed below.

Channel Roughness

The calibrated channel roughness on the Bow River varied between 0.030 to 0.045. A plausible range of channel roughness for the modelled length of the Bow River is considered to be approximately 0.025 to 0.050. For the low and high roughness sensitivity runs, the channel roughness value was adjusted by ±15% to reflect this range. The same ±15% range was applied to the roughness values in Bighill Creek, Jumpingpound Creek, Exshaw Creek, and Policeman Creek. The sensitivity analysis was run concurrently for the Bow River and the tributaries using the values summarized in Table 21.

Table 22 provides a summary of the deviation from the calibrated 100-year flood levels for low and high channel roughness for reaches of the Bow River and tributaries. Water surface profiles for each case are presented in Table B-6 in Appendix B and plotted on the Model Sensitivity Profiles – Sensitivity to Channel Roughness (Sheets 1 to 10) included in the Maps and Drawings section of this report.

The steeper Bow River reaches (downstream of Horseshoe Dam and downstream of Ghost Dam) are the most sensitive to changes in channel roughness values with average deviations from the baseline 100-year profile reaching 0.31 m and maximum deviations reaching 0.53 m. The maximum deviations from the baseline on Bighill Creek (0.23 m) is caused by Bow River backwater. Excluding the backwater effect of the Bow River, the maximum deviations from the baseline reaches 0.12 m on Bighill Creek.

Table 21 Channel roughness values used in sensitivity analysis

Roughness Reach	Reach Description	Calibrated Roughness	Low Roughness (-15%)	High Roughness (+15%)
Bow River				
118 km to 96 km	highly braided reaches near Canmore	0.035	0.030	0.040
110 km to 104 km	straight reach through Canmore	0.030	0.026	0.035
96 km to 87km	backwater through Dead Man's Flats and Lac des Arcs	0.035	0.030	0.040
87 km to 84 km	steep reach d/s of Exshaw	0.035	0.030	0.040
84 km to 80 km	deep single channel reach	0.035	0.030	0.040
80 km to 77 km	backwater reach from Kananaskis Dam	0.035	0.030	0.040
77 km to 74 km	backwater reach from Horseshoe Dam	0.035	0.030	0.040
74 km to 69 km	steep reach through Stoney FN	0.045	0.038	0.052
69 km to 57 km	less steep reach through Stoney FN	0.035	0.030	0.040
57 km to 42 km	Ghost Reservoir backwater reach	0.030	0.026	0.035
42 km to 8 km	steeper reach between Ghost and Bearspaw	0.035	0.030	0.040
8 km to 0 km	Bearspaw Reservoir backwater reach	0.035	0.030	0.040
Tributaries				
Exshaw Creek	entire reach	0.090	0.077	0.10
Jumpingpound Creek	entire reach	0.040	0.034	0.046
Bighill Creek	entire reach	0.060	0.051	0.069
Policeman Creek	entire reach	0.045	0.038	0.052

Table 22 Sensitivity analysis results for channel roughness

Reach	Reach Description	Difference from baseline profile (m)					
		Low Roughness (-15%)			High Roughness (+15%)		
		Max	Avg	Min	Min	Avg	Max
Bow River							
118 km to 96 km	highly braided reaches near Canmore	-0.17	-0.08	0.00	0.02	0.07	0.14
110 km to 104 km	straight reach through Canmore	-0.18	-0.13	-0.04	0.04	0.14	0.24
96 km to 87 km	backwater through Dead Man's Flats and Lac des Arcs	-0.11	-0.09	-0.08	0.10	0.11	0.12
87 km to 84 km	steep reach d/s of Exshaw	-0.29	-0.08	0.01	0.00	0.09	0.25
84 km to 80 km	deep single channel reach	-0.23	-0.18	-0.09	0.14	0.18	0.21
80 km to 77 km	backwater reach from Kananaskis Dam	-0.22	-0.13	0.00	0.00	0.13	0.21

Reach	Reach Description	Difference from baseline profile (m)					
		Low Roughness (-15%)			High Roughness (+15%)		
		Max	Avg	Min	Min	Avg	Max
77 km to 74 km	backwater reach from Horseshoe Dam	-0.31	-0.15	0.00	0.00	0.15	0.30
74 km to 69 km	steep reach through Stoney FN	-0.53	-0.30	-0.09	0.17	0.30	0.40
69 km to 57 km	less steep reach through Stoney FN	-0.36	-0.23	-0.06	0.07	0.22	0.34
57 km to 42 km	Ghost Reservoir backwater reach	-0.32	-0.08	0.00	0.00	0.10	0.34
42 km to 8 km	steeper reach between Ghost and Bearspaw	-0.42	-0.31	-0.19	0.20	0.28	0.36
8 km to 0 km	Bearspaw Reservoir backwater reach	-0.36	-0.15	0.00	0.00	0.14	0.30
Tributaries							
Exshaw Creek	entire reach	-0.17	-0.07	0.00	0.00	0.08	0.18
Jumpingpound Creek	entire reach	-0.36	-0.14	0.03	-0.01	0.13	0.29
Bighill Creek	entire reach	-0.23	-0.05	0.02	-0.08	0.04	0.20
Policeman Creek	entire reach	-0.10	-0.04	0.01	-0.01	0.03	0.09

Overbank Roughness

The sensitivity of computed 100-year flood levels to overbank roughness was evaluated by selecting low and high roughness coefficients for each of the overbank landcover types identified in Table 18. Considering values published by Chow (1959), plausible high and low values were identified for each of the overbank landcover types. These plausible values were generally within 20% of the overbank roughness values adopted for the calibration. For the low and high roughness sensitivity runs, the overbank roughness values were adjusted by ± 20% to reflect this range (Table 23). The sensitivity analysis was run concurrently for the Bow River and the tributary reaches.

Table 23 Overbank roughness values used in sensitivity analysis

Overbank Landcover Type	Calibrated Roughness	Low Roughness (-20%)	High Roughness (+20%)
Grass (cultivated or pasture)	0.040	0.032	0.048
Light brush or shrubs	0.070	0.056	0.084
Trees with little undergrowth	0.080	0.064	0.096
Trees with dense undergrowth	0.100	0.080	0.12
Lake or ponded water	0.025	0.020	0.030
Residential development	0.040	0.032	0.048
Industrial development	0.040	0.032	0.048

Table 24 presents a summary of the results of the 100-year computed flood level sensitivity analysis for varying overbank roughness values. Water surface profiles for each case are presented in Table B-6 in

Appendix B and plotted on the Model Sensitivity Profiles – Sensitivity to Channel Roughness (Sheets 1 to 10) included in the Maps and Drawings section of this report.

Table 24 Sensitivity analysis results for overbank roughness

Reach	Reach Description	Difference from baseline profile (m)					
		Low Roughness (-20%)			High Roughness (+20%)		
		Max	Avg	Min	Min	Avg	Max
Bow River							
118 km to 96 km	highly braided reaches near Canmore	-0.16	-0.10	-0.04	0.03	0.09	0.15
110 km to 104 km	straight reach through Canmore	-0.16	-0.06	0.00	0.00	0.06	0.15
96 km to 87 km	backwater through Dead Man's Flats and Lac des Arcs	-0.09	-0.04	-0.01	0.01	0.04	0.08
87 km to 84 km	steep reach d/s of Exshaw	-0.25	-0.16	-0.02	0.02	0.15	0.23
84 km to 80 km	deep single channel reach	-0.16	-0.09	-0.04	0.05	0.08	0.13
80 km to 77 km	backwater reach from Kananaskis Dam	-0.02	-0.01	0.00	0.00	0.01	0.03
77 km to 74 km	backwater reach from Horseshoe Dam	0.00	0.00	0.00	0.00	0.00	0.01
74 km to 69 km	steep reach through Stoney FN	-0.06	-0.03	0.01	0.00	0.02	0.07
69 km to 57 km	less steep reach through Stoney FN	-0.12	-0.05	0.00	0.00	0.05	0.12
57 km to 42 km	Ghost Reservoir backwater reach	-0.01	0.00	0.00	-0.01	0.00	0.01
42 km to 8 km	steeper reach between Ghost and Bearspaw	-0.10	-0.04	0.00	0.00	0.03	0.08
8 km to 0 km	Bearspaw Reservoir backwater reach	-0.02	-0.01	0.00	0.00	0.00	0.01
Tributaries							
Exshaw Creek	entire reach	0.00	0.00	0.00	0.00	0.00	0.00
Jumpingpound Creek	entire reach	-0.17	-0.03	0.03	-0.03	0.02	0.09
Bighill Creek	entire reach	-0.10	-0.05	0.00	-0.09	0.04	0.09
Policeman Creek	entire reach	-0.05	-0.01	0.01	-0.01	0.01	0.05

On average, flood levels were 0 to 0.16 m below calibrated values for low overbank roughness. For high overbank roughness, computed flood levels were on average between 0 and 0.15 m above calibrated values. The largest deviations of 0.16 to 0.25 m from calibrated flood levels were found in the highly braided Bow River reaches near Canmore, in the Bow River reach downstream of Exshaw, and in Jumpingpound Creek.

6 CONCLUSIONS

The objectives of this study were to assess river flood-related hazards along 118 km of the Bow River (including Policeman Creek), 1 km of Exshaw Creek, 5 km of Bighill Creek, and 5 km of Jumpingpound Creek. The Upper Bow River Hazard Study was divided into eight major project components. This report summarizes the work of the Hydraulic Model Creation and Calibration component, for which a numerical model has been developed using the HEC-RAS computer program from the U.S. Army Corps of Engineers. River bathymetry and digital terrain data from the Survey and Base Data Collection component as well as flood frequency estimates developed by Golder (2017) were used to develop, calibrate, and apply the open water hydraulic model as described. The Survey and Base Data Collection report (NHC, 2017) should be read in conjunction with this report, as it provides additional pertinent background information.

Open water flooding has occurred on the Bow River and tributaries, most notably at the communities of Canmore, Exshaw, Morley, and Cochrane where the largest concentration of population and infrastructure exists within the study reach. Floods on the Bow River have historically caused direct overbank flooding in Canmore (prior to construction of the Canmore flood control dikes) and damage to railway and road embankments throughout the study area. Although the largest Bow River floods likely occurred in 1879 and 1897, the largest recorded flood event was the June 2013 flood. The severity of flooding varied throughout the study reach but generally, some tributaries (e.g. Exshaw Creek) experienced severe debris flows and damages, while on the Bow River, the severity of flooding and damages increased in a downstream direction. This event was adopted for model calibration due both to its high magnitude and the number of highwater mark observations available along the study reach to support model calibration. Difficulties with the model calibration arose from the limited availability of reliable 2013 peak flows in the highly regulated system. Other flood events (2012, 2005, 1990, 1986) were relied upon for additional model calibration and validation. Results of the calibration and validation show that the open water hydraulic model computes water levels that agree with the observed highwater marks, with the average difference between modelled and observed water levels being approximately 0.2 m.

Water surface profiles were prepared for the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1000-year open water flood frequency return period discharges on the Bow River, as well as Policeman, Exshaw, Jumpingpound, and Bighill creeks. The crest of the flood control dikes in Canmore are generally 0.15 to 0.5 m above the 100-year open water flood level and would be expected to start overtopping at multiple locations at the 200-year to 350-year flood events. The exception to this is the lower 1.1 km of the Canmore Town Dike near the Canmore WWTP, where the dike is overtopped between a 35 and 75-year flood event. Also, a short reach of the Canmore Town Dike, upstream of the Engine Bridge, has a lower crest elevation which results in flooding of parkland at a 2-year to 5-year flood; however, houses located north of the park are on higher ground and would not be affected until a 50-year event.

The short Jumpingpound Creek flood control dike in Cochrane is generally 0.1 m below the 100-year open water flood level and would be expected to be overtopped at the 100-year flood event.

The sensitivity of simulated water levels to various model parameters was also investigated. Reservoir water levels were shown to influence upstream water levels over a distance ranging from 2 to 15 km. The overbank roughness were shown to have a smaller effect on predicted 100-year flood levels than the channel roughness within a range of plausible values. The average difference from baseline on the Bow River and all tributaries was ±0.14 m when channel roughness coefficients were raised or lowered by 15% and ± 0.04 m when overbank roughness values were raised or lowered by 20%.

Based on the available data, calibration results, and sensitivity analysis, the open water HEC-RAS hydraulic model produces representative water levels throughout the study reach for a wide range of discharges. Results have also been shown to be consistent with the available WSC and TransAlta rating curves on the Bow River. The model includes all pertinent physical features, flood control structures, and the most up-to-date bathymetry and terrain data presently available. As such, the calibrated HEC-RAS model is considered appropriate for use in the subsequent open water inundation mapping and flood hazard identification components of this Upper Bow River Hazard Study.

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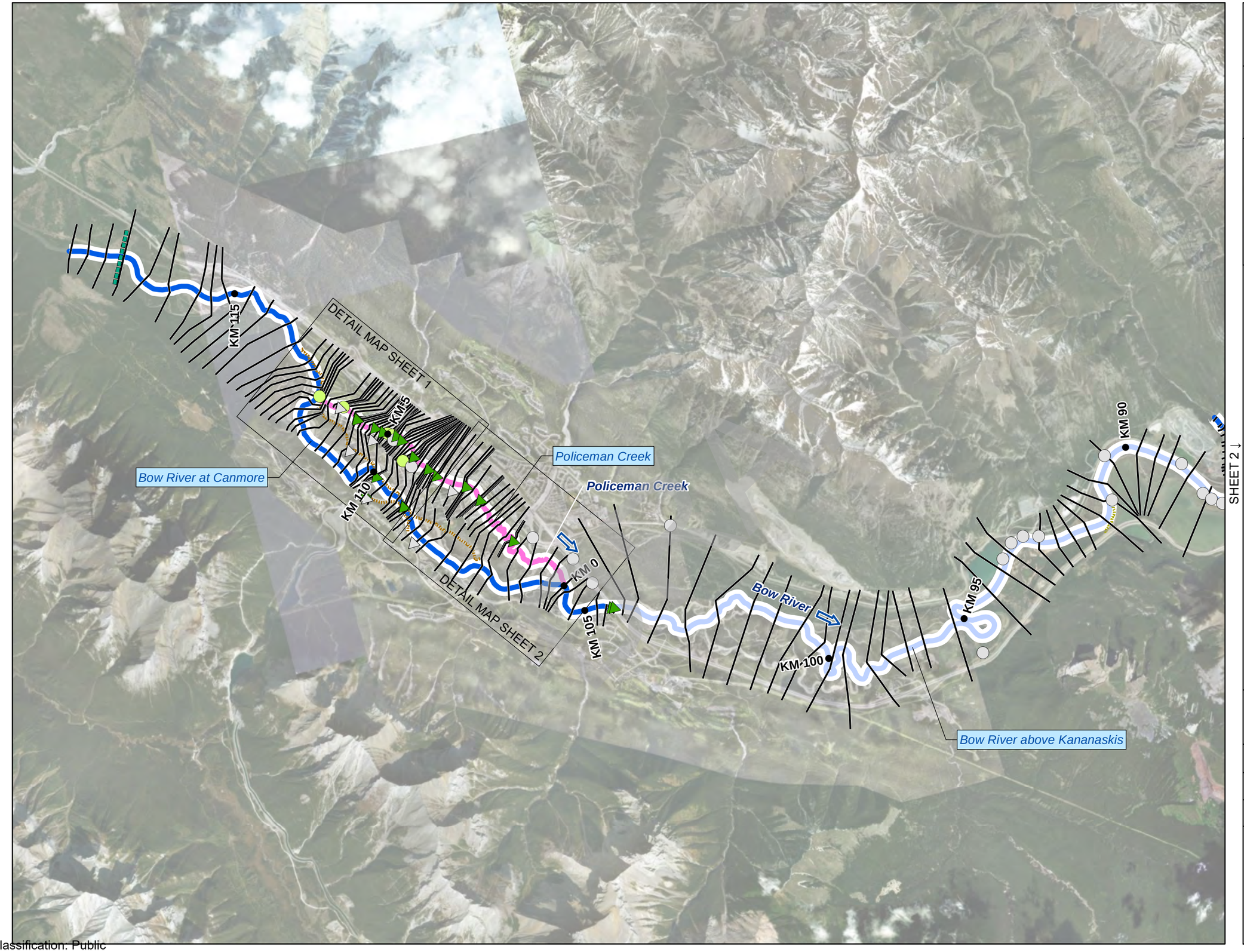
MAPS AND DRAWINGS



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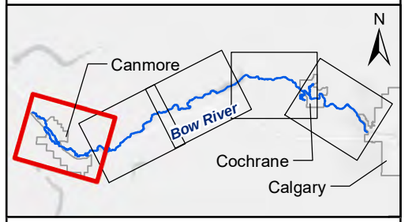

- FLOOD CONTROL STRUCTURE
- OTHER FEATURE
- DAM
- MODELLED BRIDGE
- OTHER BRIDGE
- MODELLED CULVERT
- OTHER CULVERT
- CROSS SECTION

Flow Zone
- MODEL STREAM NETWORK (BY FLOW ZONE)
- STUDY LIMIT
- DETAIL MAP EXTENTS

DATA SOURCES: Orthoimagery from Esri.

SCALE - 1:60,000

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Coordinate System: NAD 1983 CSRS 3TM 114
Units: METRES

Engineer	GIS	Reviewer
VFOC	MSN	MCM

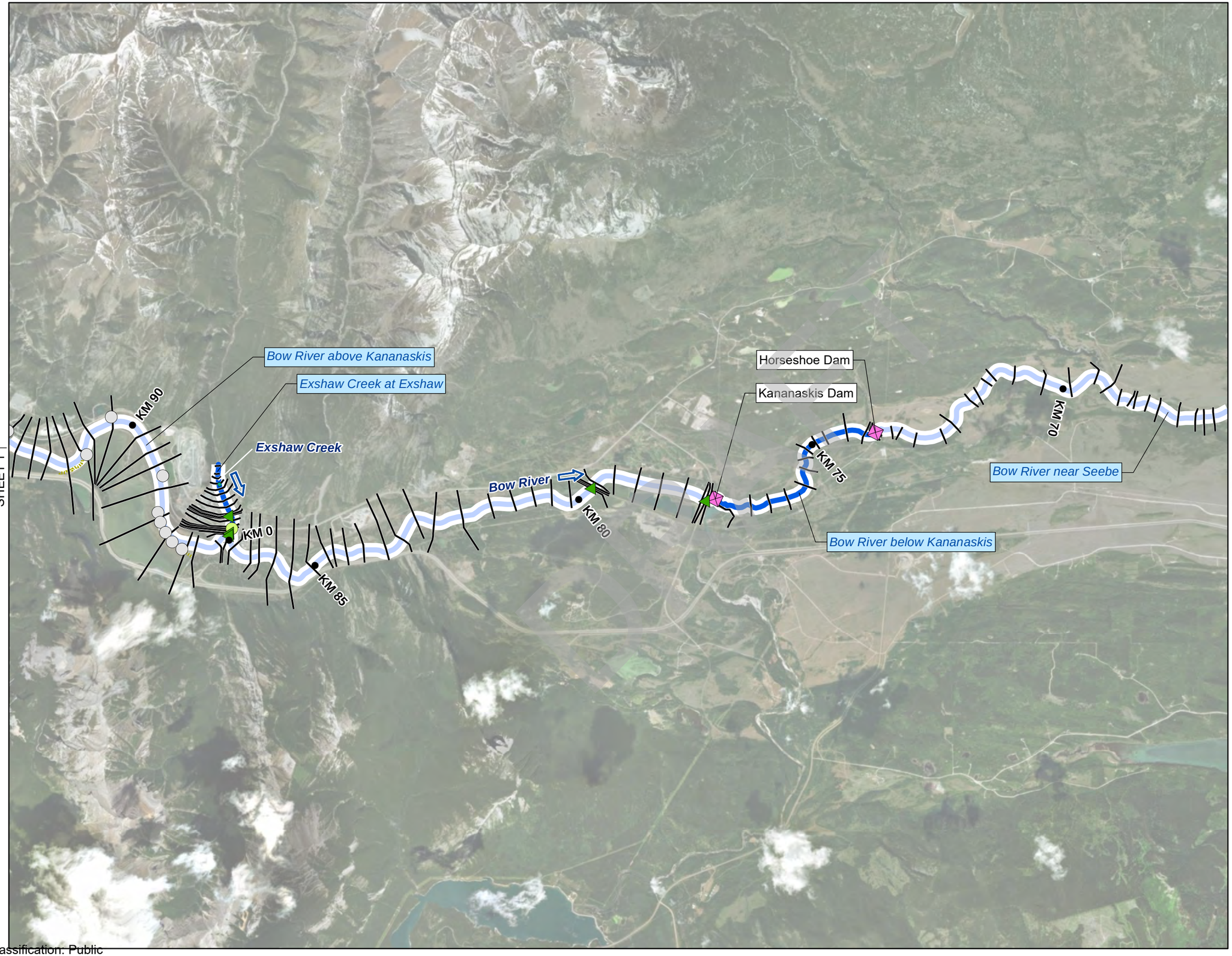
Job Number	Date
3001178	23-JAN-2018

UPPER BOW RIVER HAZARD STUDY

MODEL OVERVIEW

SHEET 1 OF 5

MSN, \\mainille-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\9D GIS\3001178_MSN_Fig_T2_ModelOverview3.mxd



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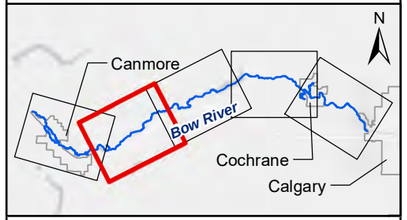

- FLOOD CONTROL STRUCTURE
- OTHER FEATURE
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- MODELLED BRIDGE
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- MODELLED CULVERT
- OTHER CULVERT
- CROSS SECTION
- *Flow Zone*
- MODEL STREAM NETWORK (BY FLOW ZONE)
- STUDY LIMIT
- DETAIL MAP EXTENTS

DATA SOURCES: Orthoimagery from Esri.

SCALE - 1:60,000

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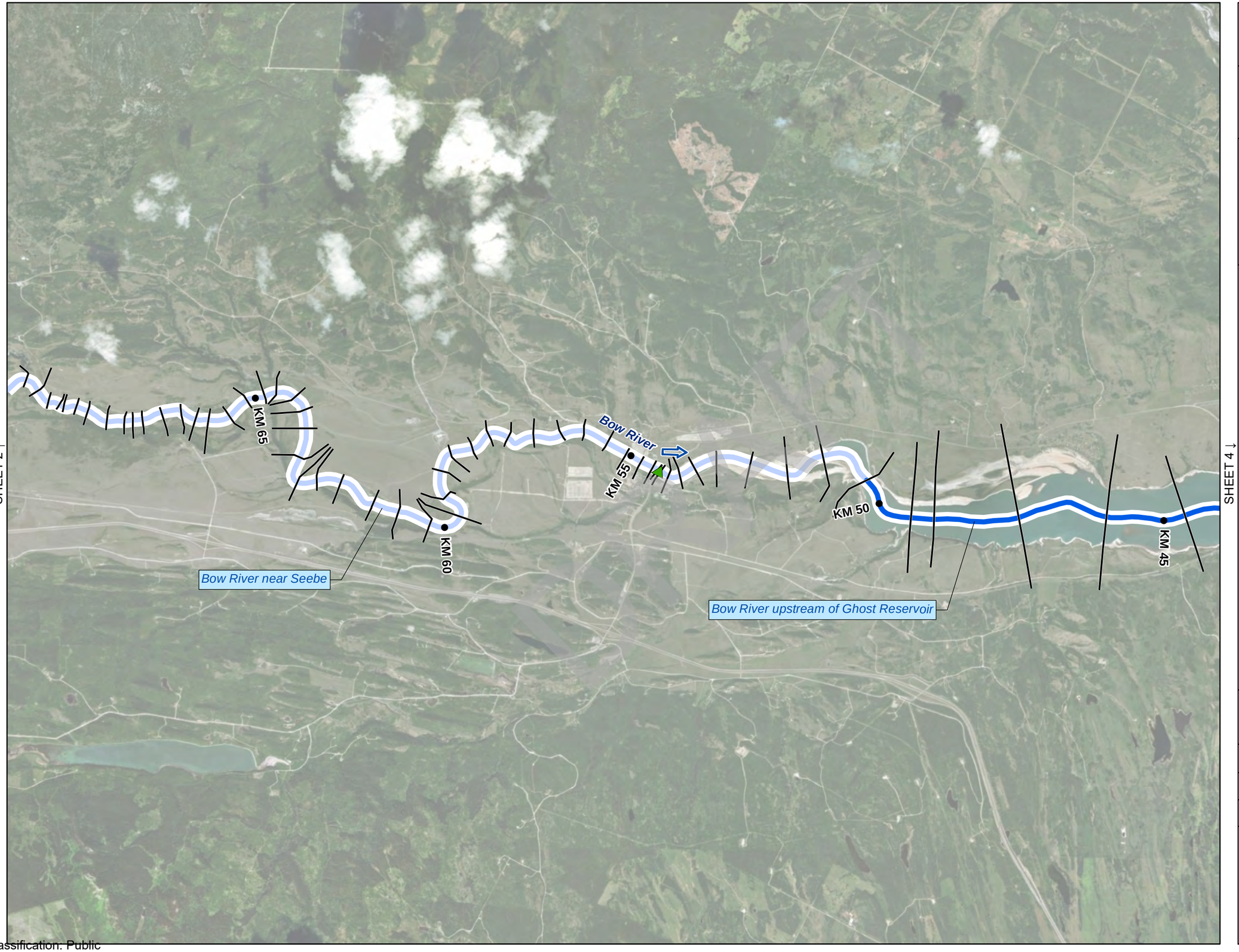
3001178	23-JAN-2018

UPPER BOW RIVER HAZARD STUDY

MODEL OVERVIEW

SHEET 2 OF 5

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelOverview3.mxd



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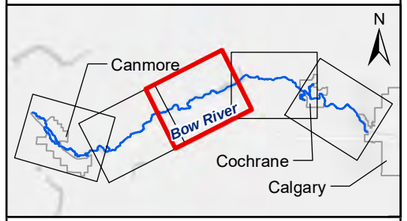

- FLOOD CONTROL STRUCTURE
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UPPER BOW RIVER HAZARD STUDY

MODEL OVERVIEW

SHEET 3 OF 5

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\9D GIS\3001178_MSN_Fig_T2_ModelOverview3.mxd

Ghost Dam

KM 40

KM 35

Bow River

KM 30

KM 45

SHEET 3 ↑

Bow River upstream of Ghost Reservoir

Bow River downstream of Ghost Reservoir

Bighill Creek at Cochrane

Bighill Creek

KM 5

KM 25

KM 0

DETAIL MAP SHEET 3

DETAIL MAP SHEET 4

KM 0

KM 5

Jumpingpound Creek at Cochrane

Jumpingpound Creek

Bow River between Bighill and Jumpingpound Creeks

Bow River at Cochrane

SHEET 5 ↓

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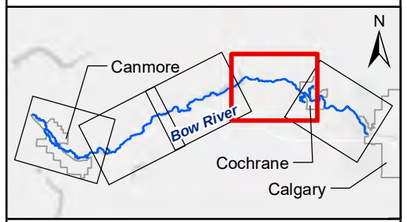

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- STUDY LIMIT
- DETAIL MAP EXTENTS

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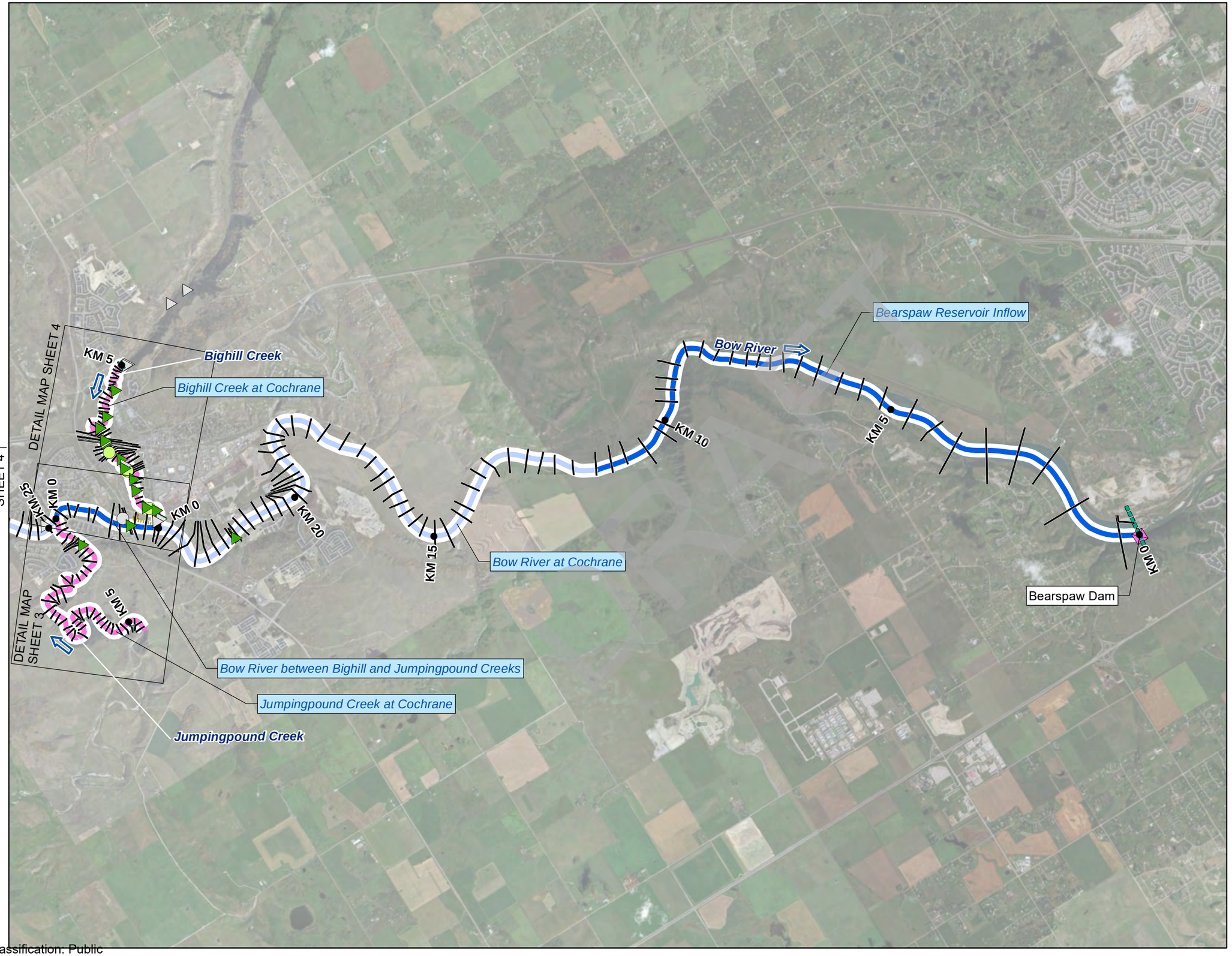
UPPER BOW RIVER HAZARD STUDY

MODEL OVERVIEW

SHEET 4 OF 5

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelOverview3.mxd



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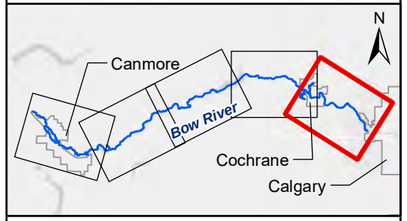

- FLOOD CONTROL STRUCTURE
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- OTHER BRIDGE
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- DETAIL MAP EXTENTS

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UPPER BOW RIVER HAZARD STUDY

MODEL OVERVIEW

SHEET 5 OF 5

MSN, \\mainille-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelOverview3.mxd

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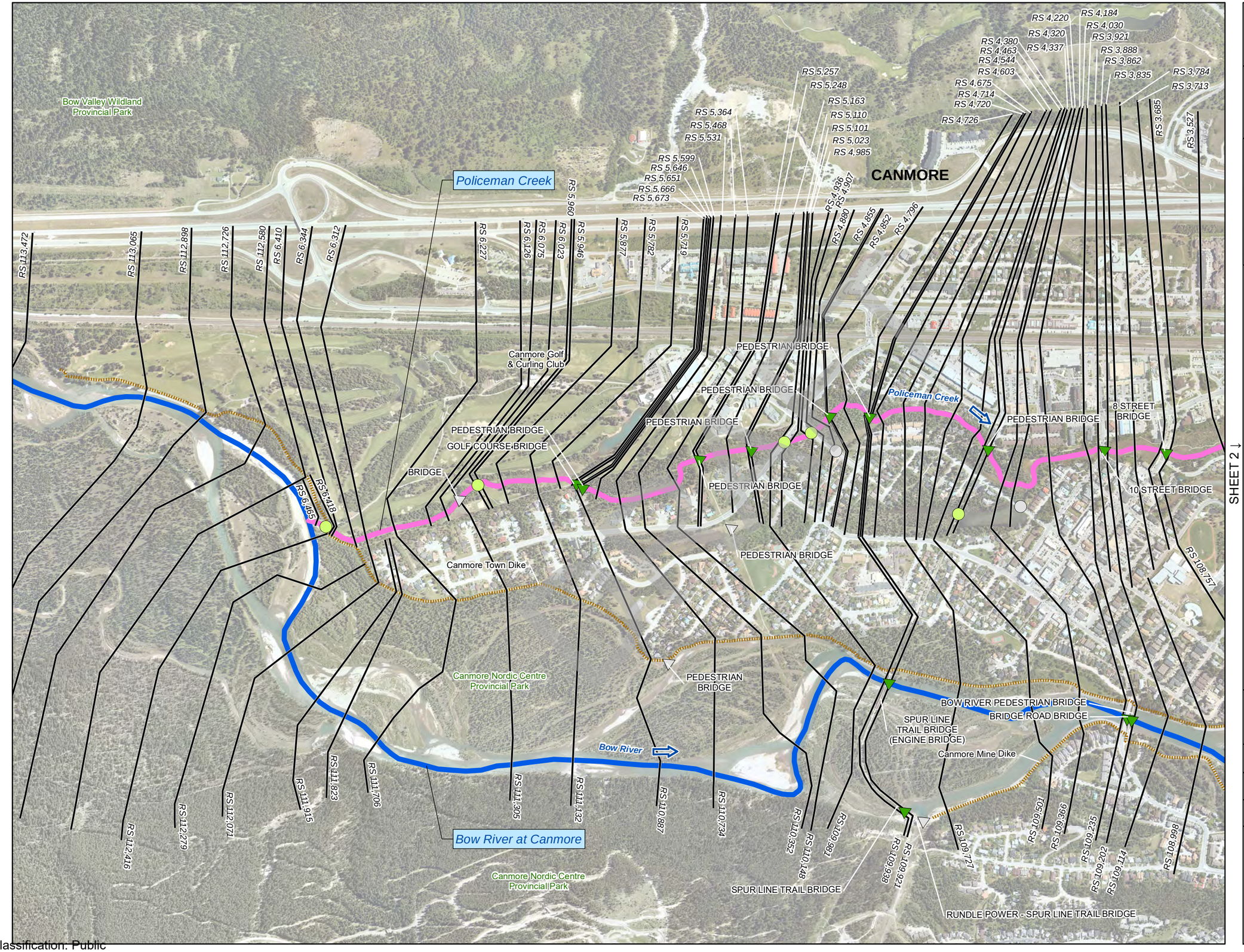

SHEET 2 ↓

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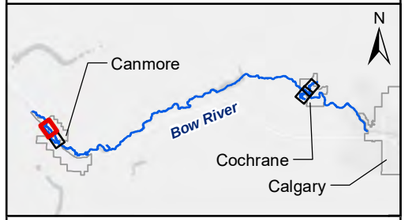


- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- OTHER FEATURE
- MODELLED BRIDGE
- OTHER BRIDGE
- MODELLED CULVERT
- OTHER CULVERT

Flow Zone
MODEL STREAM NETWORK (BY FLOW ZONE)
STUDY LIMIT

DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

SCALE - 1:10,000

0 200 400 M

Coordinate System: NAD 1983 CSRS 3TM 114
Units: METRES

Engineer	GIS	Reviewer
VFOC	MSN	MCM

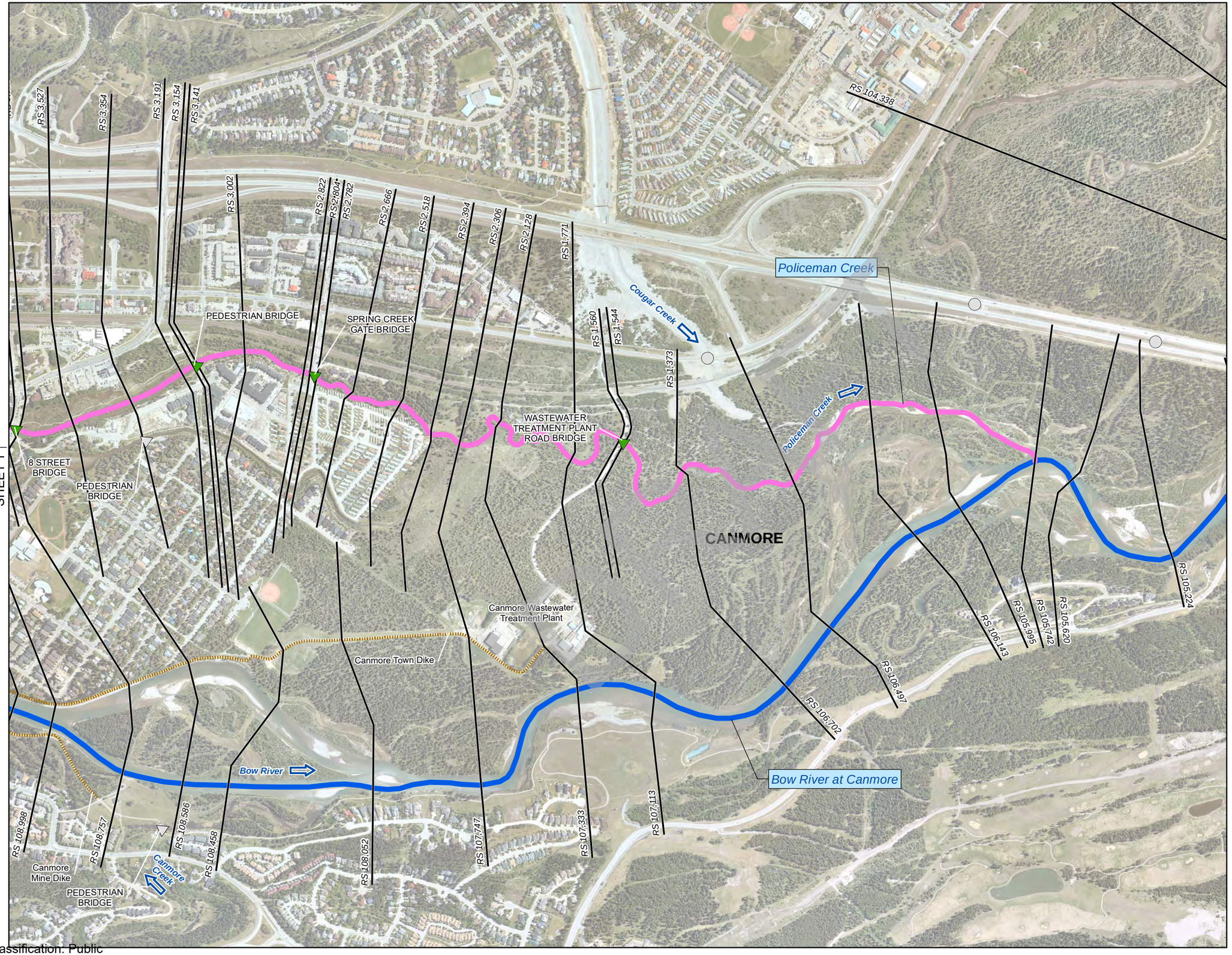
Job Number	Date
3001178	29-JAN-2018

UPPER BOW RIVER HAZARD STUDY

MODEL DETAIL

SHEET 1 OF 4

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelDetail2.mxd



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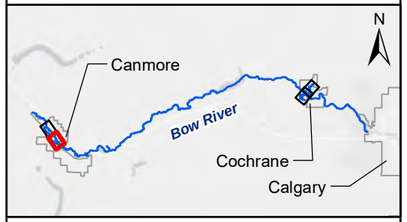

- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- OTHER FEATURE
- MODELLED BRIDGE
- OTHER BRIDGE
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Flow Zone
MODEL STREAM NETWORK (BY FLOW ZONE)
STUDY LIMIT

DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

SCALE - 1:10,000

0 200 400 M

Coordinate System: NAD 1983 CSRS 3TM 114
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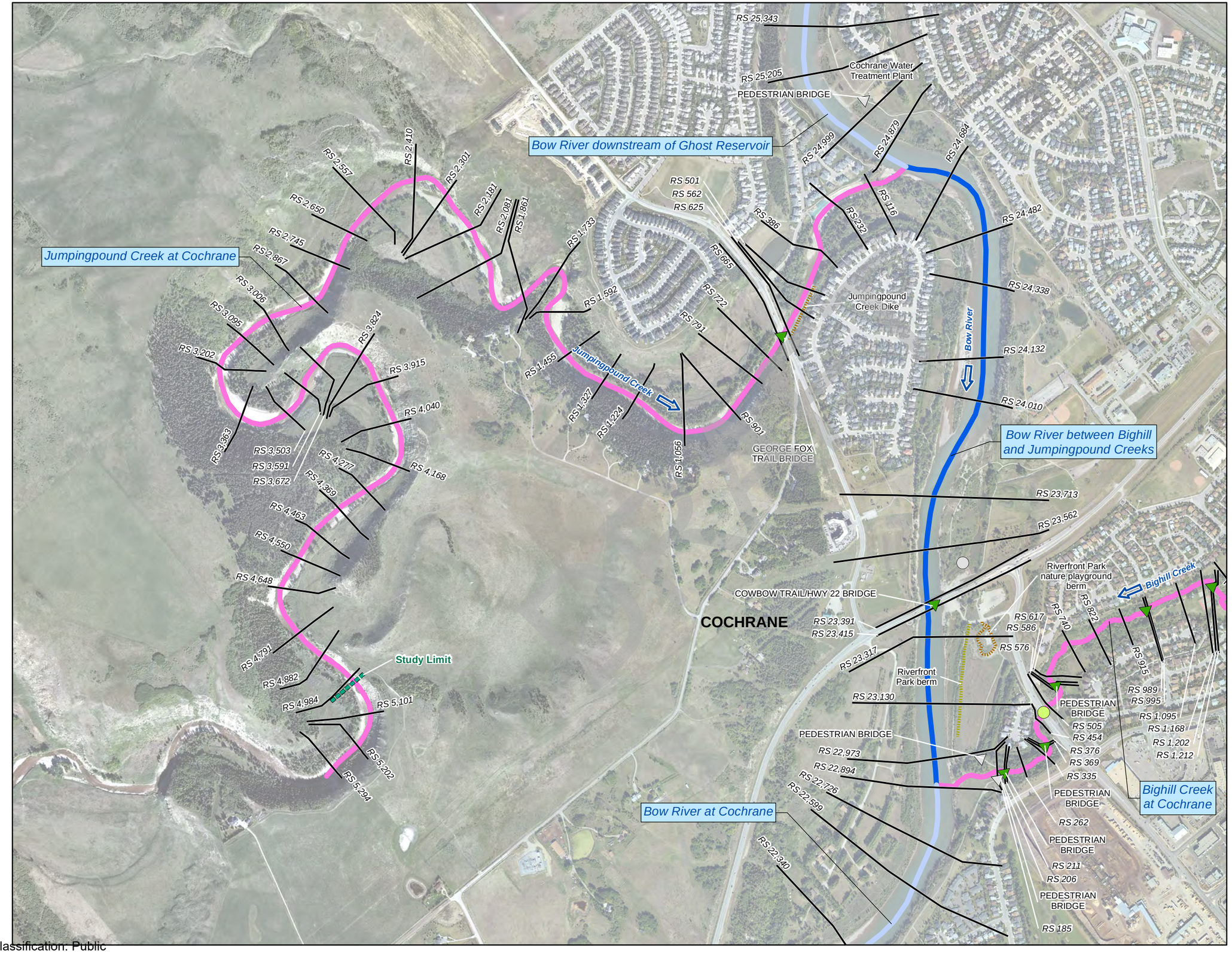
UPPER BOW RIVER HAZARD STUDY

MODEL DETAIL

SHEET 2 OF 4

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelDetail2.mxd



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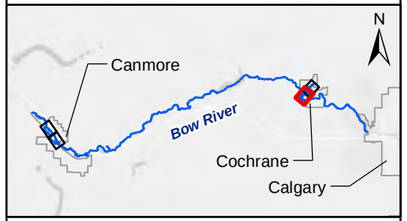

- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- OTHER FEATURE
- MODELLED BRIDGE
- OTHER BRIDGE
- MODELLED CULVERT
- OTHER CULVERT

Flow Zone
MODEL STREAM NETWORK (BY FLOW ZONE)
STUDY LIMIT

DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

SCALE - 1:10,000

0 200 400 M

Coordinate System: NAD 1983 CSRS 3TM 114
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Engineer	GIS	Reviewer
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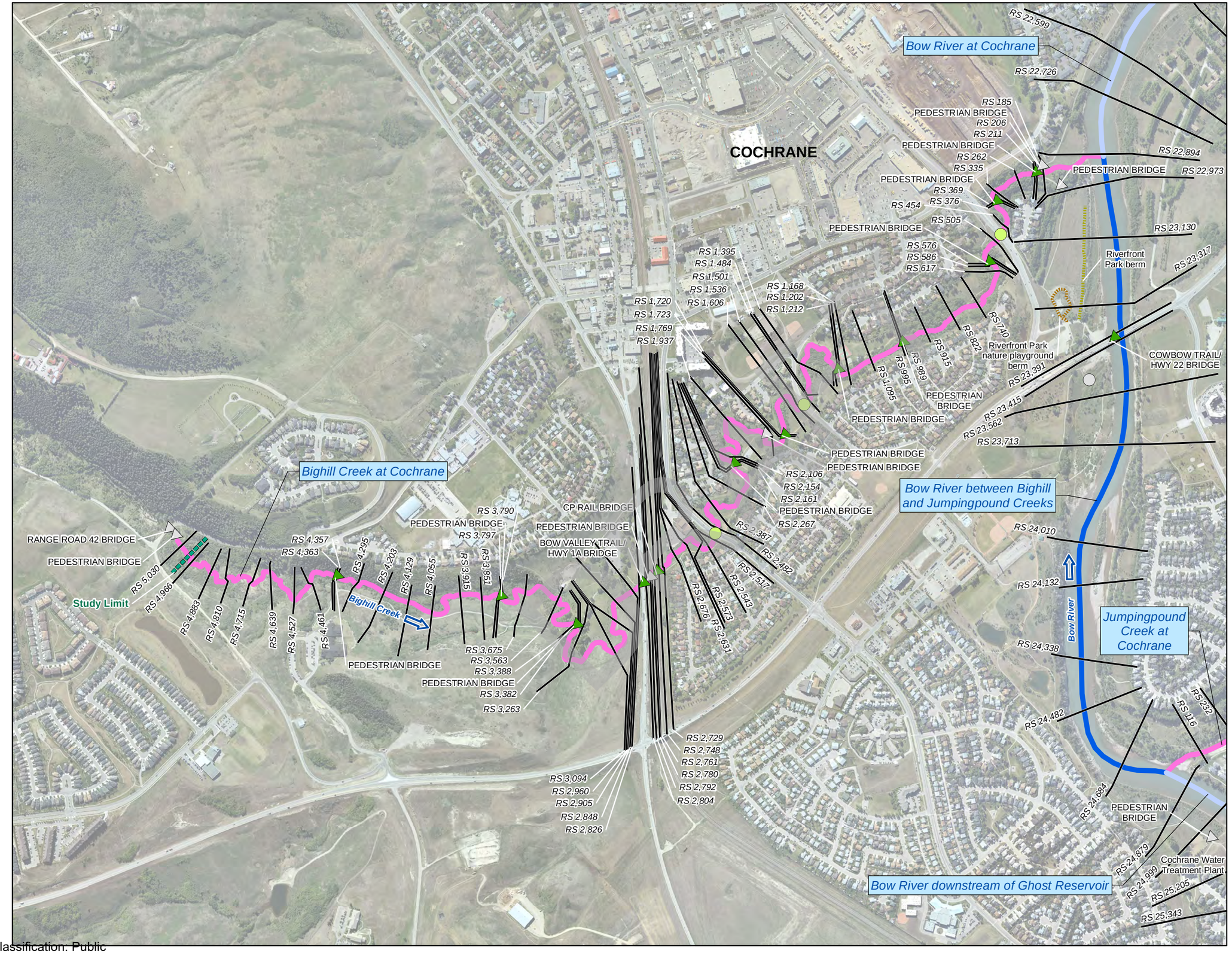
3001178	29-JAN-2018

UPPER BOW RIVER HAZARD STUDY

MODEL DETAIL

SHEET 3 OF 4

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelDetail2.mxd



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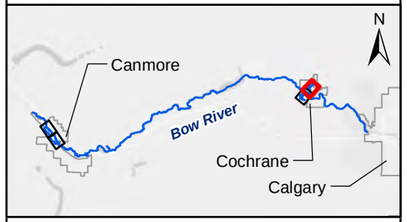

- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- OTHER FEATURE
- MODELLED BRIDGE
- OTHER BRIDGE
- MODELLED CULVERT
- OTHER CULVERT

Flow Zone
- MODEL STREAM NETWORK (BY FLOW ZONE)
- STUDY LIMIT

DATA SOURCES: 2016 orthoimagery from AEP, supplemented by orthoimagery from Esri.

SCALE - 1:10,000

0 200 400 M

Coordinate System: NAD 1983 CSRS 3TM 114
Units: METRES

Engineer	GIS	Reviewer
VFOC	MSN	MCM

Job Number	Date
3001178	29-JAN-2018

UPPER BOW RIVER HAZARD STUDY

MODEL DETAIL

SHEET 4 OF 4

MSN, \\mainfile-van\Projects\Active\3001178 Upper Bow River Flood Hazard Study\90 GIS\3001178_MSN_Fig_T2_ModelDetail2.mxd

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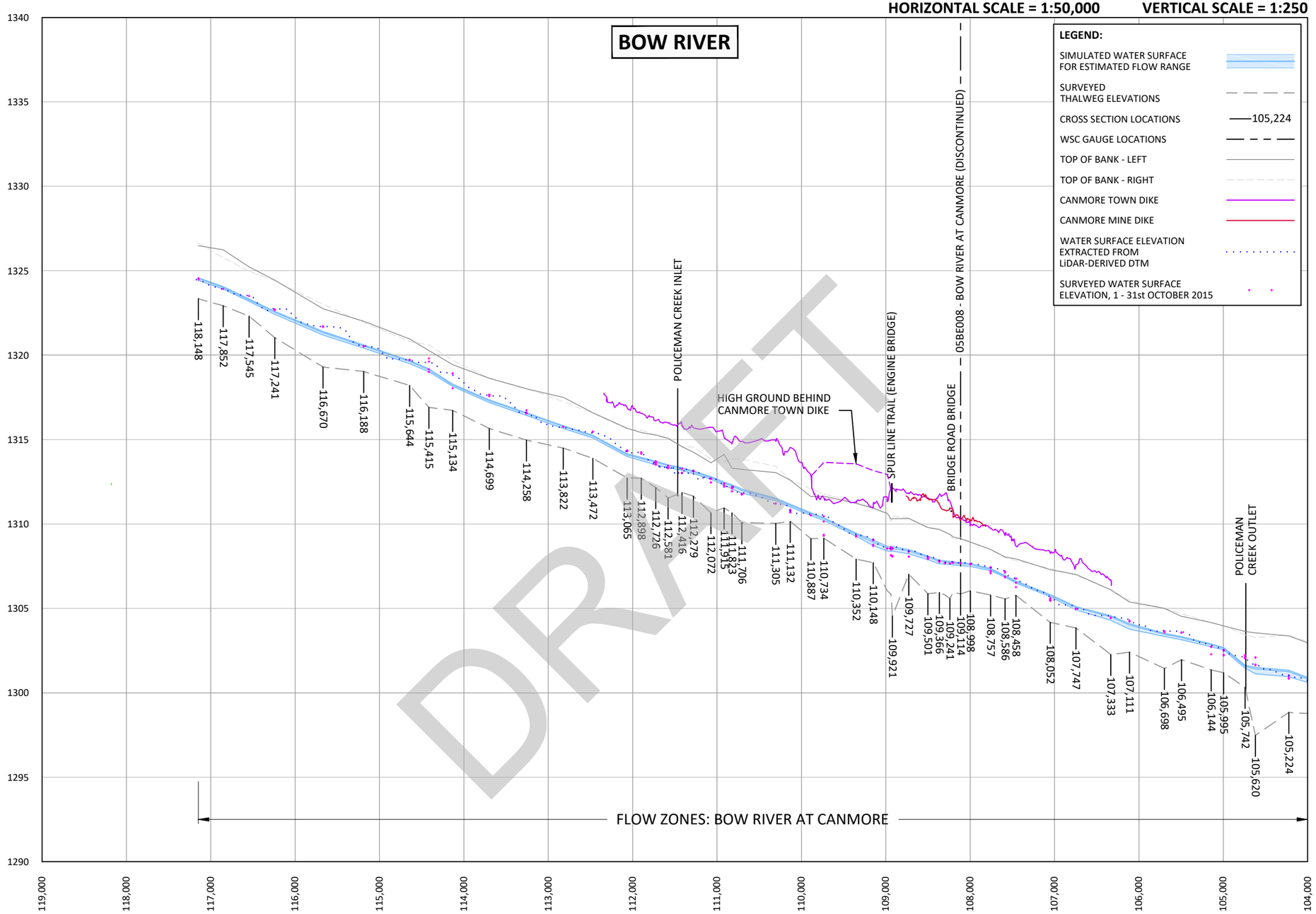

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NOTES:

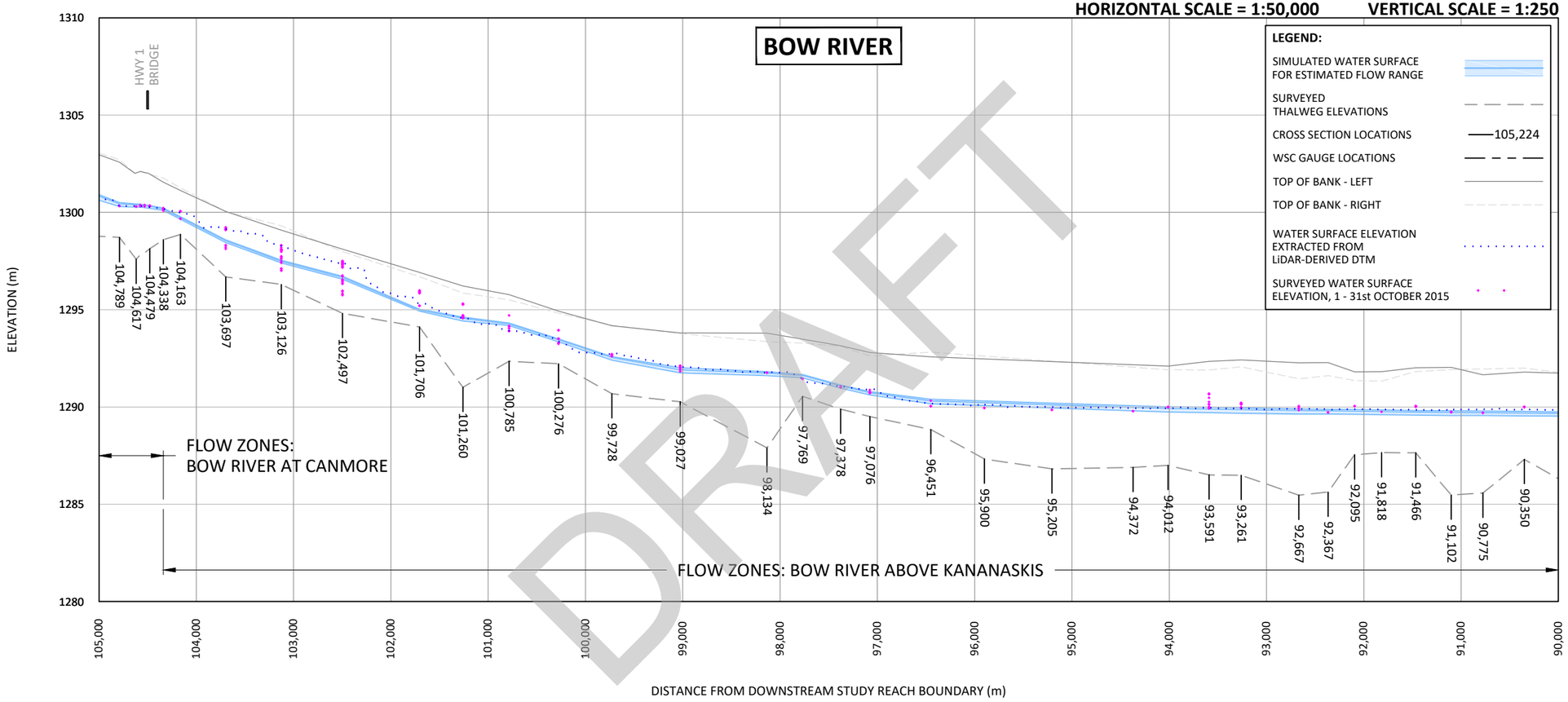
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-601
SHEET NUMBER	1 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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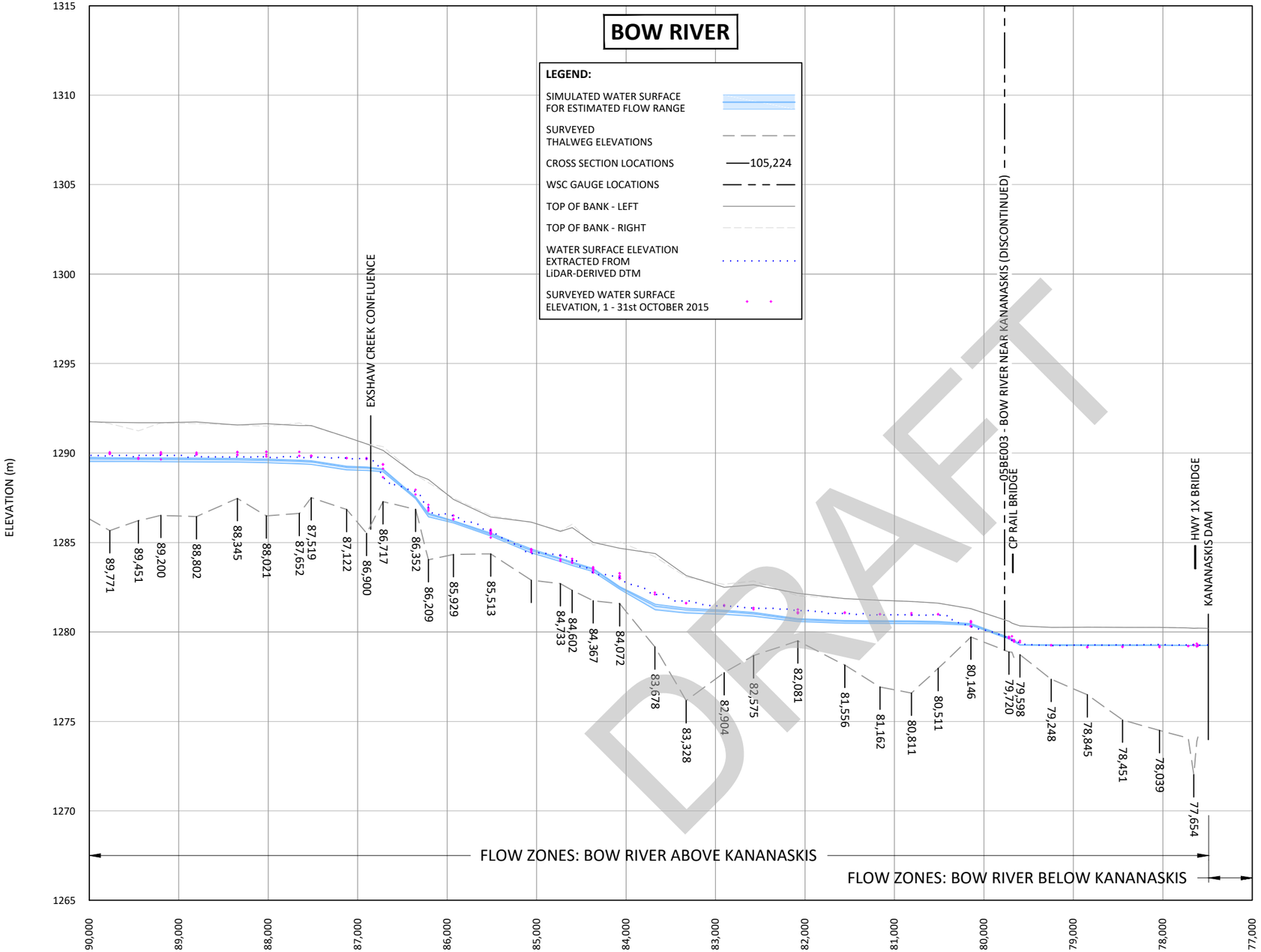
UPPER BOW RIVER HAZARD STUDY

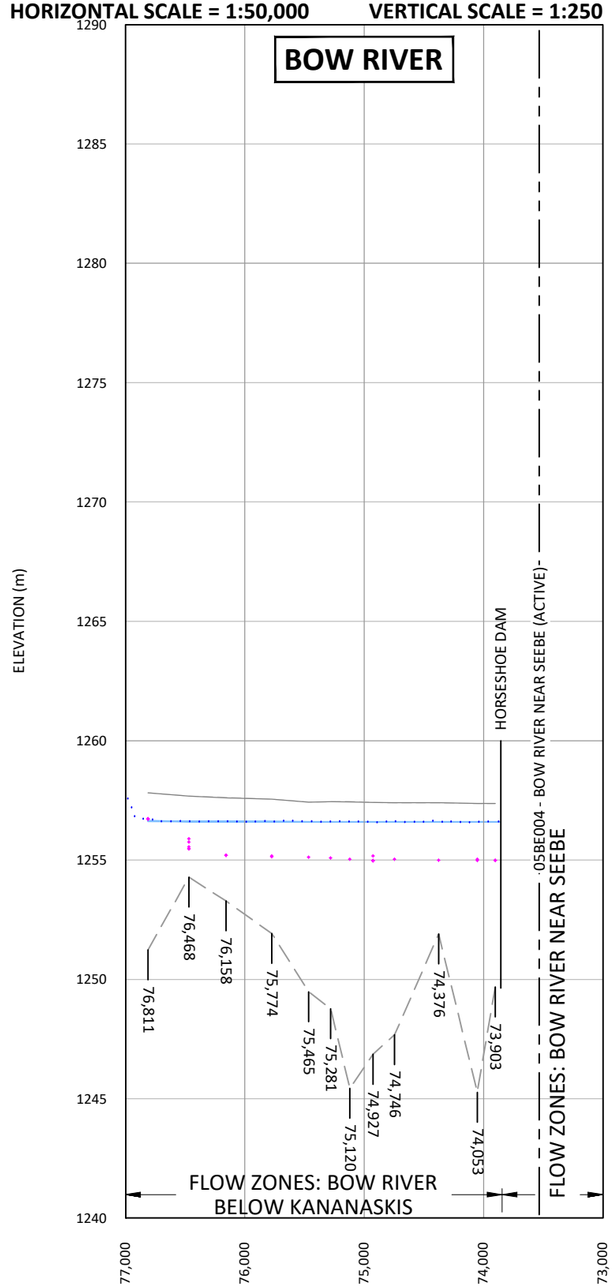
WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-602
SHEET NUMBER	2 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER





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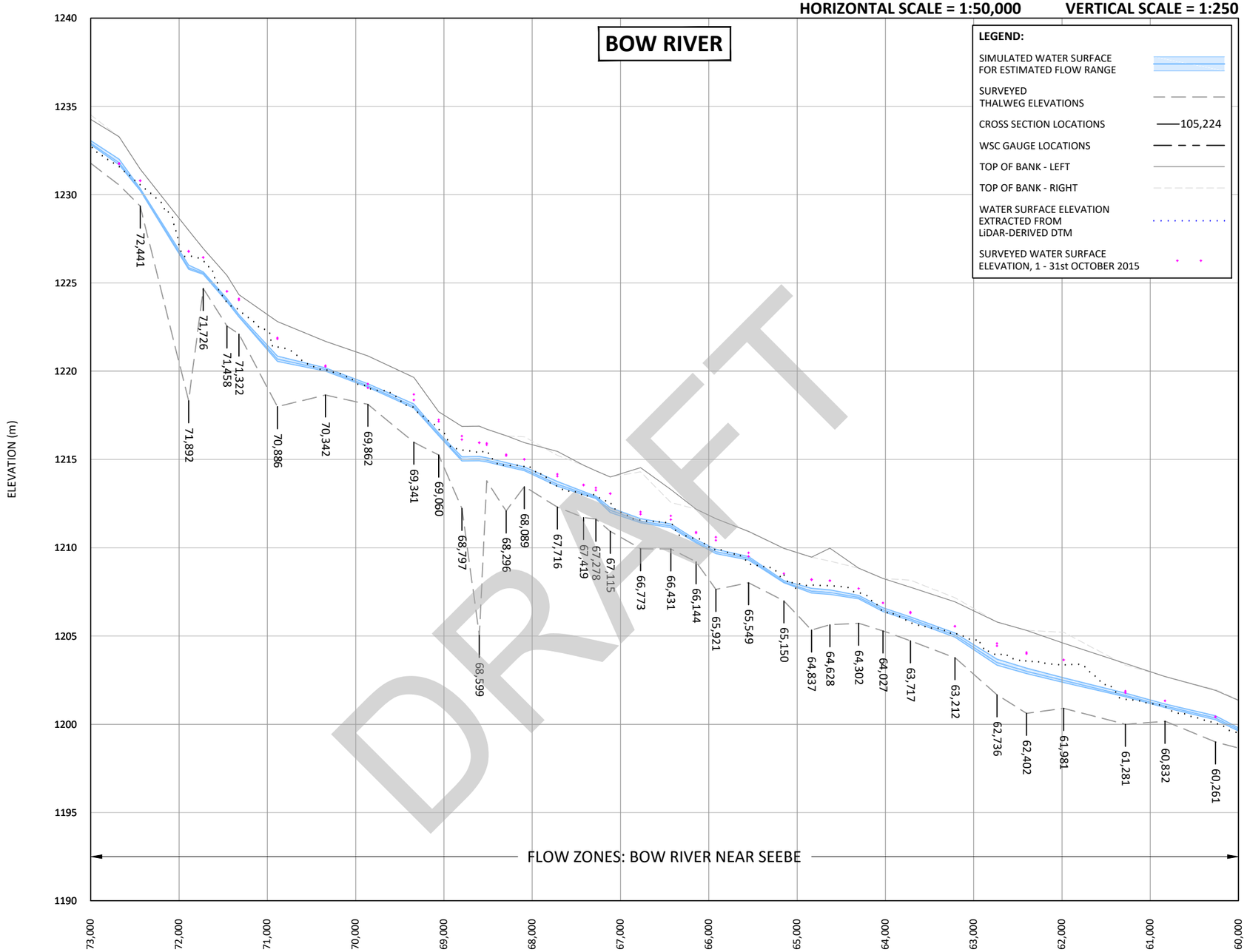
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-603
SHEET NUMBER	3 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

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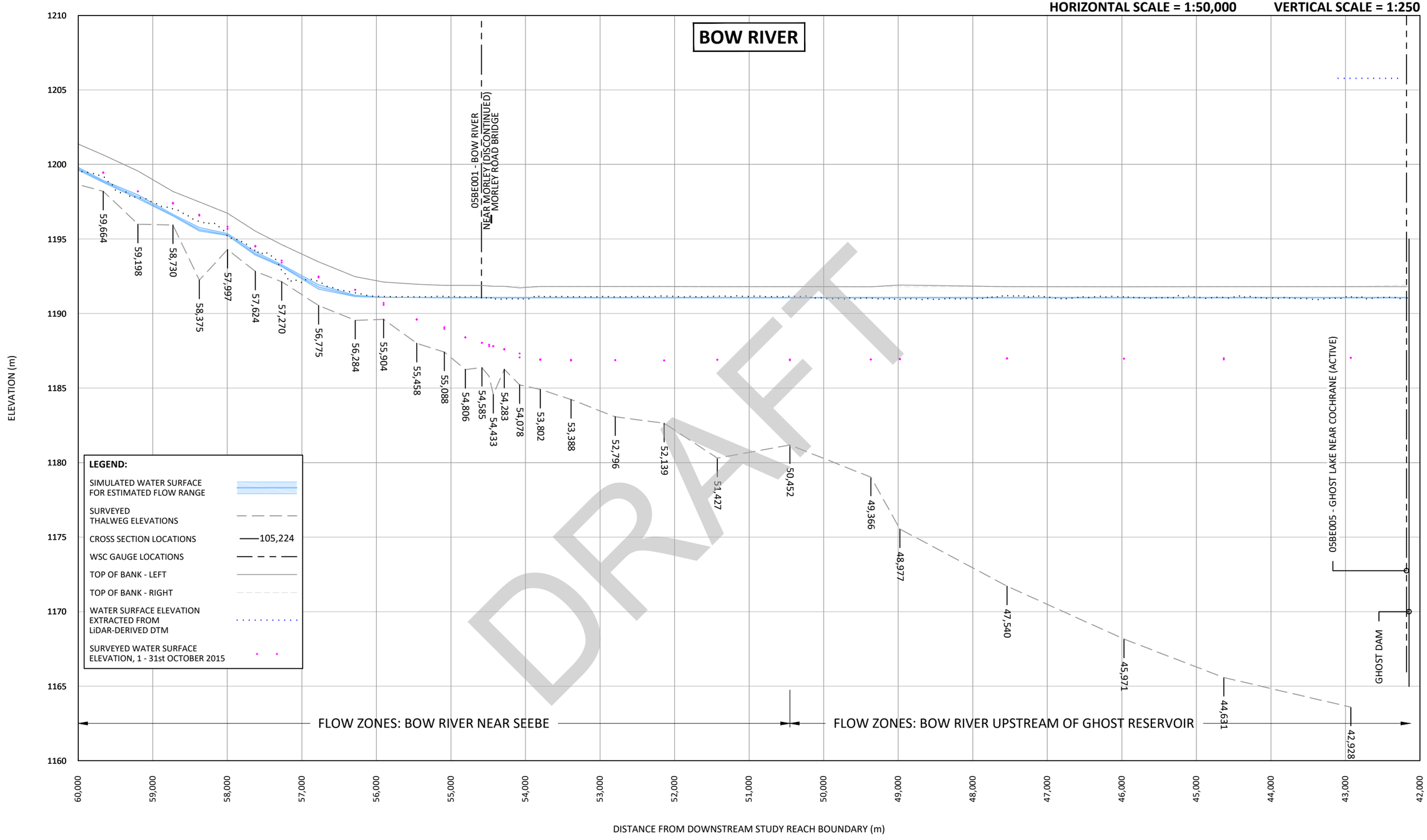
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-604
SHEET NUMBER	4 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER



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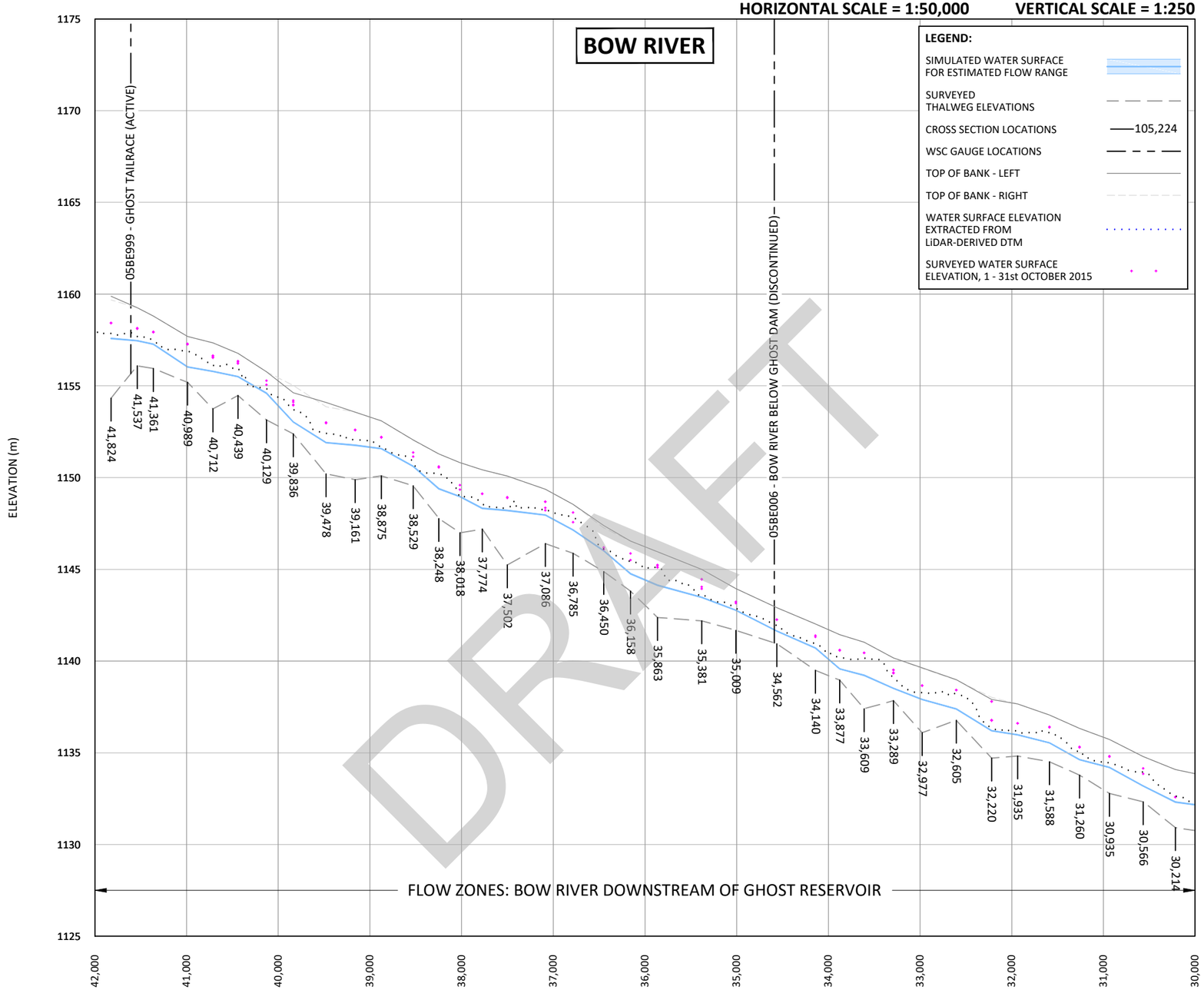
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-605
SHEET NUMBER	5 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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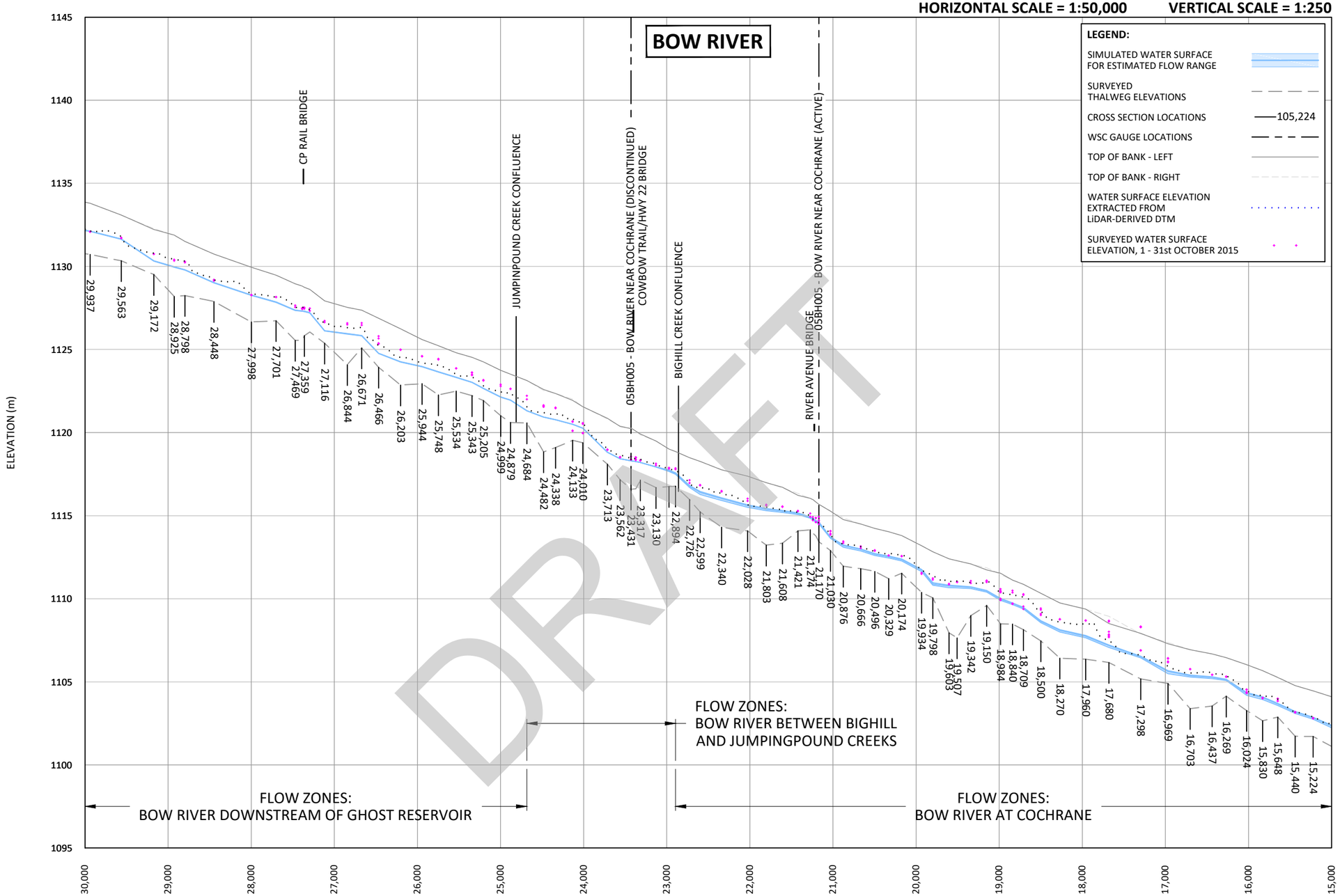
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-606
SHEET NUMBER	6 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

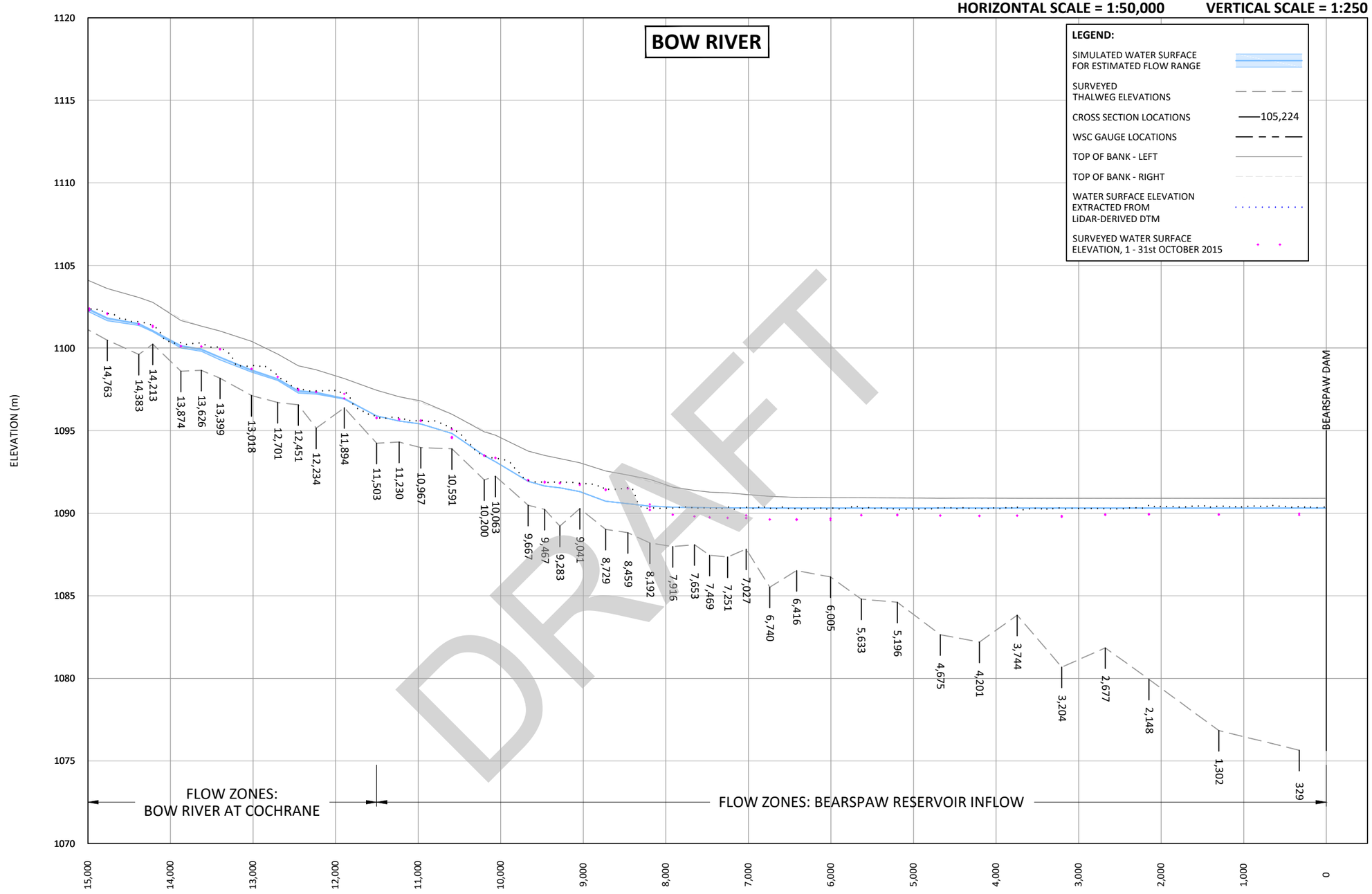
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-607
SHEET NUMBER	7 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

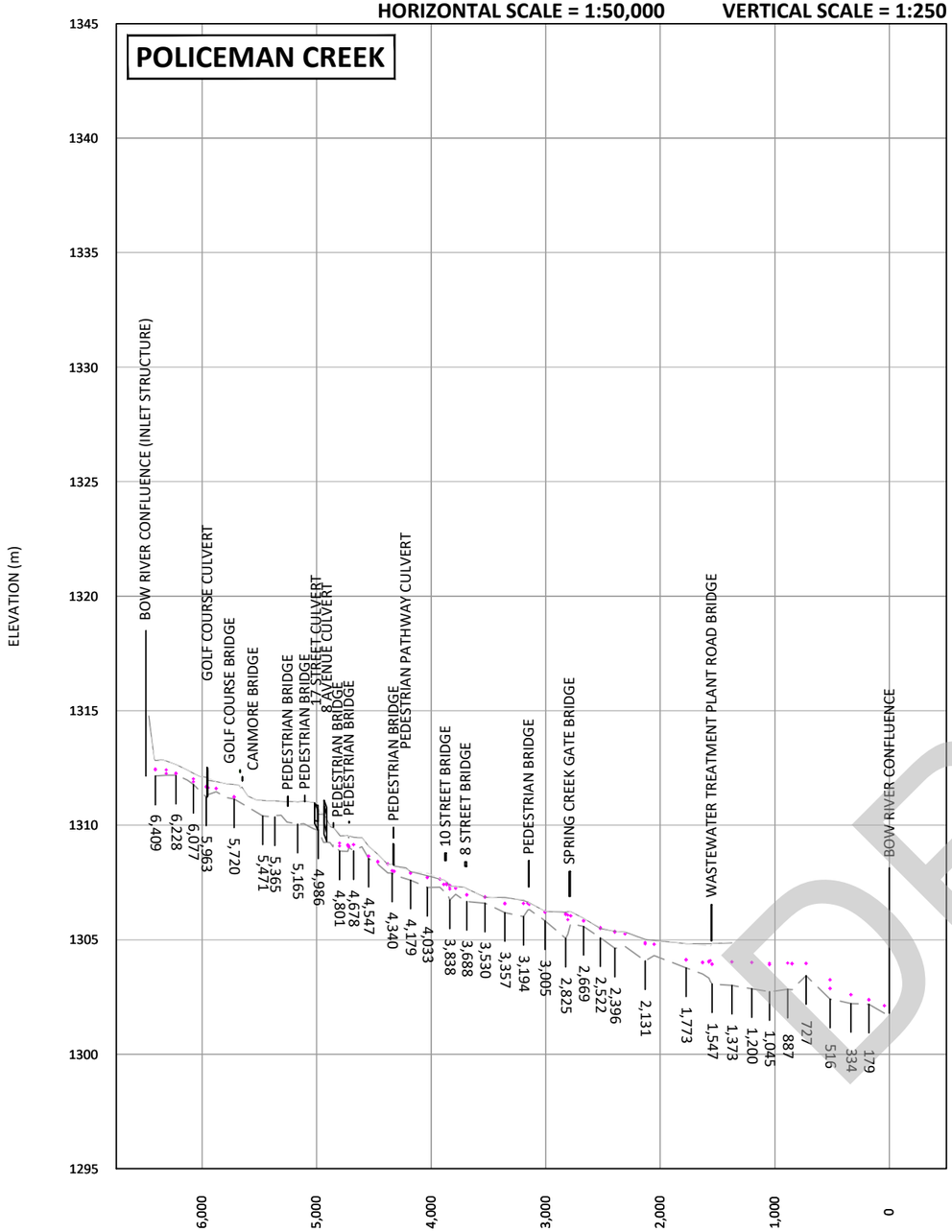
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-608
SHEET NUMBER	8 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

POLICEMAN CREEK

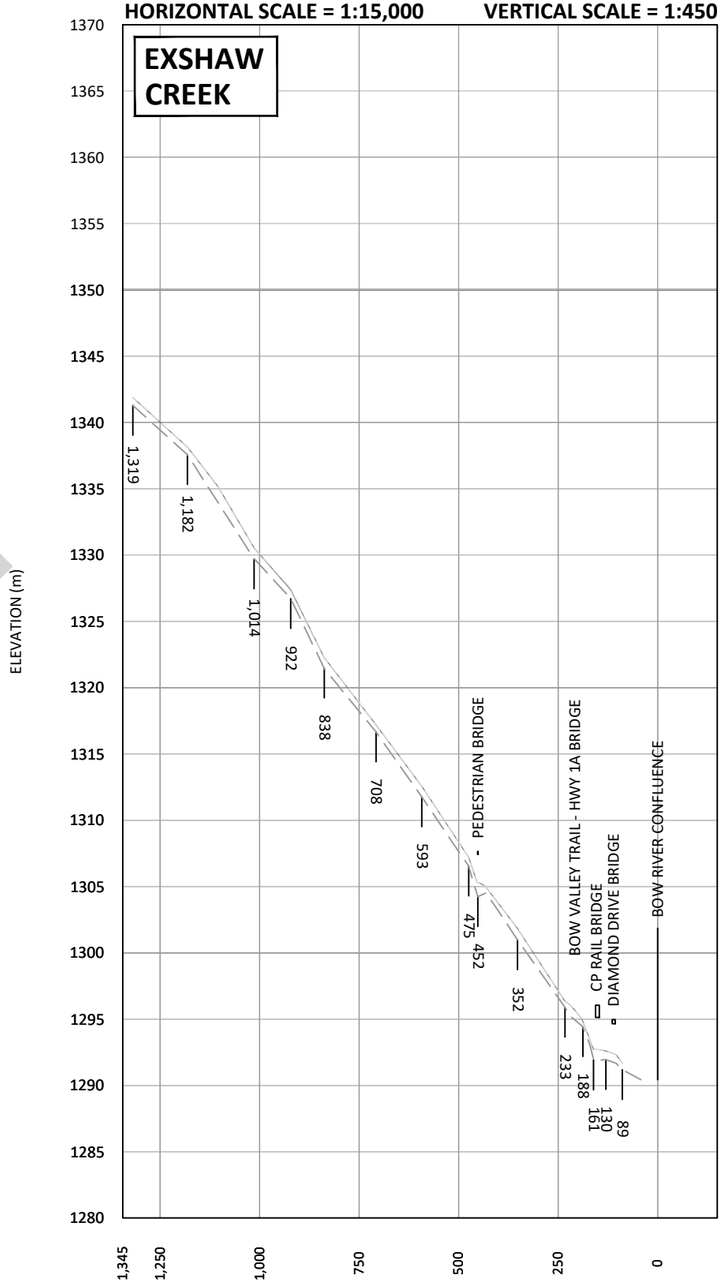


LEGEND:

- SIMULATED WATER SURFACE FOR ESTIMATED FLOW RANGE
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT
- WATER SURFACE ELEVATION EXTRACTED FROM LiDAR-DERIVED DTM
- SURVEYED WATER SURFACE ELEVATION, 1 - 31st OCTOBER 2015

HORIZONTAL SCALE = 1:15,000 VERTICAL SCALE = 1:450

EXSHAW CREEK



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

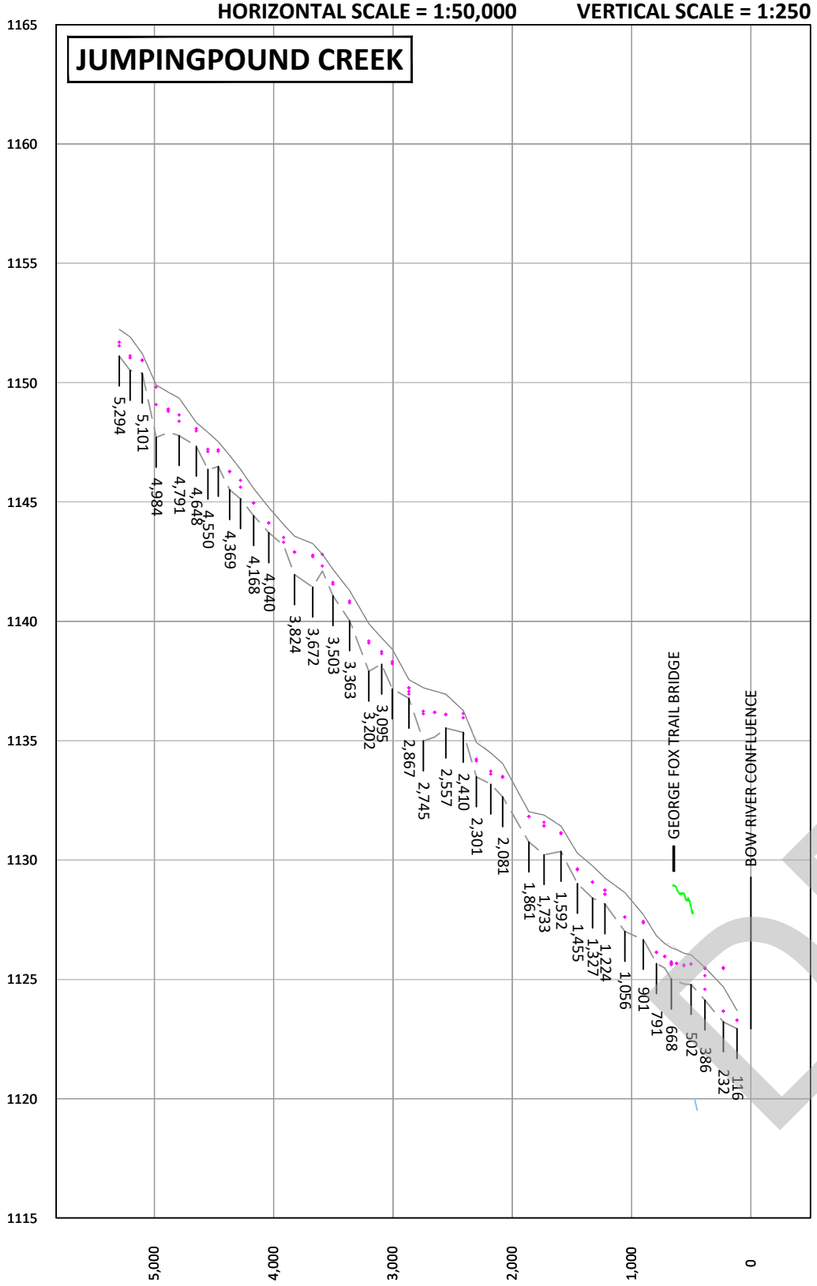
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-609
SHEET NUMBER	9 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

JUMPINGPOUND CREEK

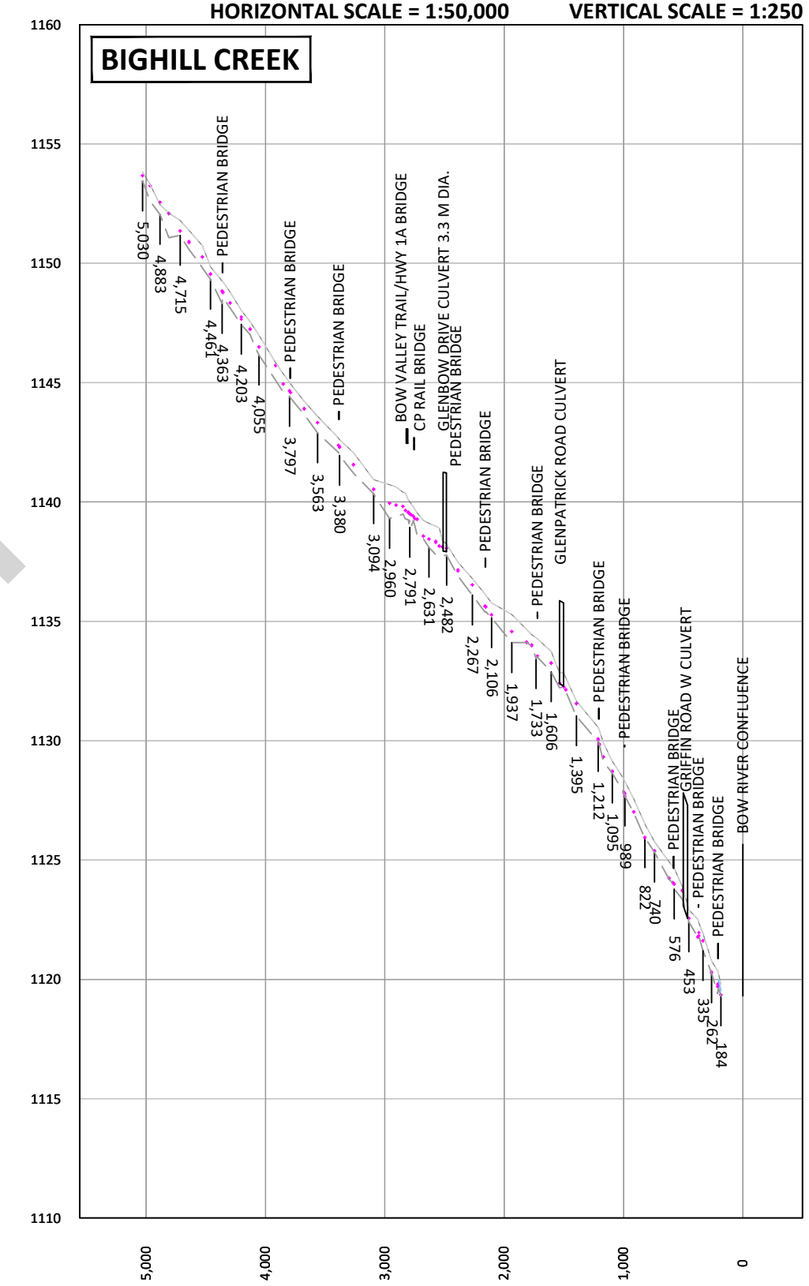


LEGEND:

- SIMULATED WATER SURFACE FOR ESTIMATED FLOW RANGE
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT
- JUMPINGPOUND DIKE
- WATER SURFACE ELEVATION EXTRACTED FROM LiDAR-DERIVED DTM
- SURVEYED WATER SURFACE ELEVATION, 1 - 31st OCTOBER 2015

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BIGHILL CREEK



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NOTES:

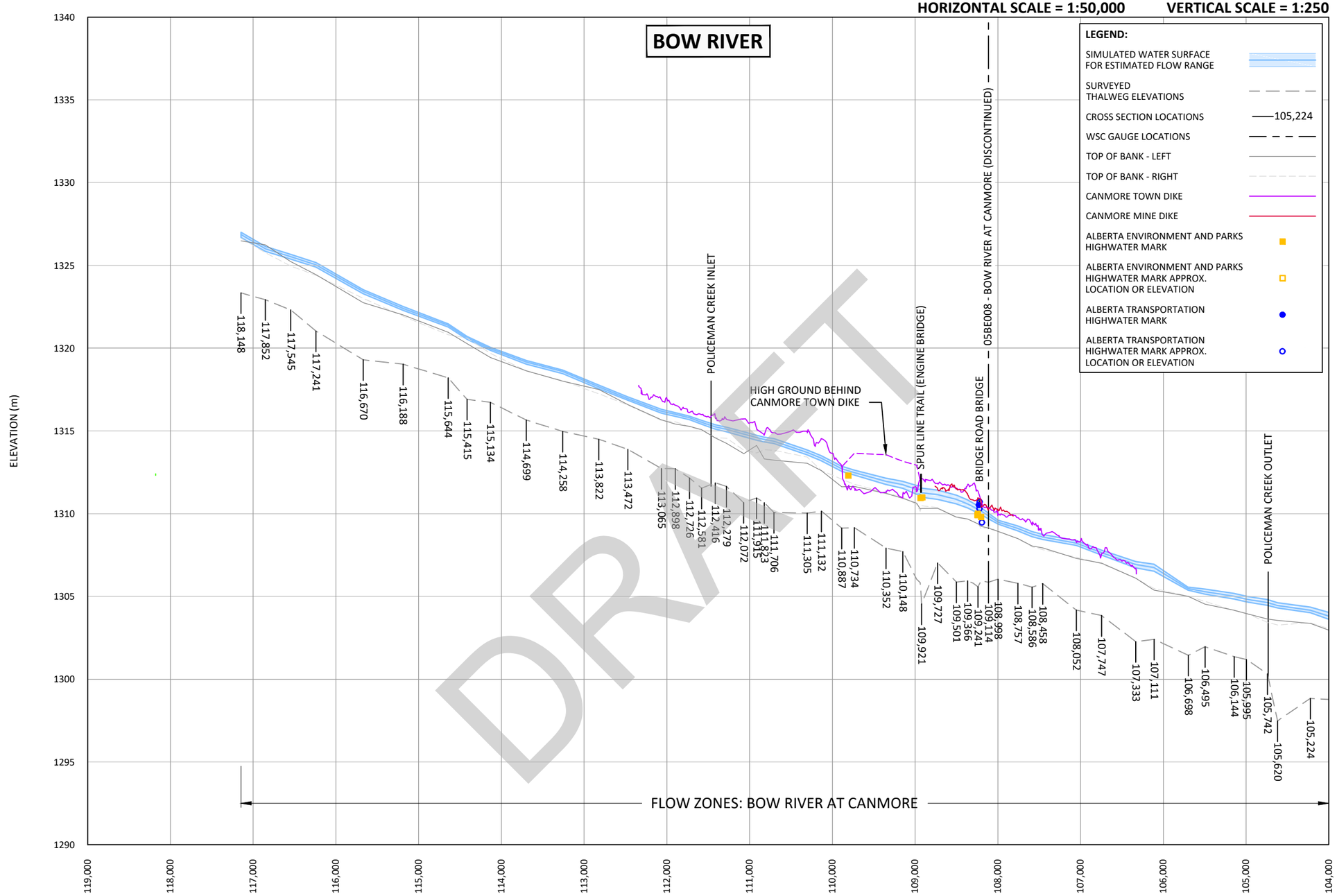
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LIDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION LOW FLOW

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-610
SHEET NUMBER	10 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

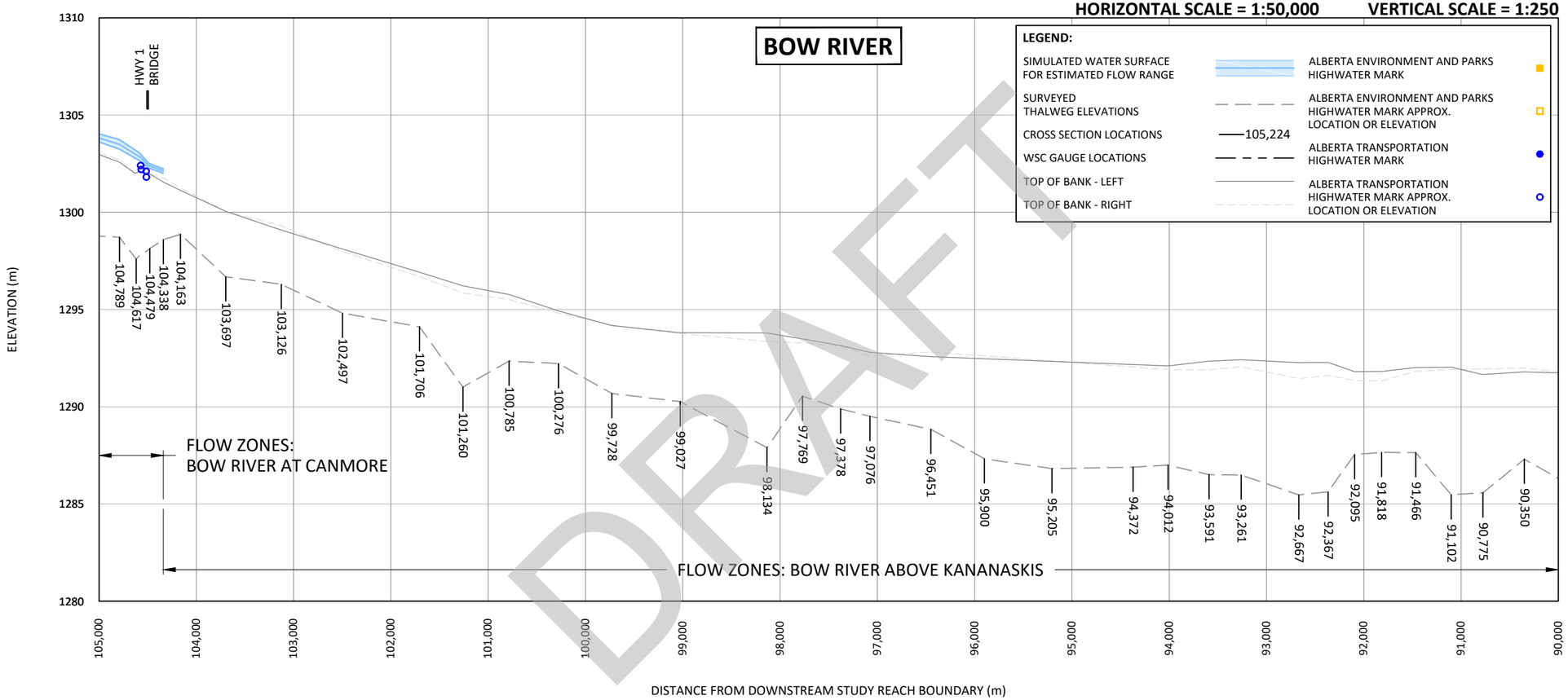
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-501
SHEET NUMBER	1 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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NOTES:

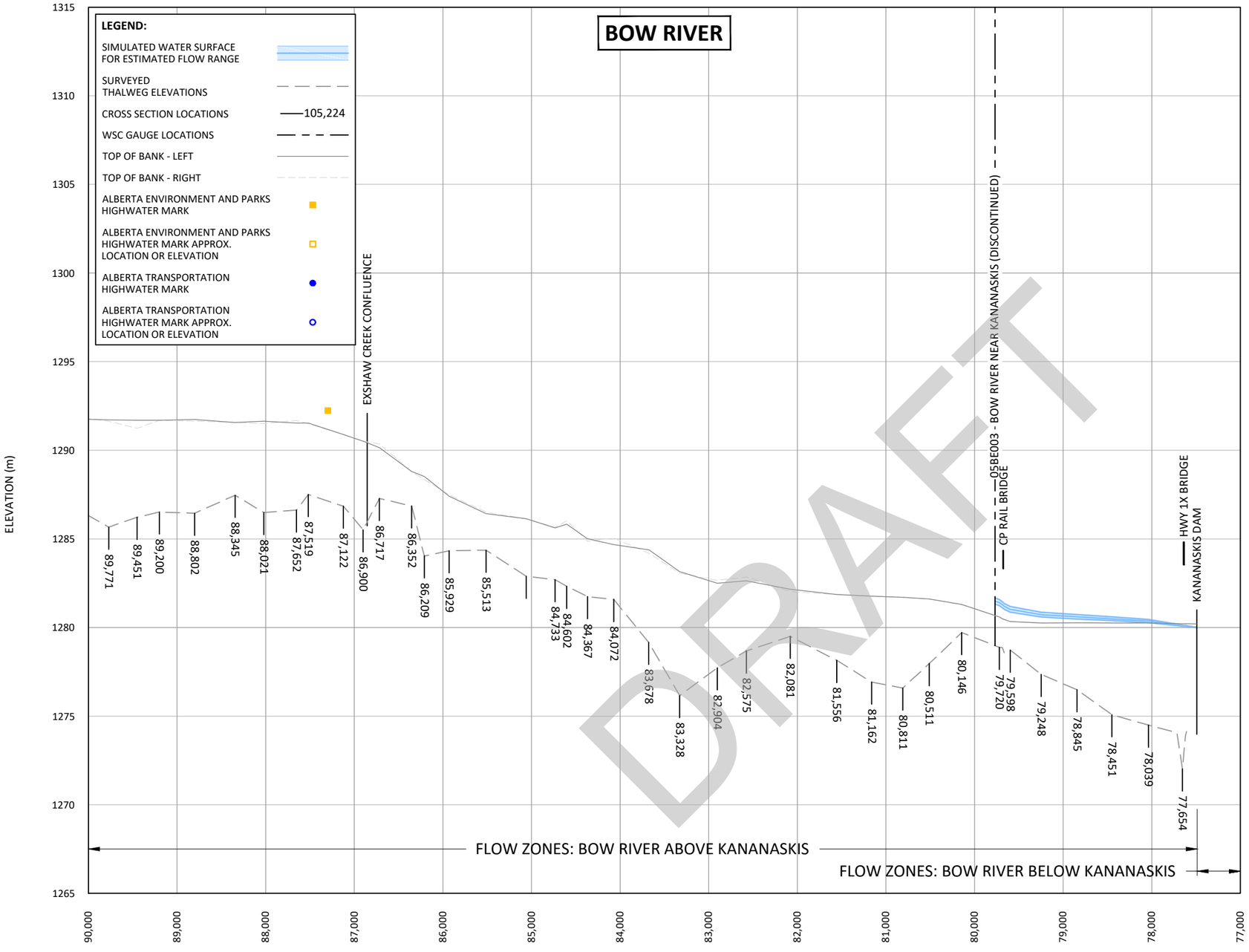
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

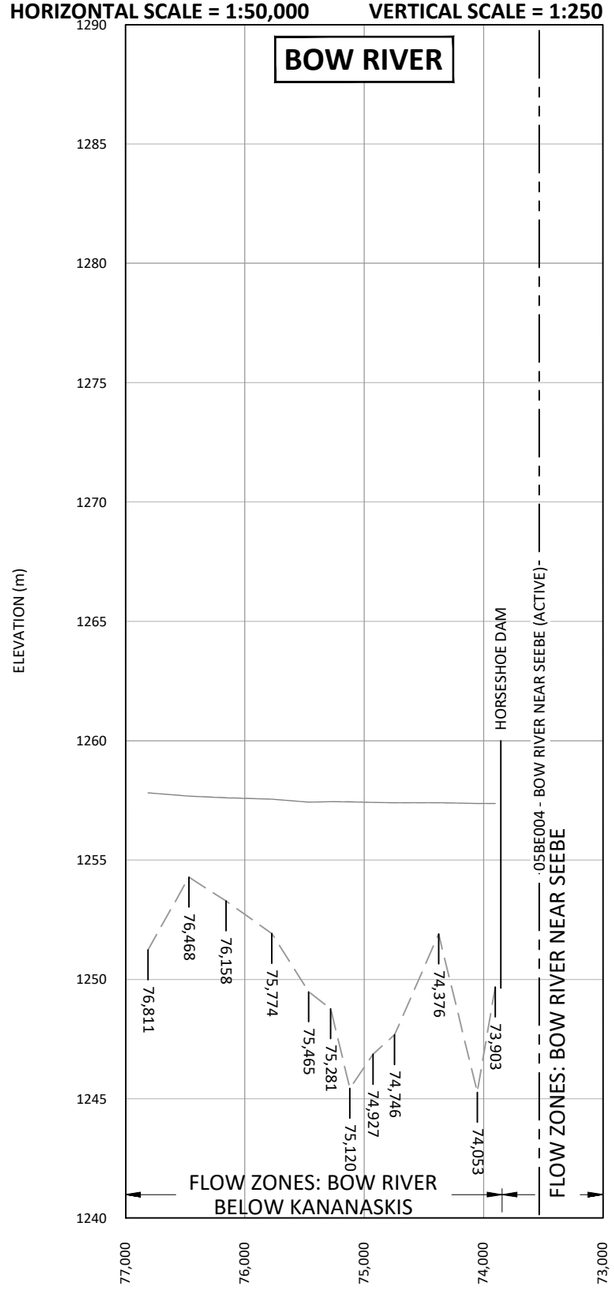
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-502
SHEET NUMBER	2 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250





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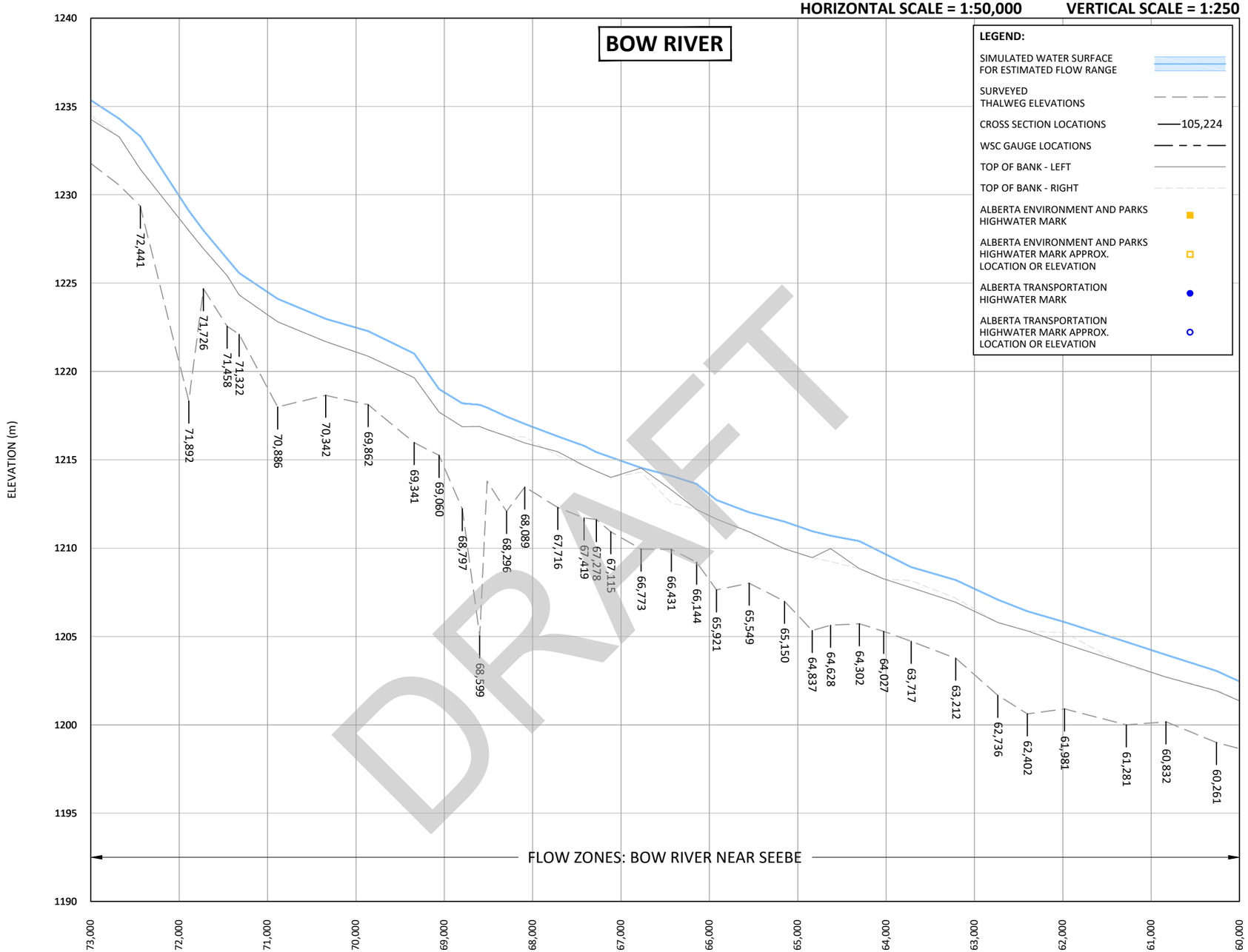
NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-503
SHEET NUMBER	3 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2016 (APR. 27 TO MAY 27).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

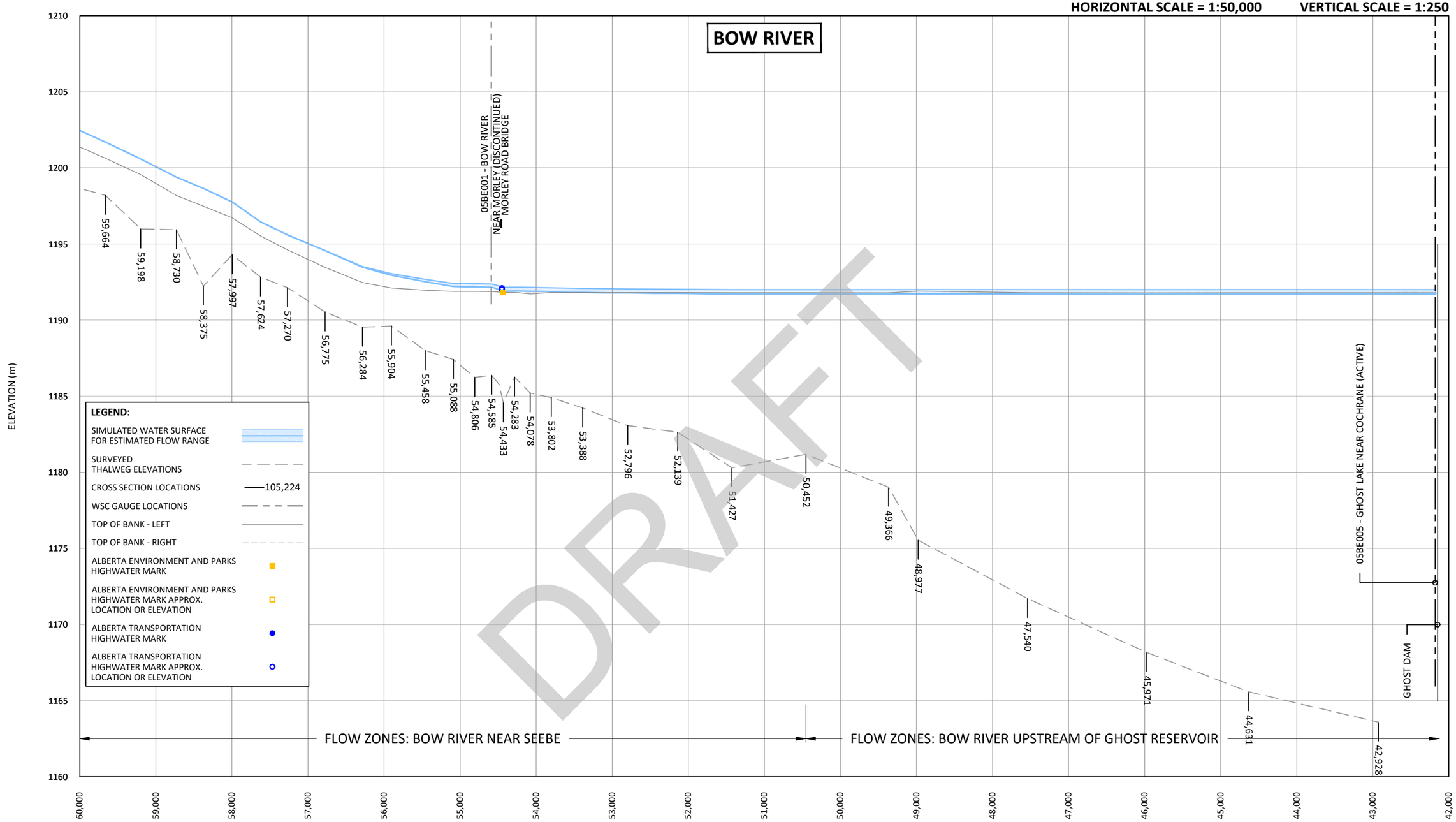
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-504
SHEET NUMBER	4 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER



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NOTES:

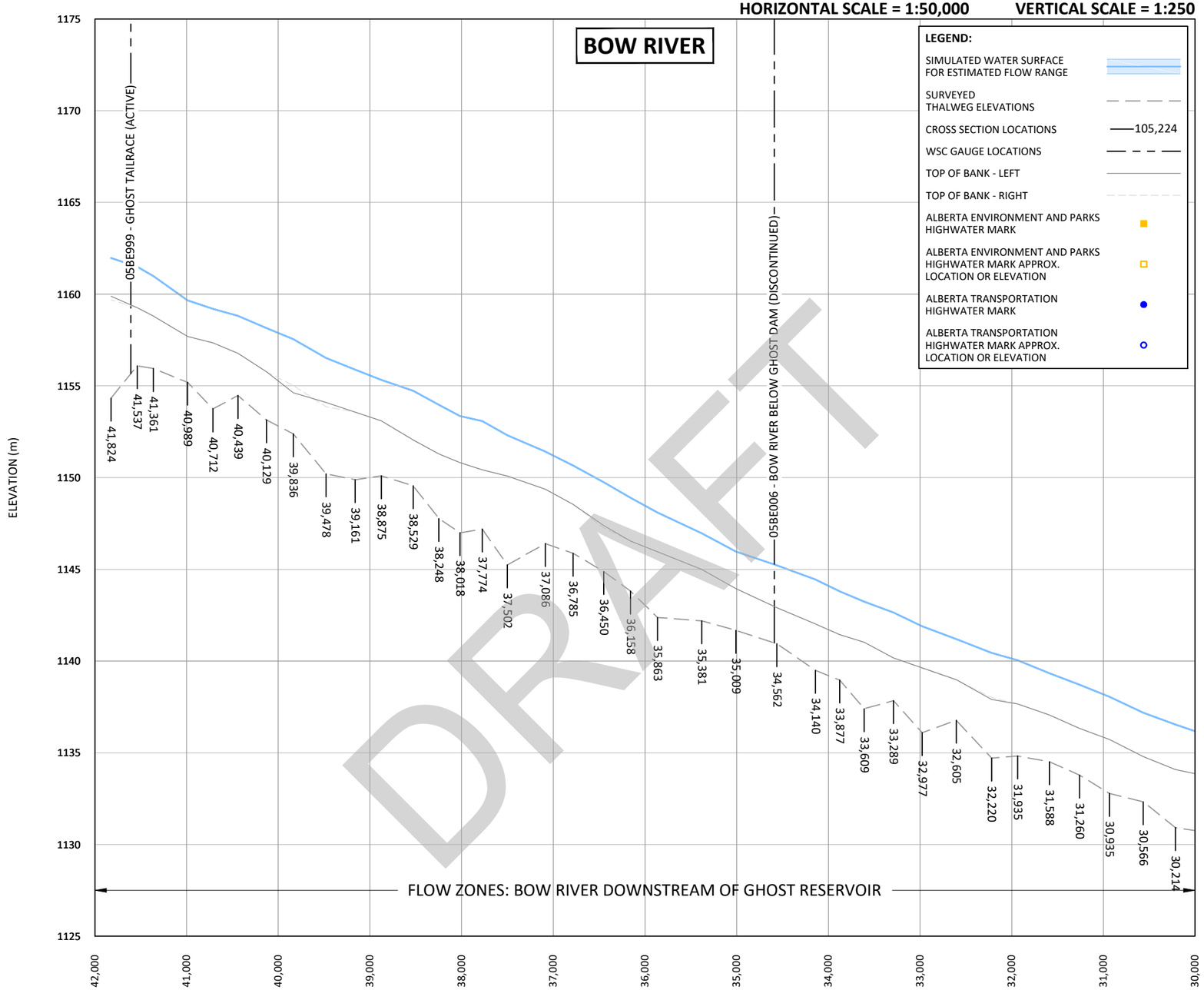
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2016 (APR. 27 TO MAY 27).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-505
SHEET NUMBER	5 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

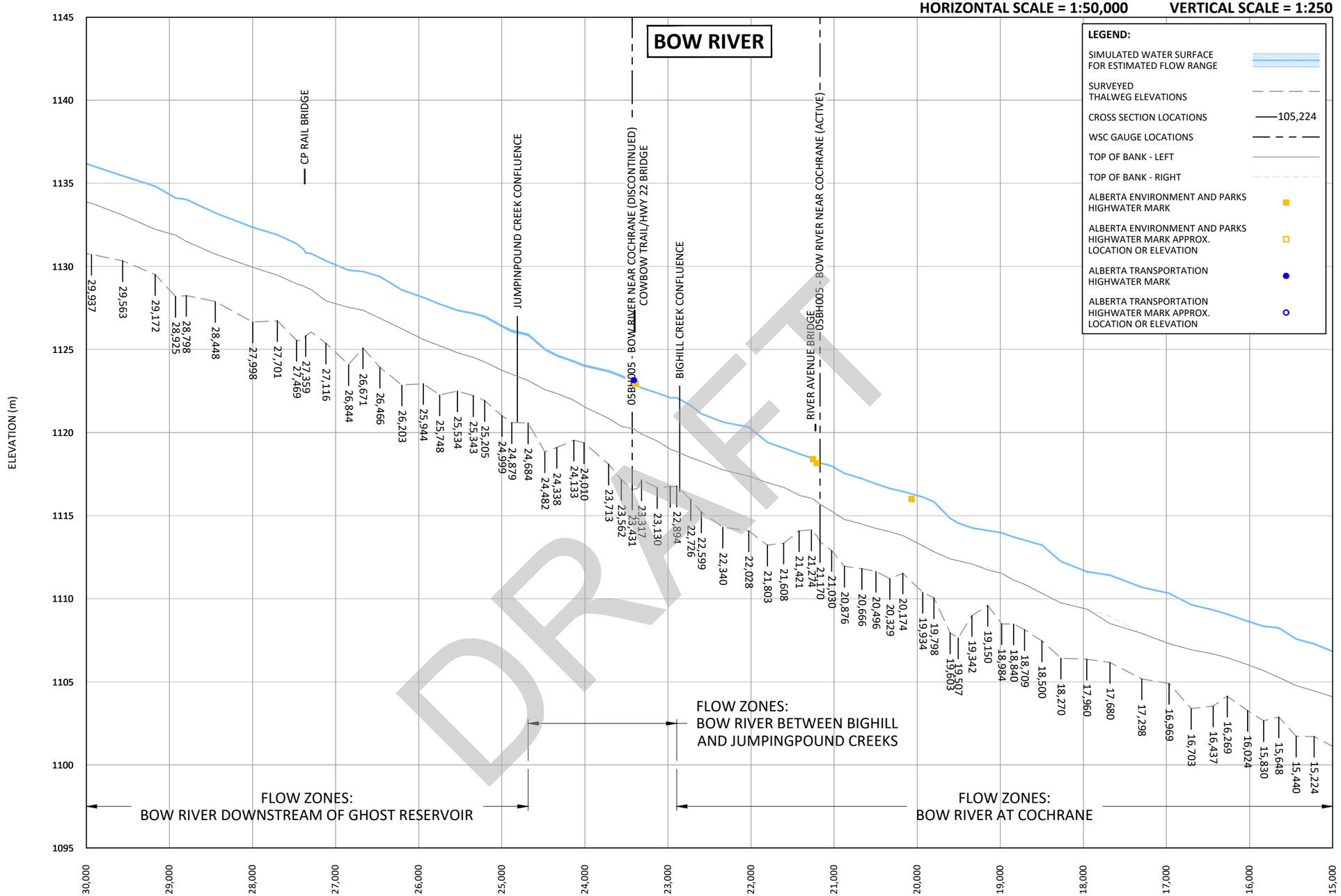
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-506
SHEET NUMBER	6 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

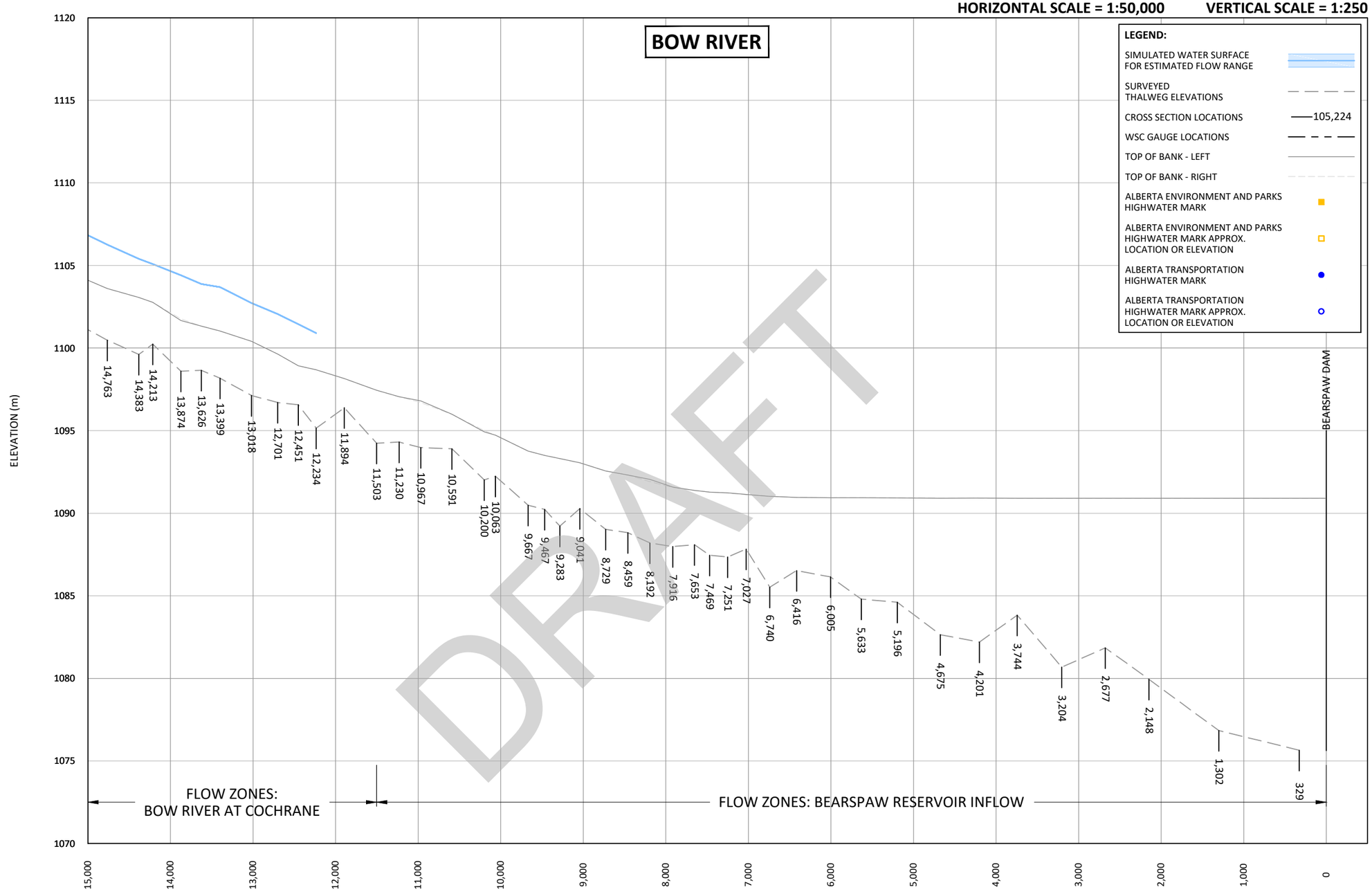
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-507
SHEET NUMBER	7 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

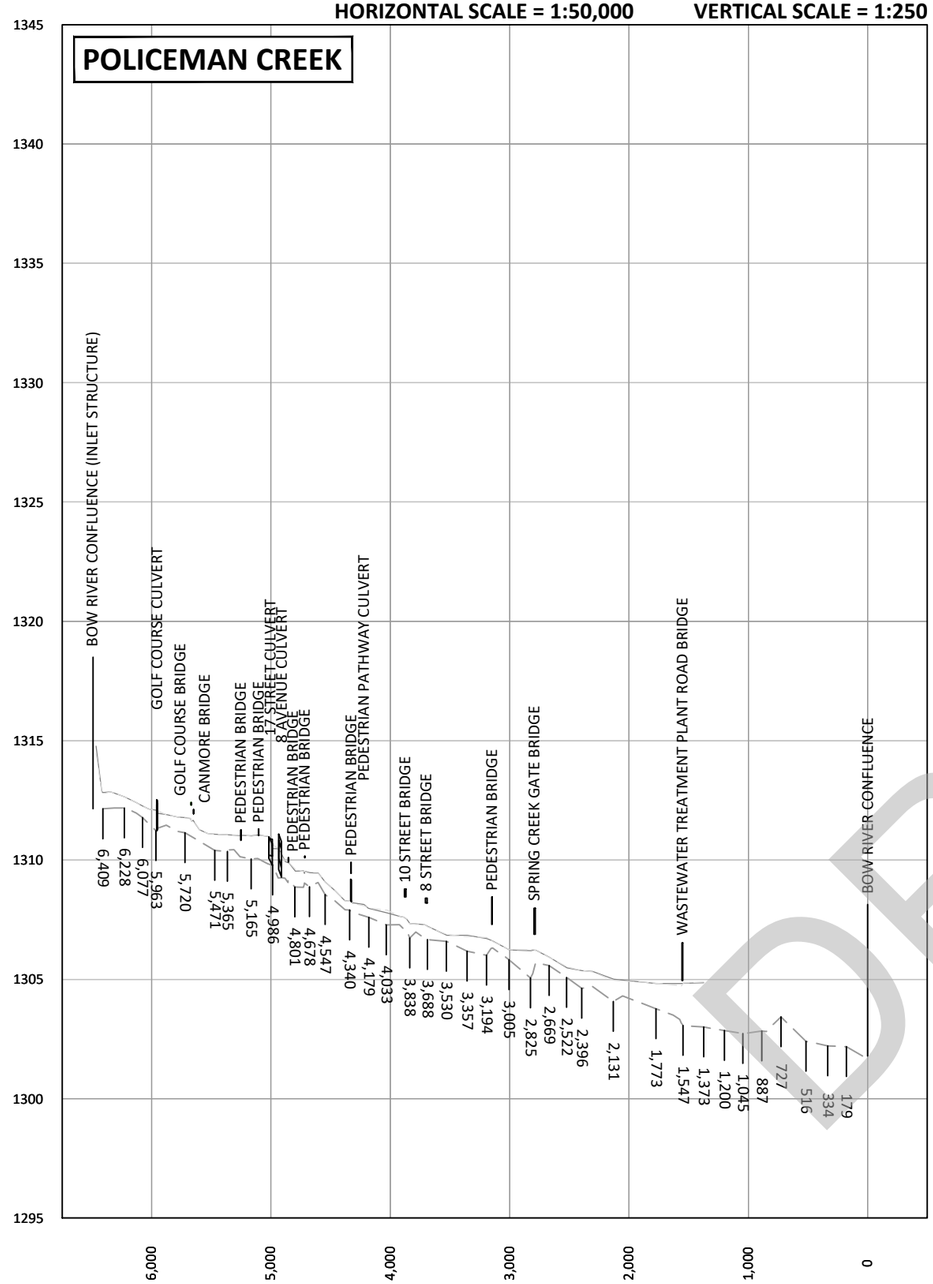
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-508
SHEET NUMBER	8 of 10

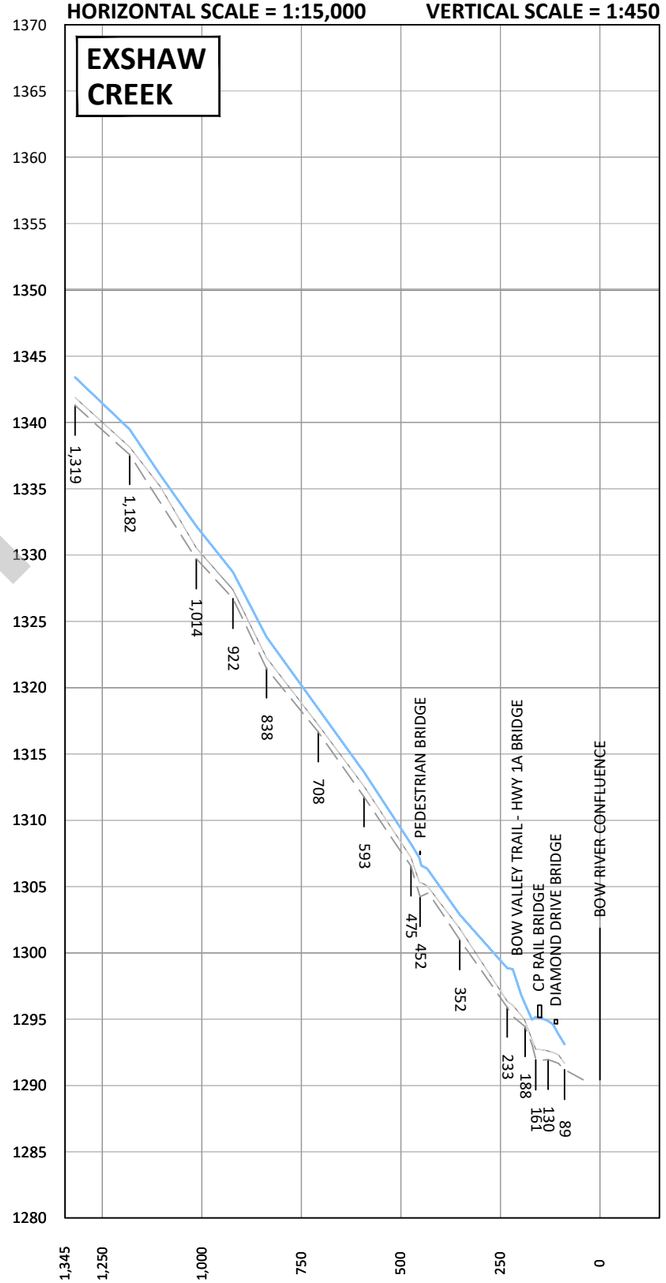
HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



LEGEND:

- SIMULATED WATER SURFACE FOR ESTIMATED FLOW RANGE
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT
- ALBERTA ENVIRONMENT AND PARKS HIGHWATER MARK
- ALBERTA ENVIRONMENT AND PARKS HIGHWATER MARK APPROX. LOCATION OR ELEVATION
- ALBERTA TRANSPORTATION HIGHWATER MARK
- ALBERTA TRANSPORTATION HIGHWATER MARK APPROX. LOCATION OR ELEVATION

HORIZONTAL SCALE = 1:15,000 VERTICAL SCALE = 1:450



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LiDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

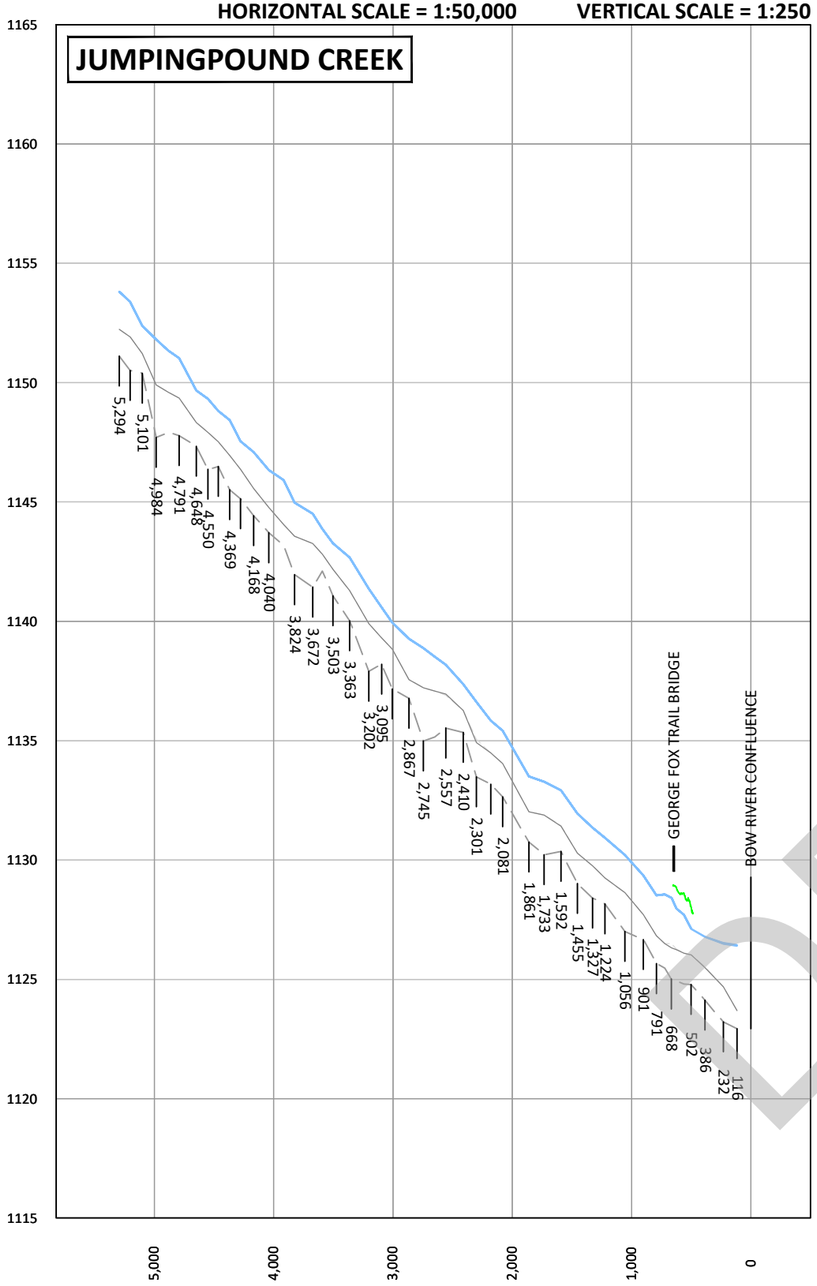
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-509
SHEET NUMBER	9 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

JUMPINGPOUND CREEK

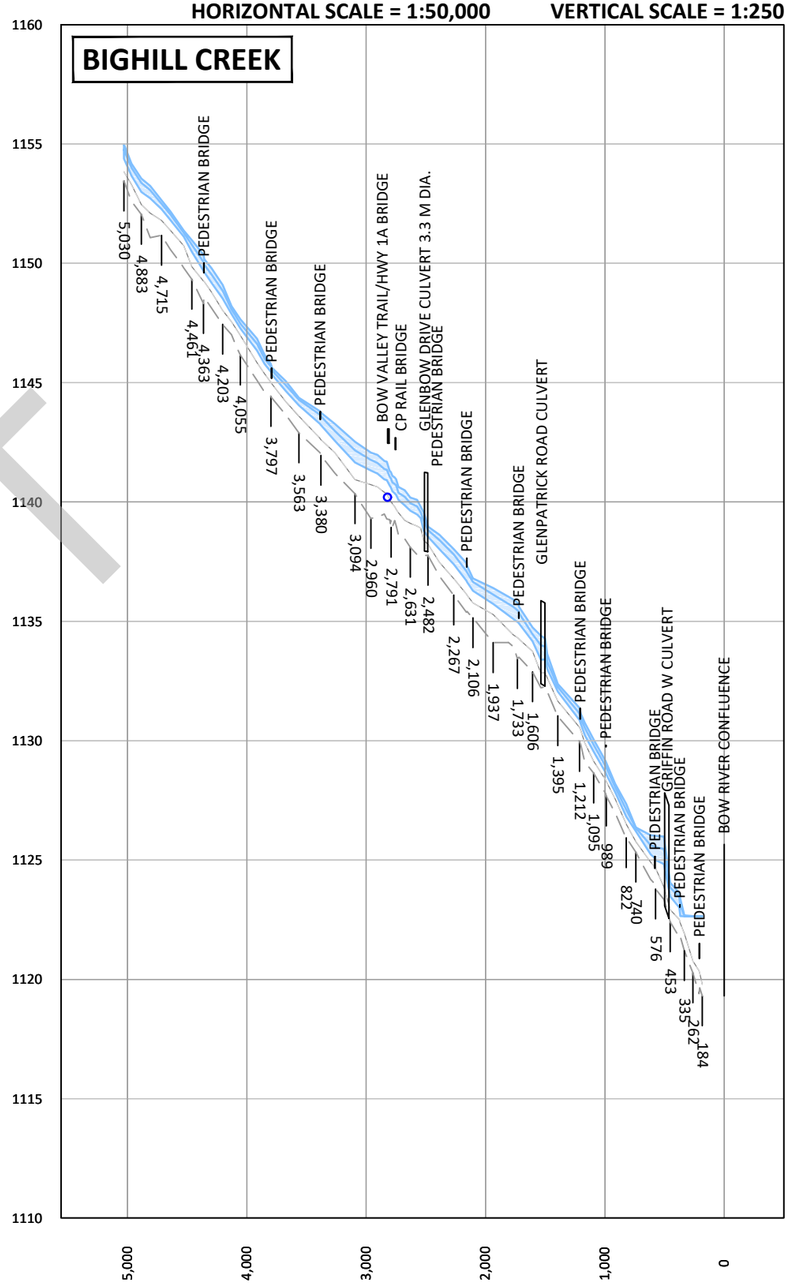


LEGEND:

- SIMULATED WATER SURFACE FOR ESTIMATED FLOW RANGE
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT
- JUMPINGPOUND DIKE
- ALBERTA ENVIRONMENT AND PARKS HIGHWATER MARK
- ALBERTA ENVIRONMENT AND PARKS HIGHWATER MARK APPROX. LOCATION OR ELEVATION
- ALBERTA TRANSPORTATION HIGHWATER MARK
- ALBERTA TRANSPORTATION HIGHWATER MARK APPROX. LOCATION OR ELEVATION

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BIGHILL CREEK



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.
2. CHANNEL SURVEY CONDUCTED BY NHC IN 2015 (OCT. 1 TO 31).
3. LIDAR DATA ACQUISITION BY AIRBORNE IMAGING INC. IN 2015 (SEPT. 10 TO 11, OCT. 5 AND 11).

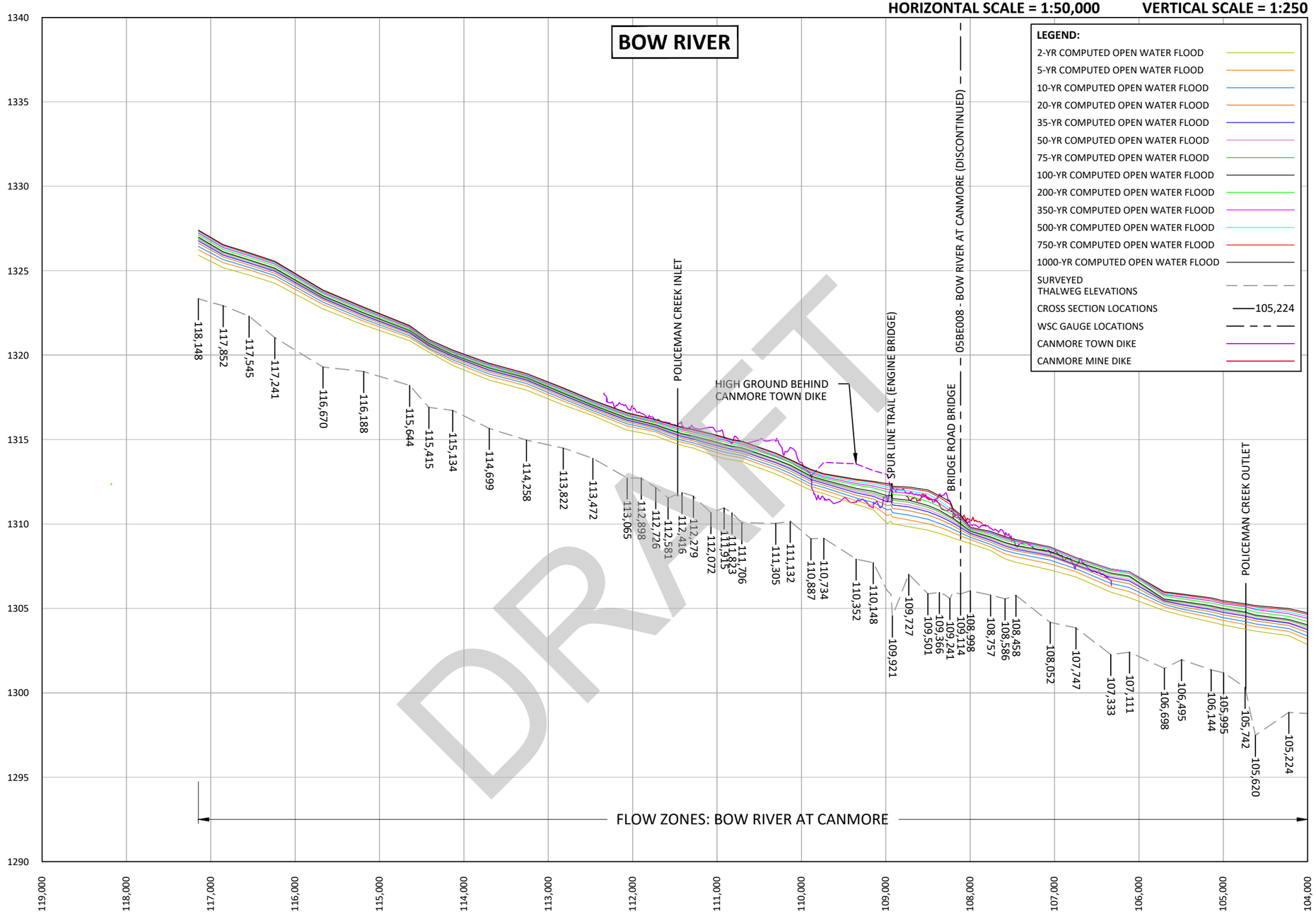
UPPER BOW RIVER HAZARD STUDY

WATER SURFACE PROFILE CALIBRATION 2013 FLOOD

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-510
SHEET NUMBER	10 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER



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NOTES:

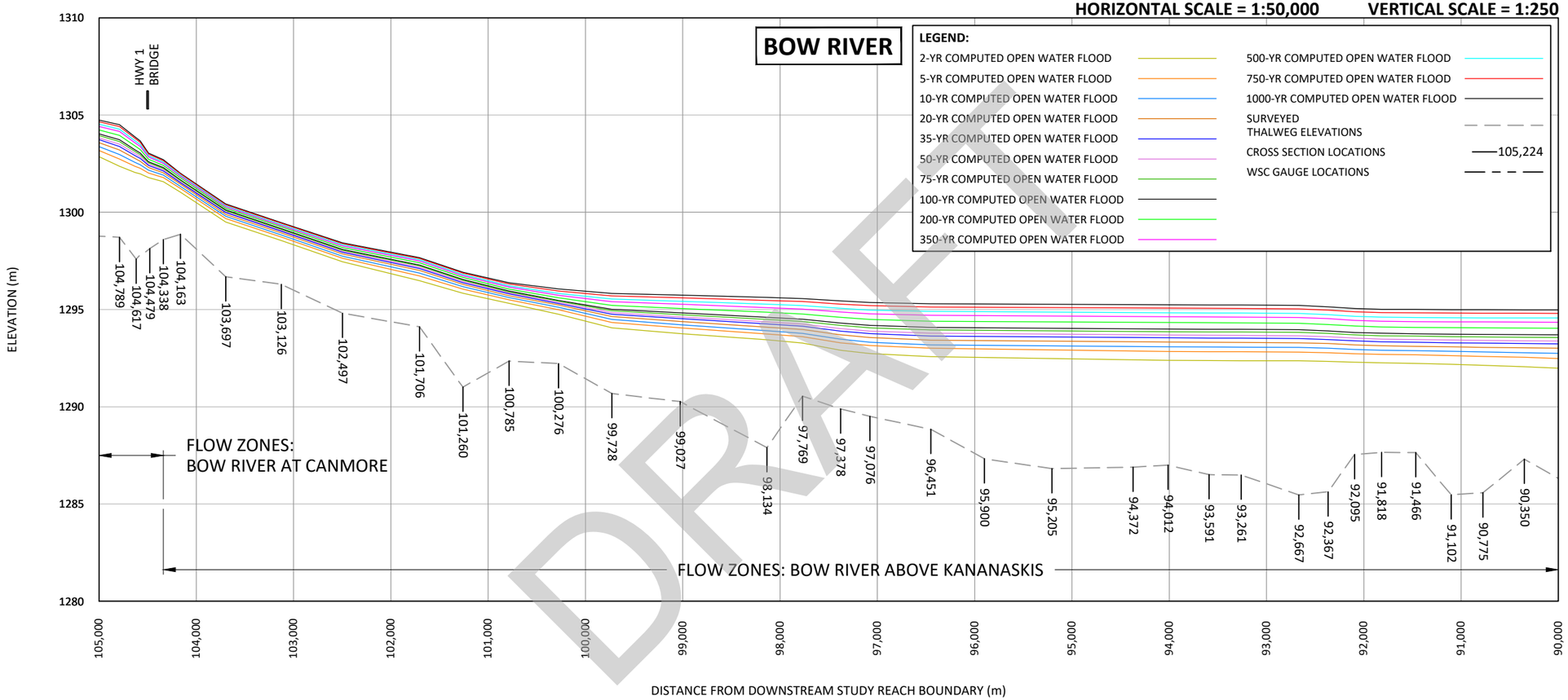
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-701
SHEET NUMBER	1 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

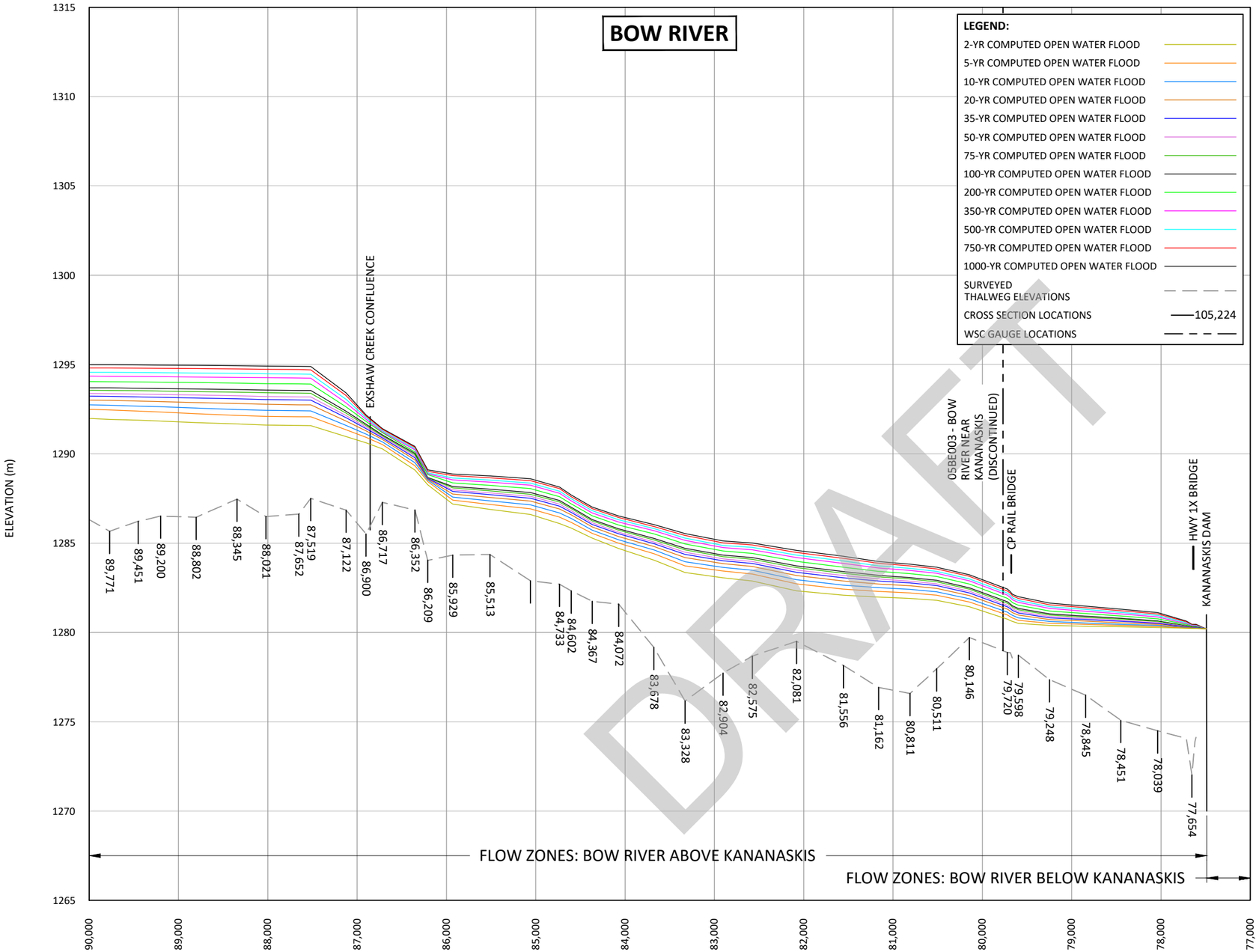
UPPER BOW RIVER HAZARD STUDY

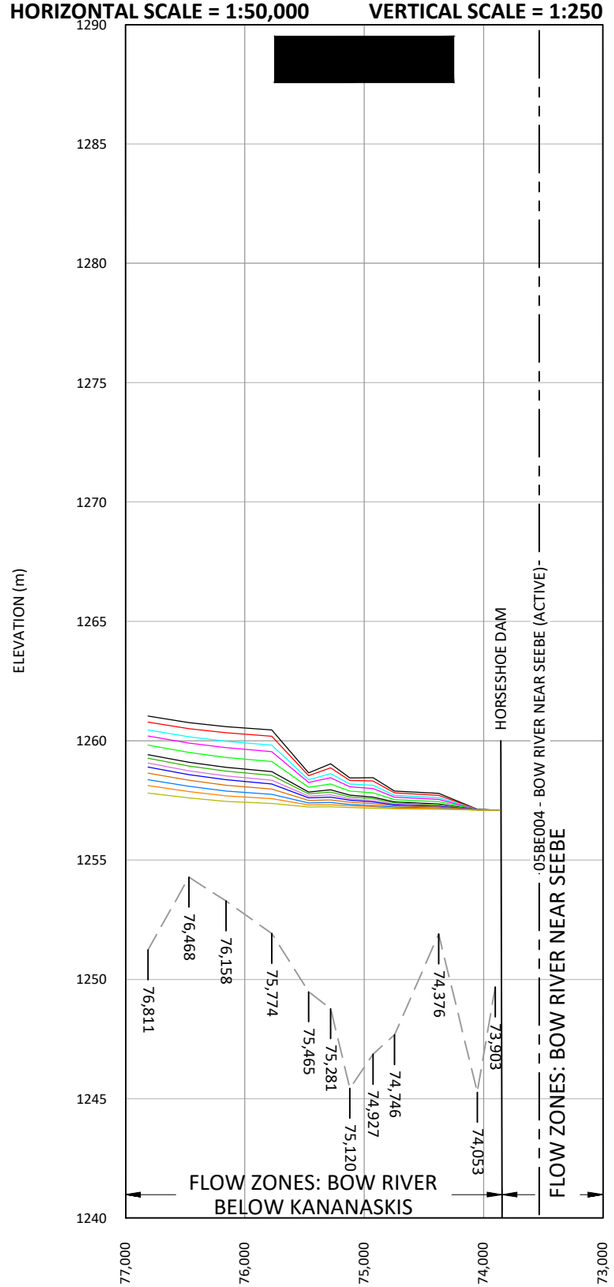
COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-702
SHEET NUMBER	2 of 10

BOW RIVER

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250





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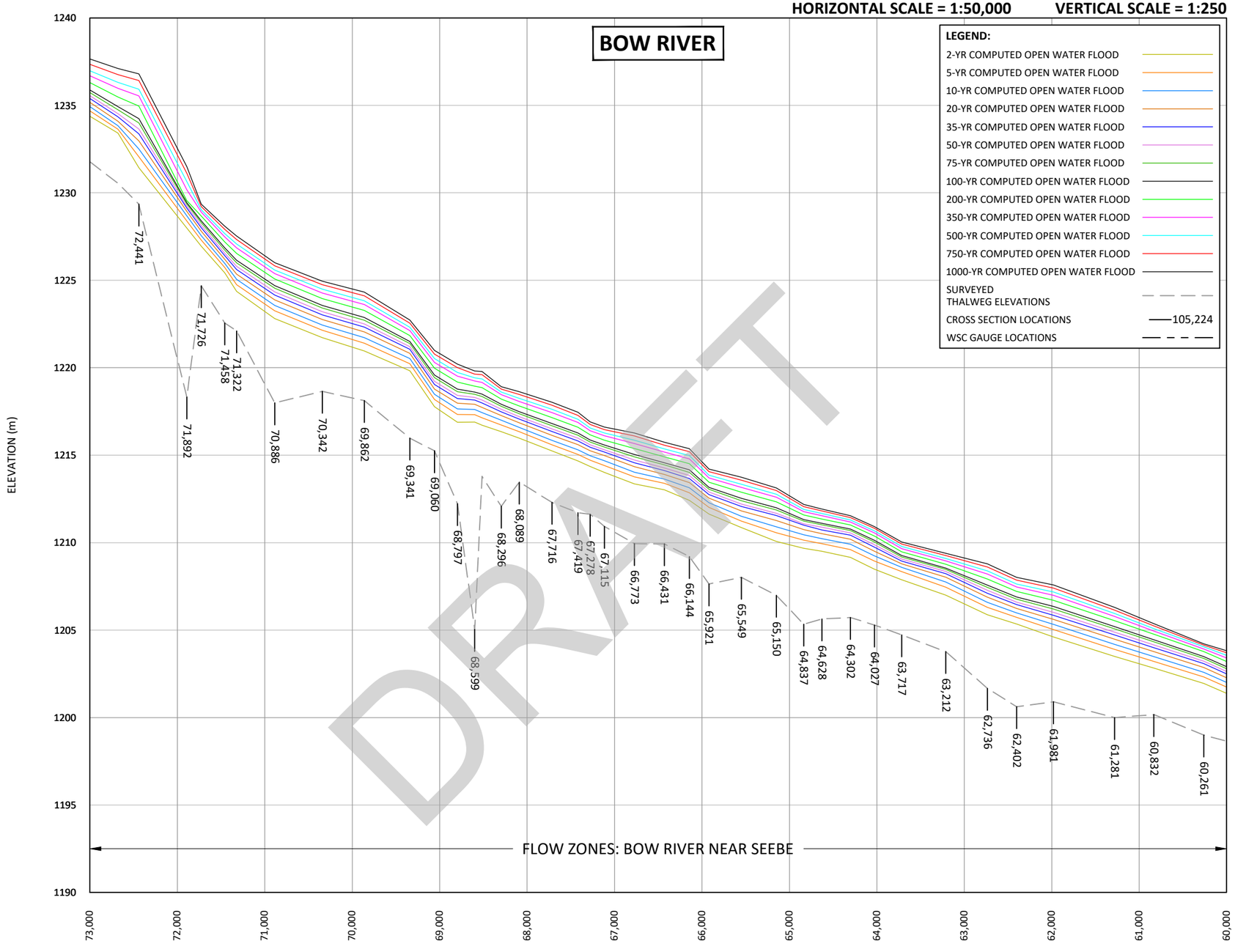
NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-703
SHEET NUMBER	3 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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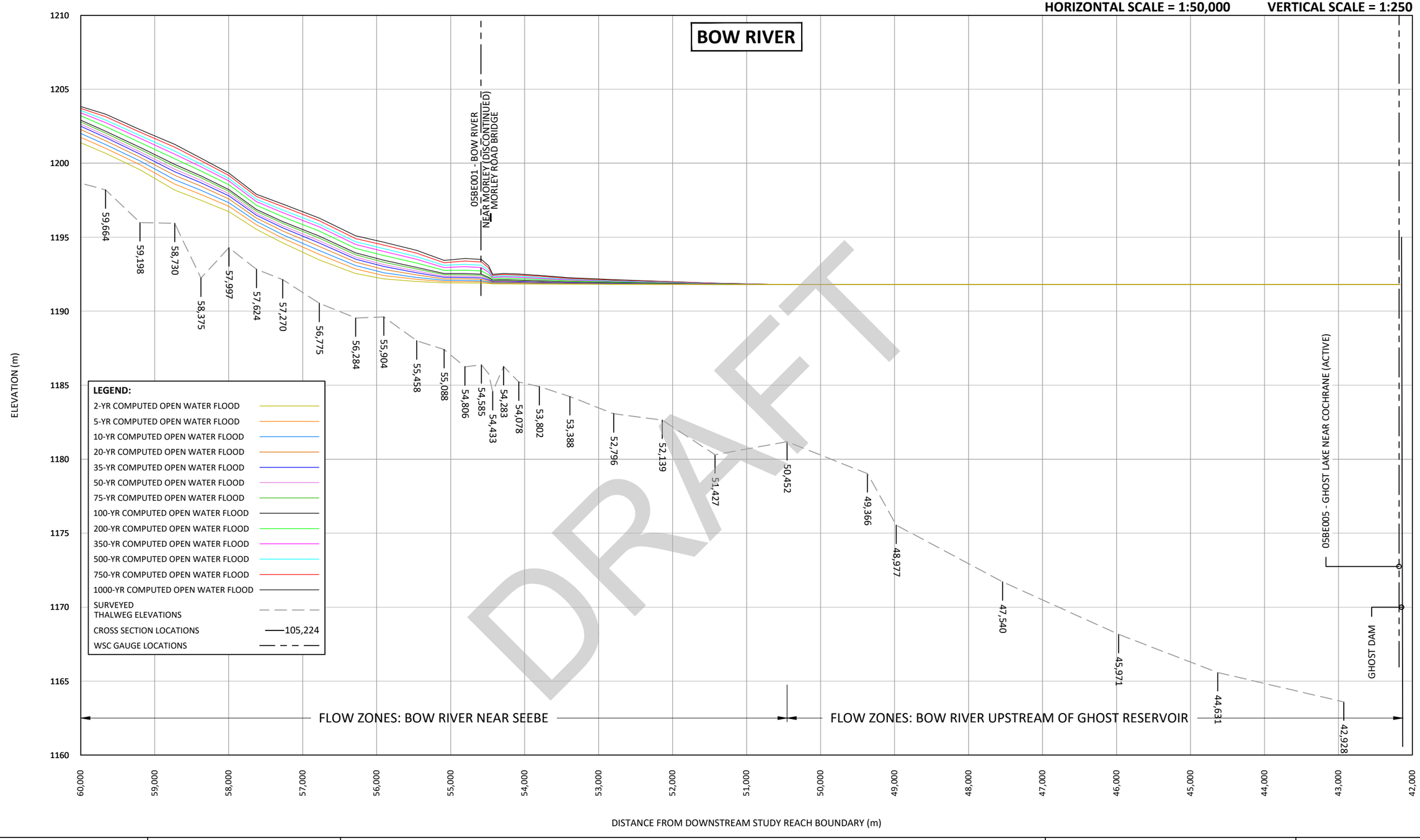
NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-704
SHEET NUMBER	4 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

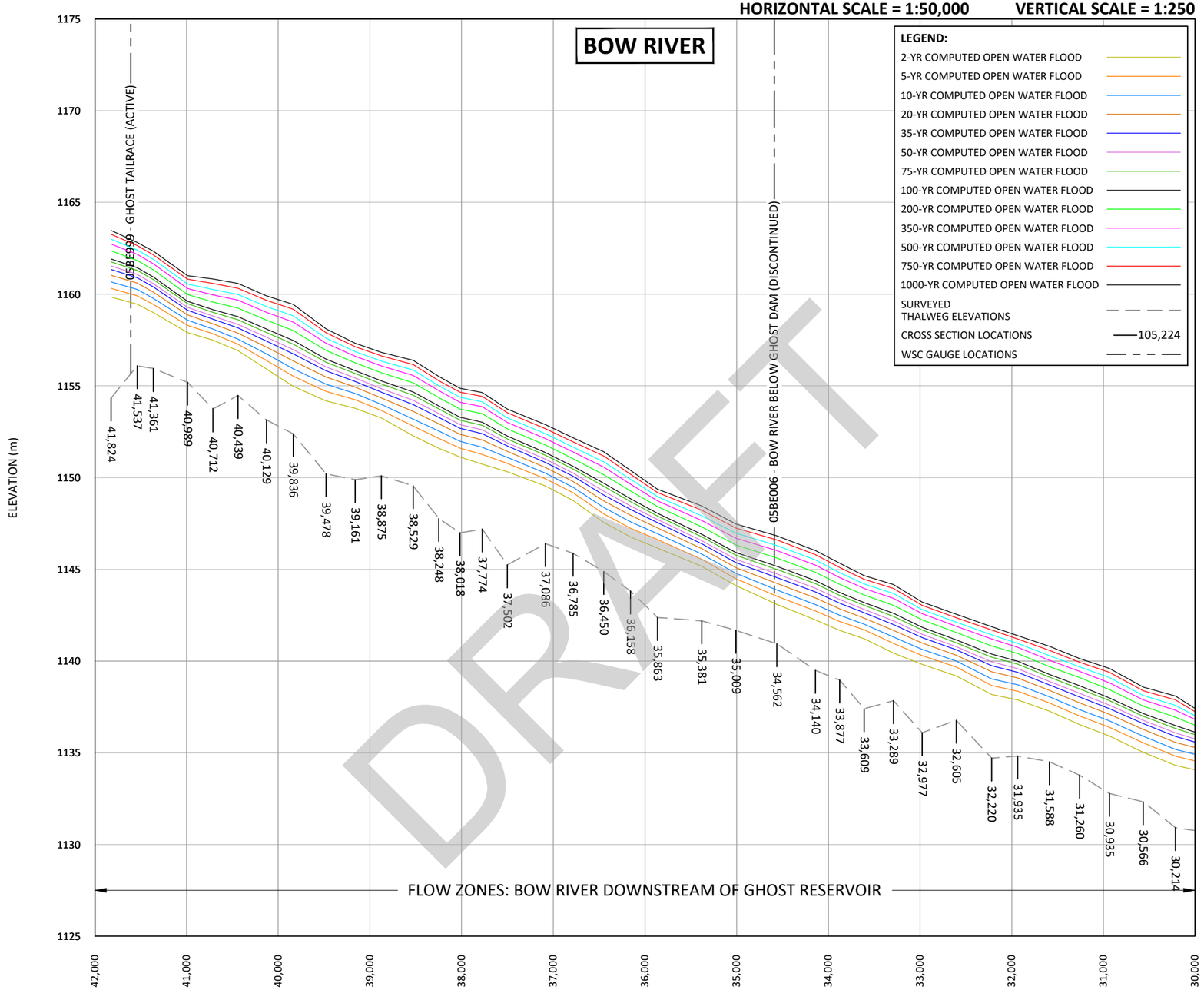
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-705
SHEET NUMBER	5 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

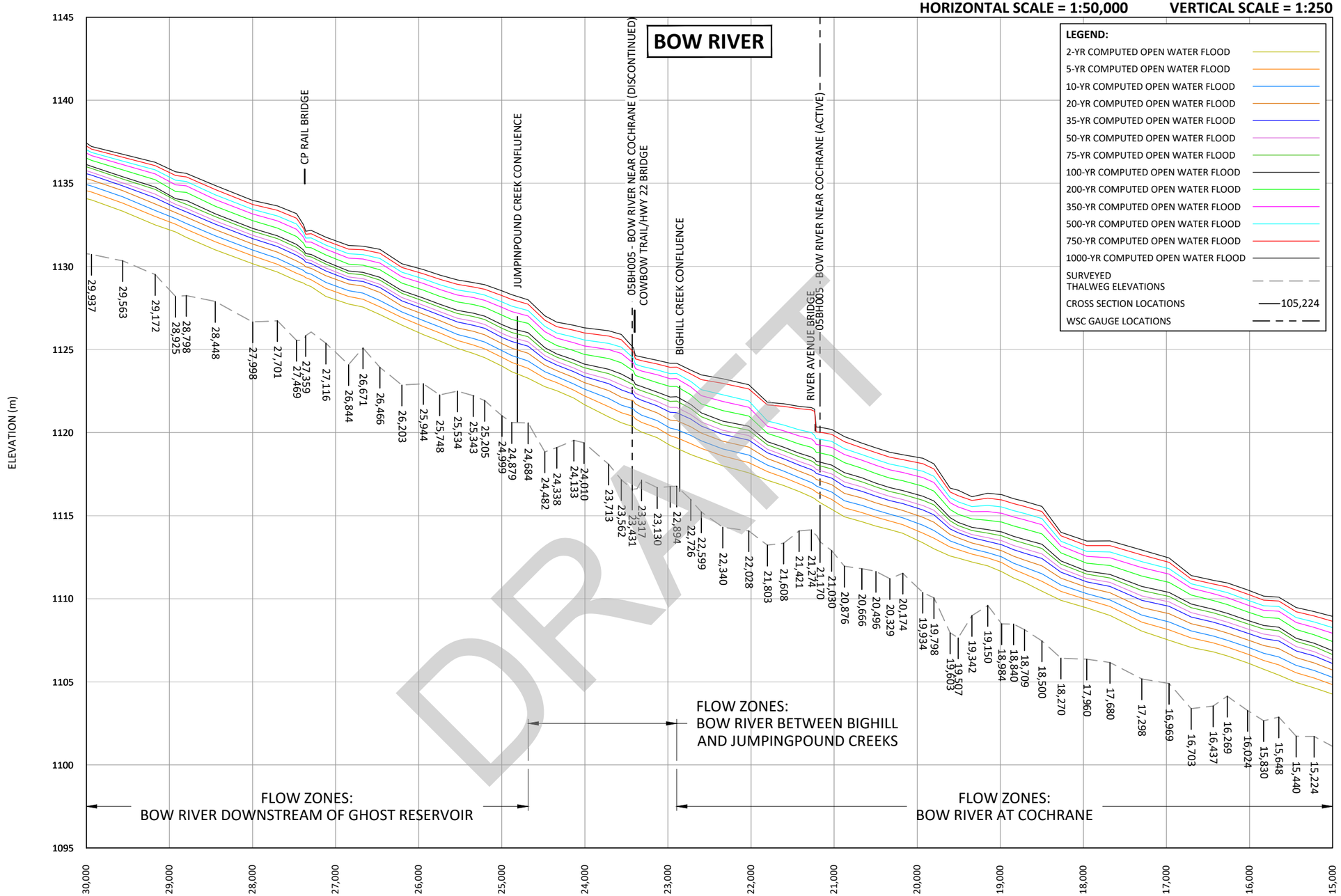
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-706
SHEET NUMBER	6 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

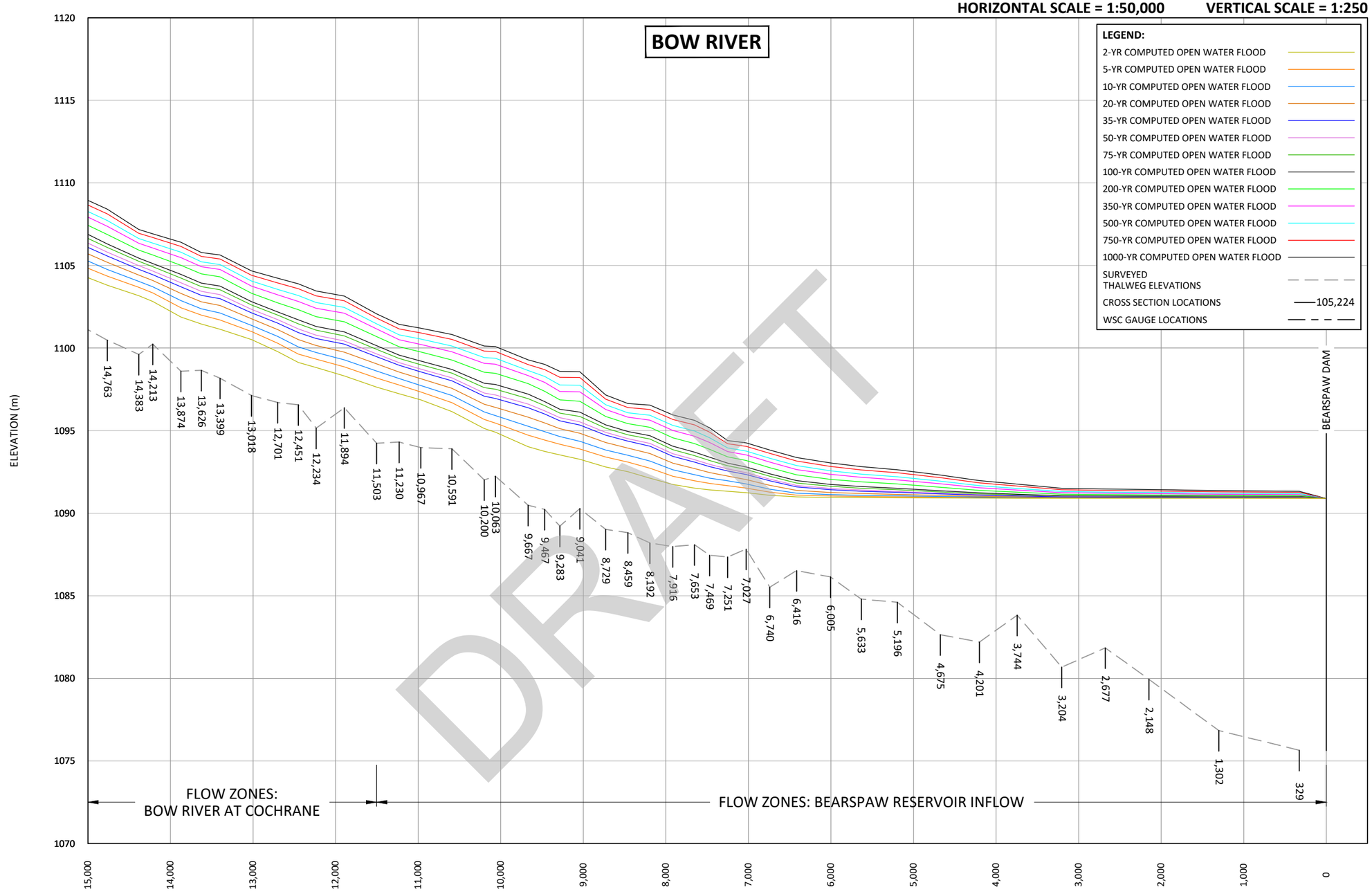
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-707
SHEET NUMBER	7 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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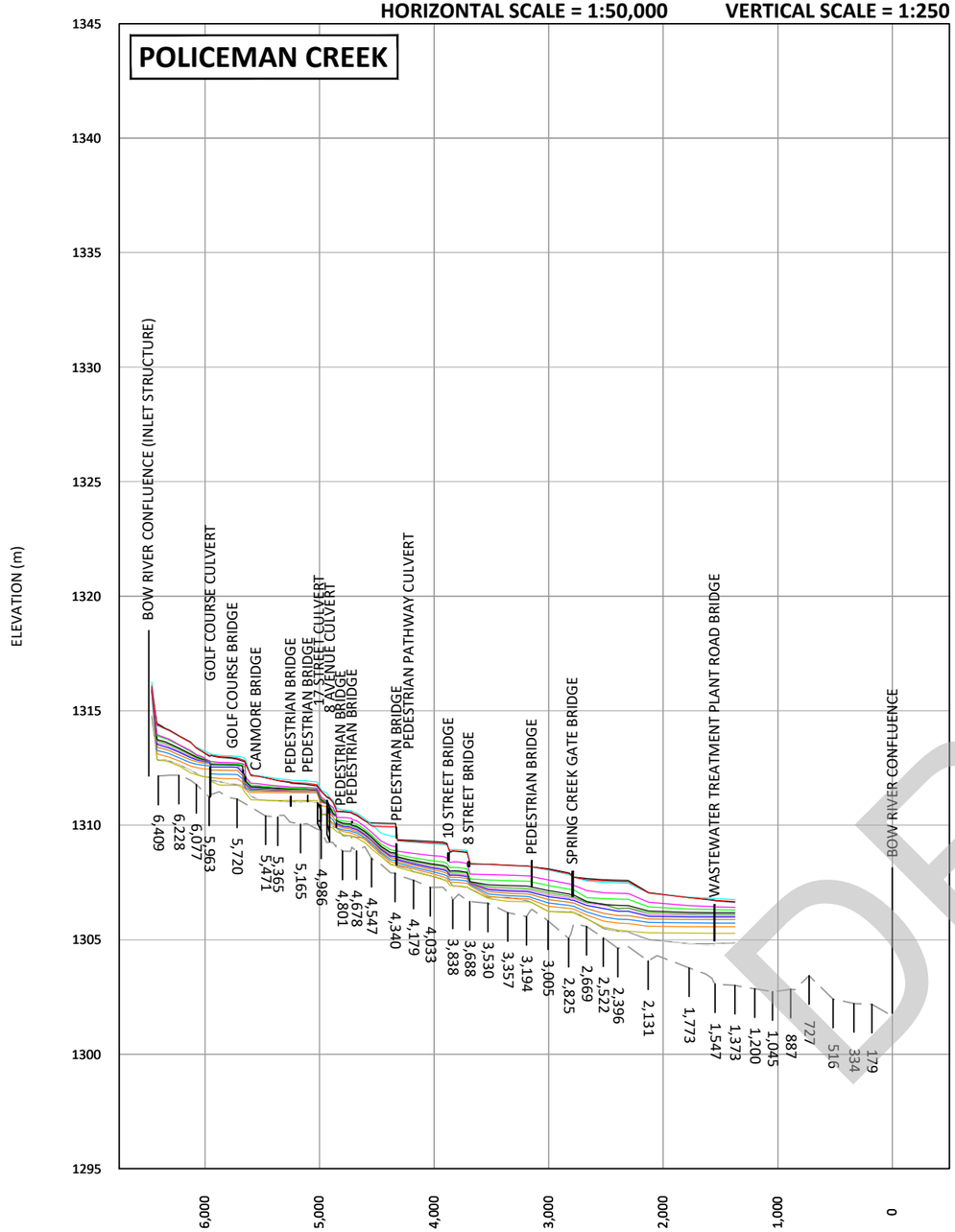
NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-708
SHEET NUMBER	8 of 10

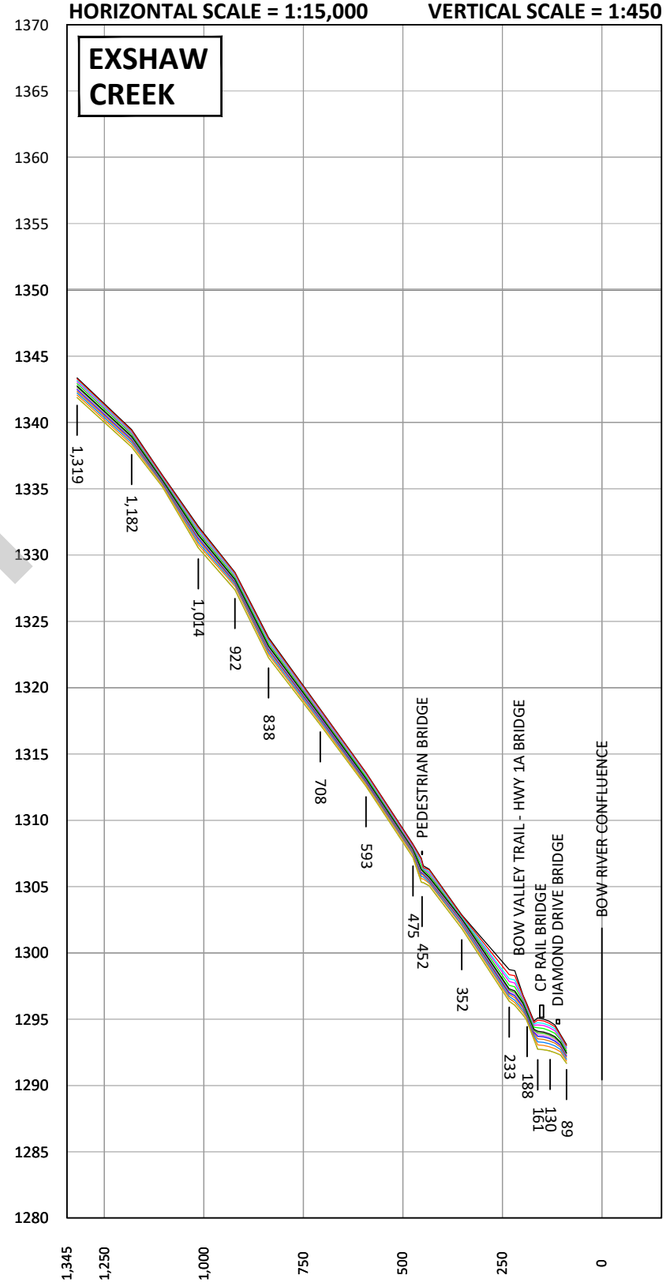
HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



LEGEND:

- 2-YR COMPUTED OPEN WATER FLOOD
- 5-YR COMPUTED OPEN WATER FLOOD
- 10-YR COMPUTED OPEN WATER FLOOD
- 20-YR COMPUTED OPEN WATER FLOOD
- 35-YR COMPUTED OPEN WATER FLOOD
- 50-YR COMPUTED OPEN WATER FLOOD
- 75-YR COMPUTED OPEN WATER FLOOD
- 100-YR COMPUTED OPEN WATER FLOOD
- 200-YR COMPUTED OPEN WATER FLOOD
- 350-YR COMPUTED OPEN WATER FLOOD
- 500-YR COMPUTED OPEN WATER FLOOD
- 750-YR COMPUTED OPEN WATER FLOOD
- 1000-YR COMPUTED OPEN WATER FLOOD
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS

HORIZONTAL SCALE = 1:15,000 VERTICAL SCALE = 1:450



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

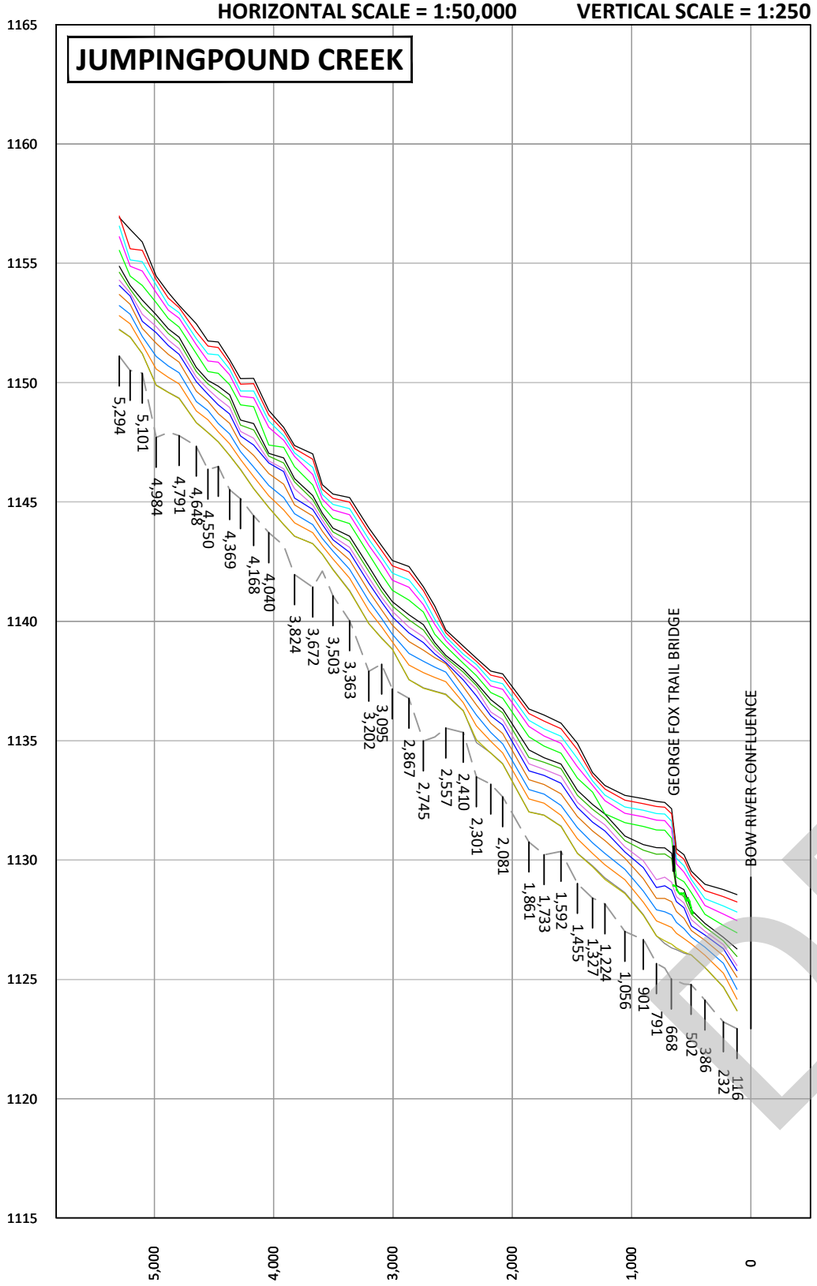
UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-709
SHEET NUMBER	9 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

JUMPINGPOUND CREEK

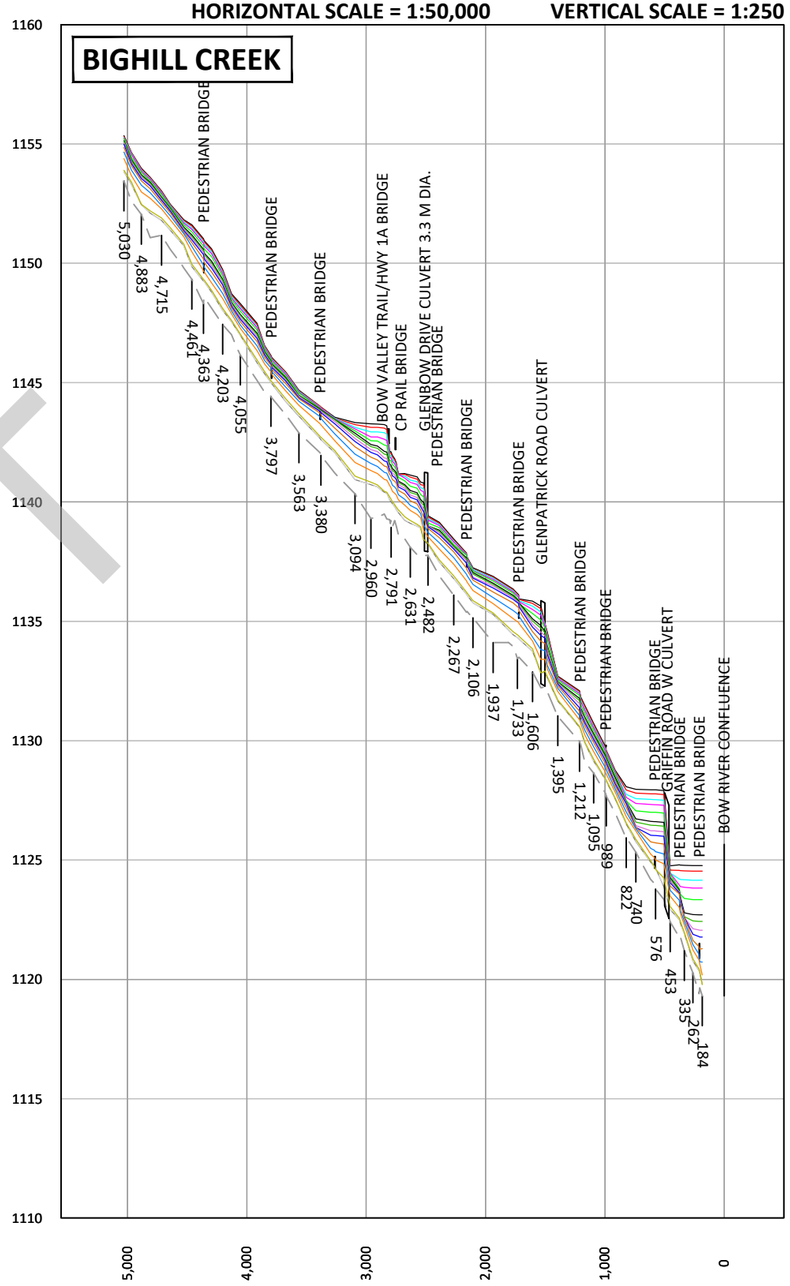


LEGEND:

- 2-YR COMPUTED OPEN WATER FLOOD
- 5-YR COMPUTED OPEN WATER FLOOD
- 10-YR COMPUTED OPEN WATER FLOOD
- 20-YR COMPUTED OPEN WATER FLOOD
- 35-YR COMPUTED OPEN WATER FLOOD
- 50-YR COMPUTED OPEN WATER FLOOD
- 75-YR COMPUTED OPEN WATER FLOOD
- 100-YR COMPUTED OPEN WATER FLOOD
- 200-YR COMPUTED OPEN WATER FLOOD
- 350-YR COMPUTED OPEN WATER FLOOD
- 500-YR COMPUTED OPEN WATER FLOOD
- 750-YR COMPUTED OPEN WATER FLOOD
- 1000-YR COMPUTED OPEN WATER FLOOD
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- JUMPINGPOUND CREEK DIKE

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BIGHILL CREEK



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NOTES:

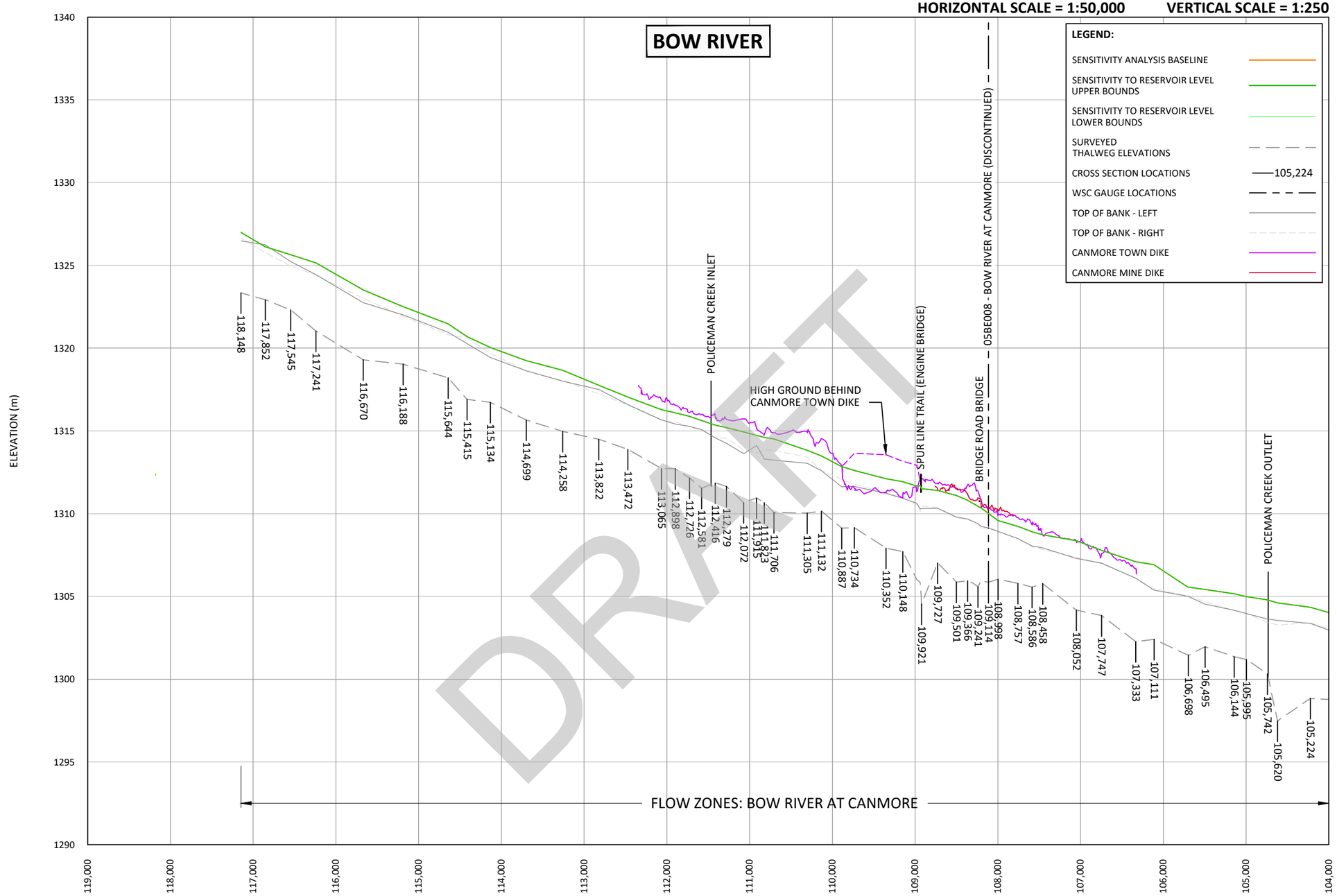
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

COMPUTED OPEN WATER FLOOD FREQUENCY PROFILES

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-710
SHEET NUMBER	10 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

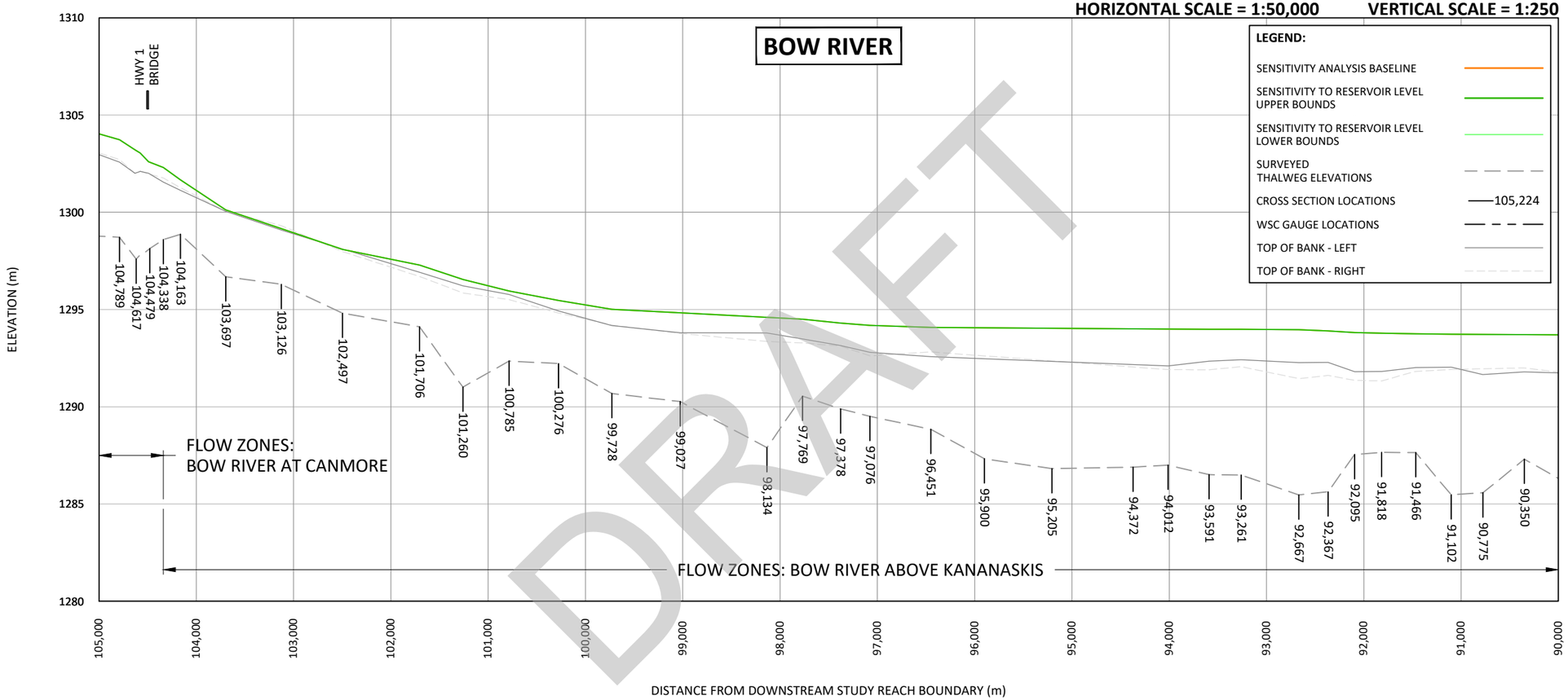
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1001
SHEET NUMBER	1 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

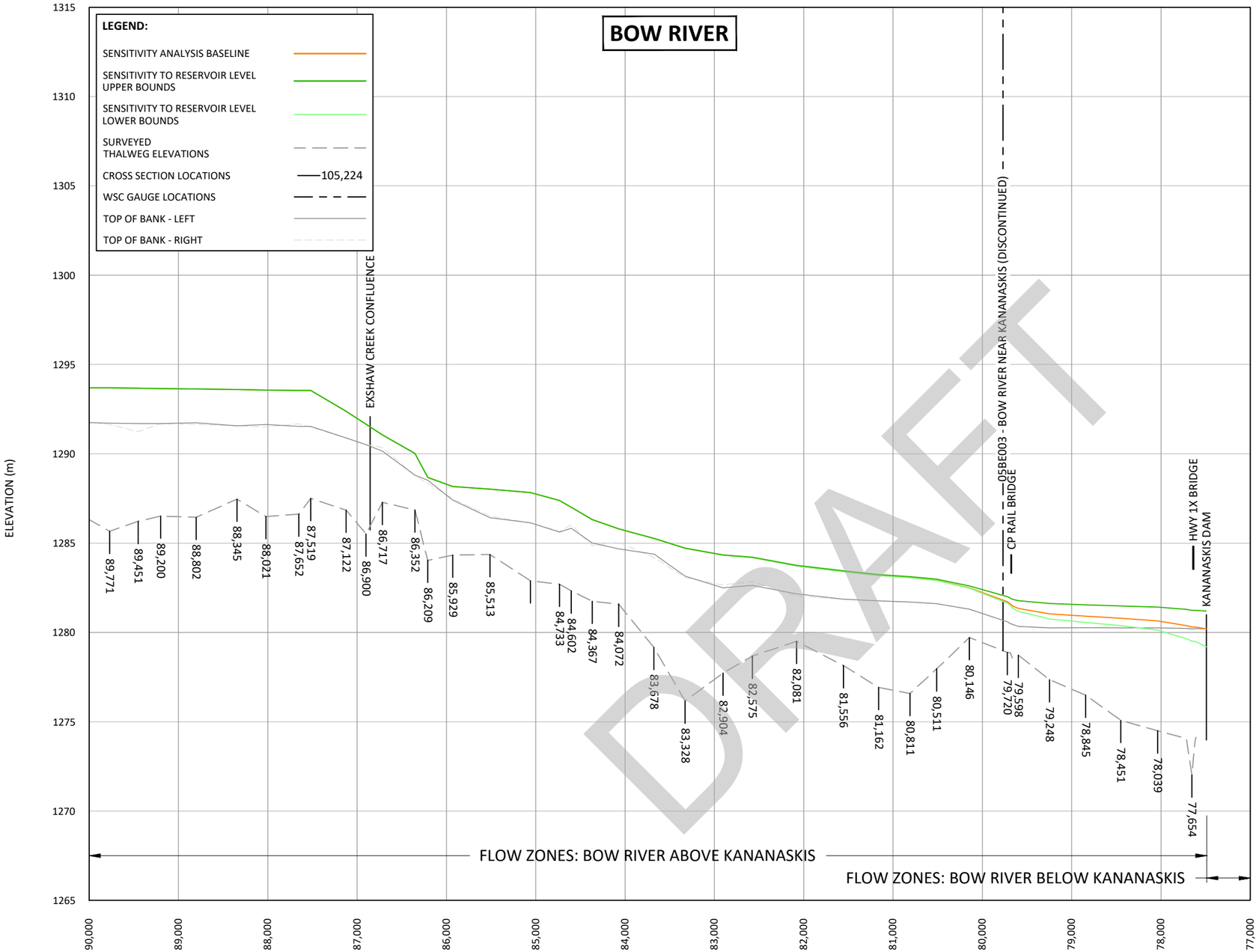
UPPER BOW RIVER HAZARD STUDY

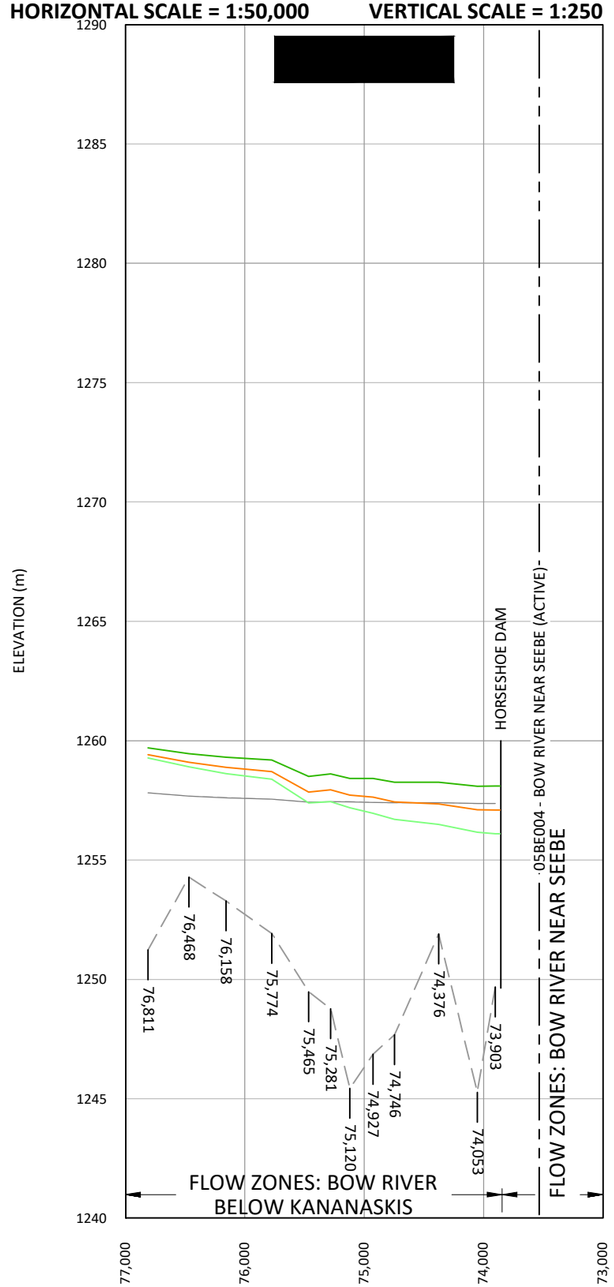
SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1002
SHEET NUMBER	2 of 10

BOW RIVER

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250





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NOTES:

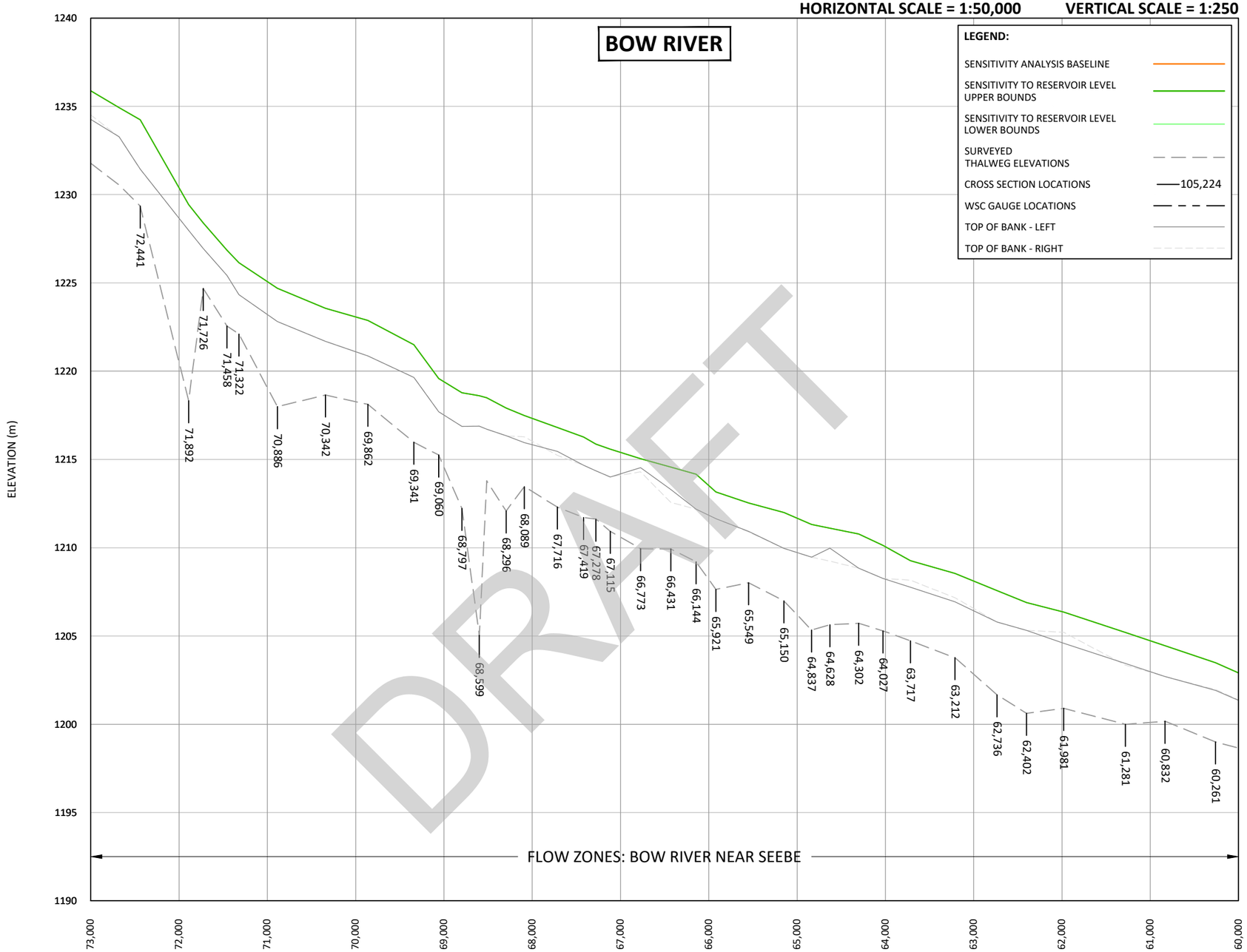
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1003
SHEET NUMBER	3 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

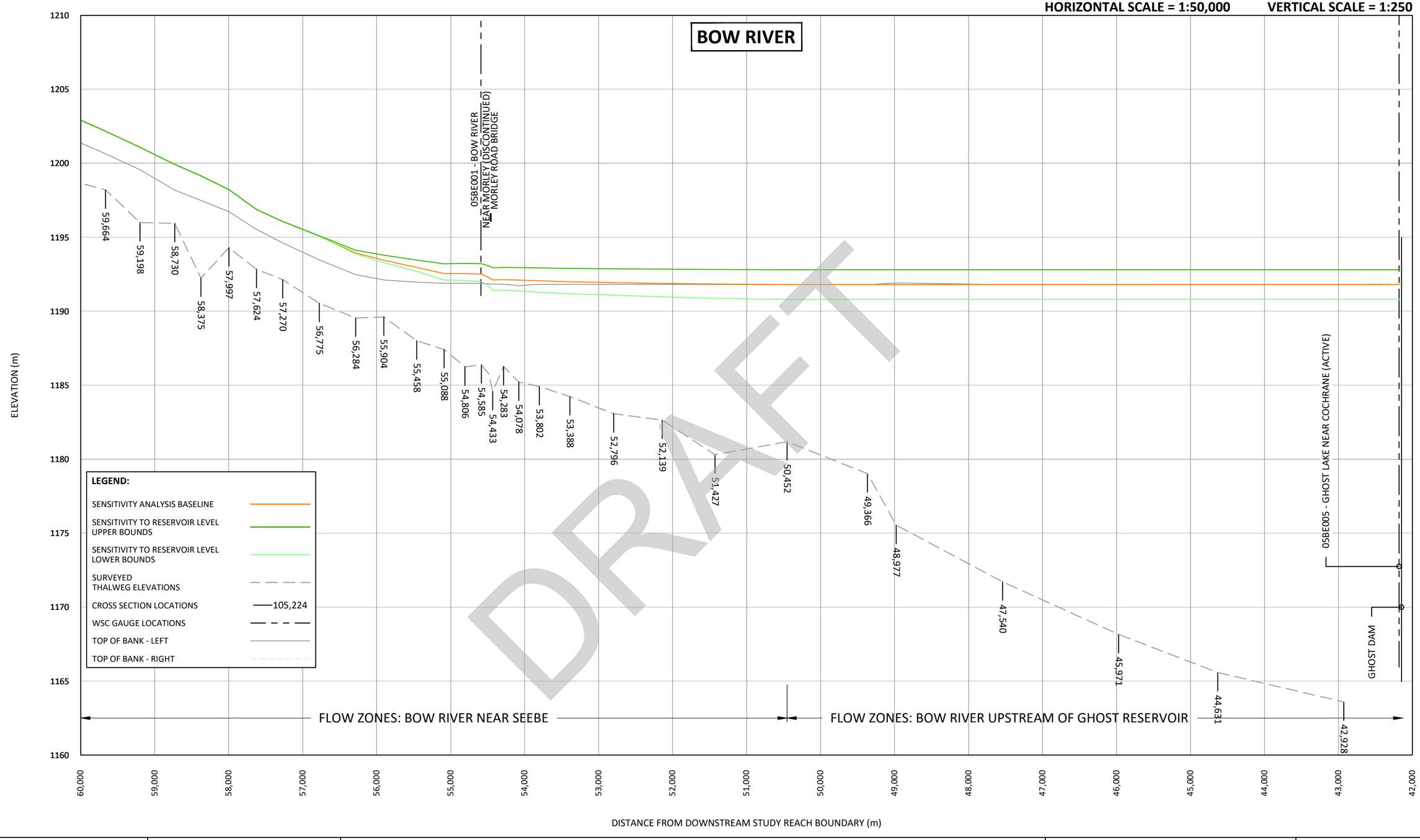
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1004
SHEET NUMBER	4 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

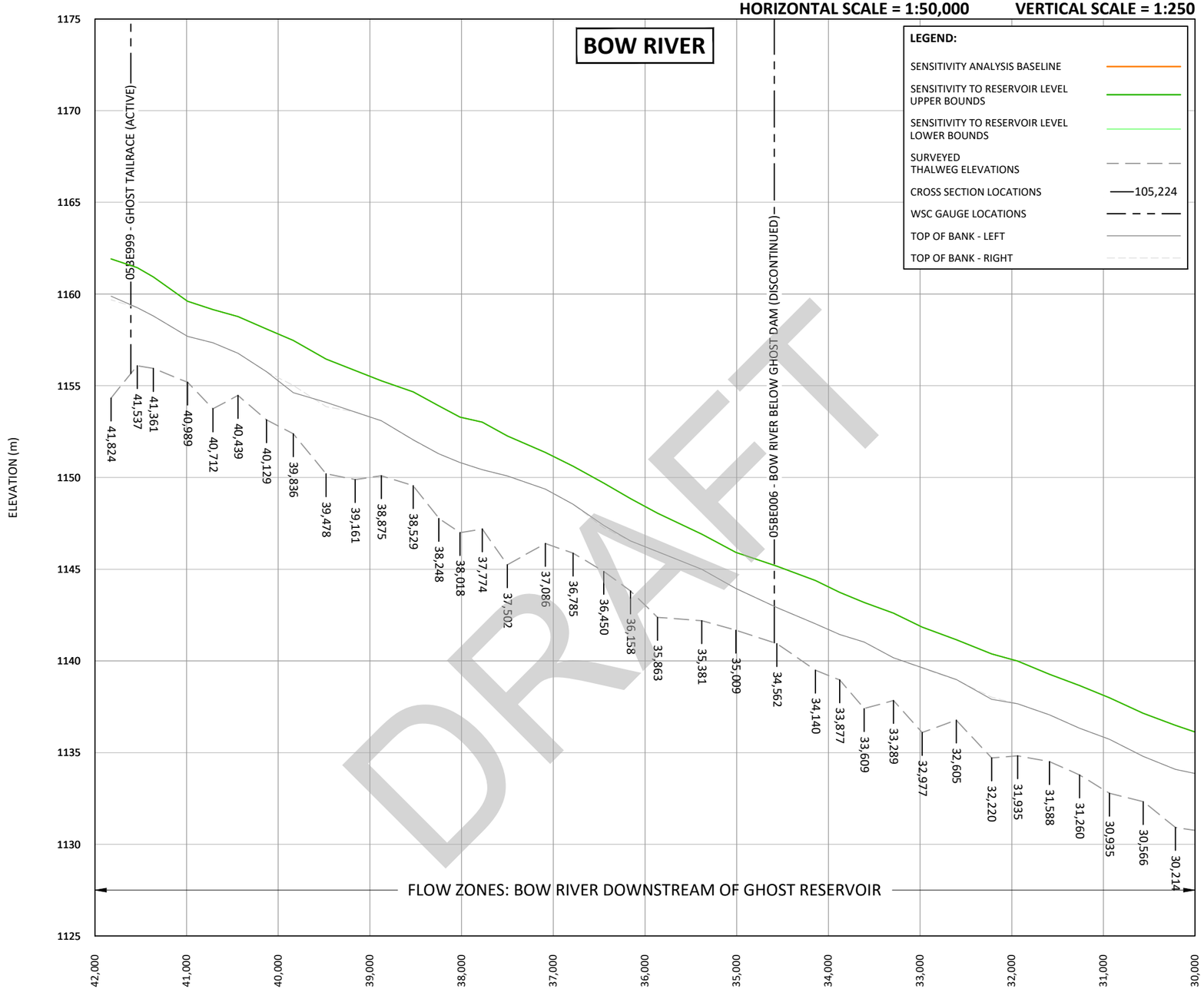
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1005
SHEET NUMBER	5 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

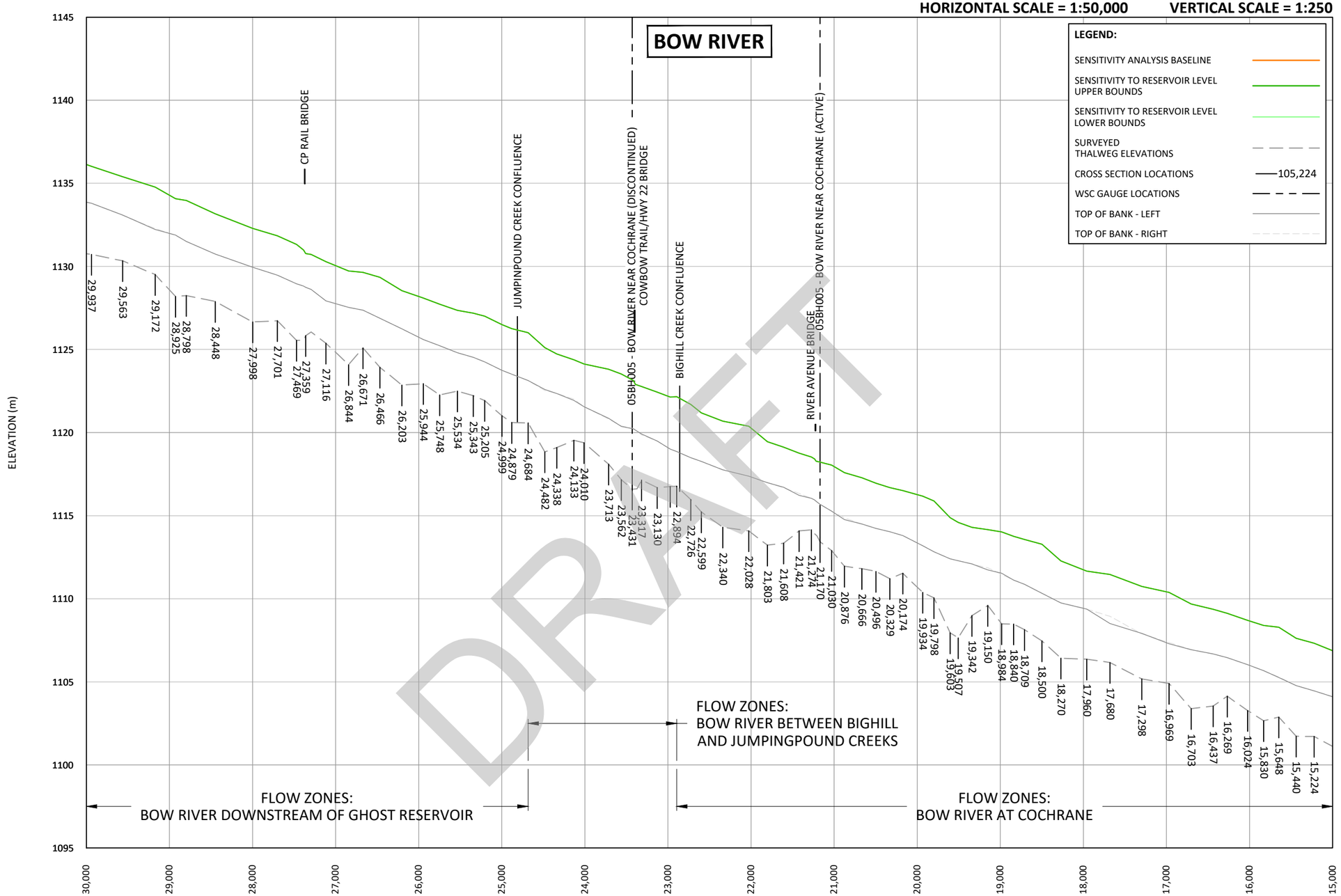
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1006
SHEET NUMBER	6 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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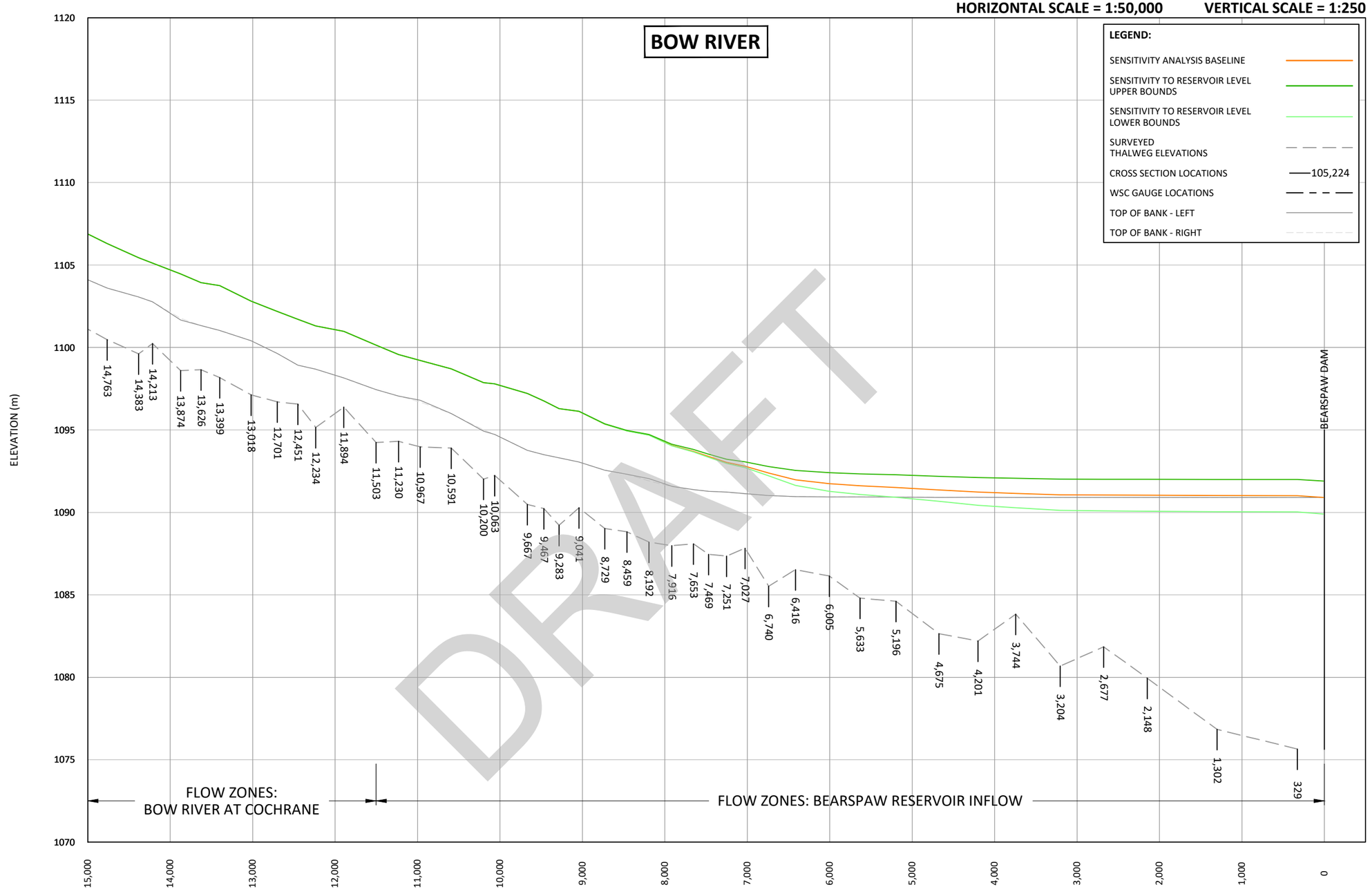
NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1007
SHEET NUMBER	7 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

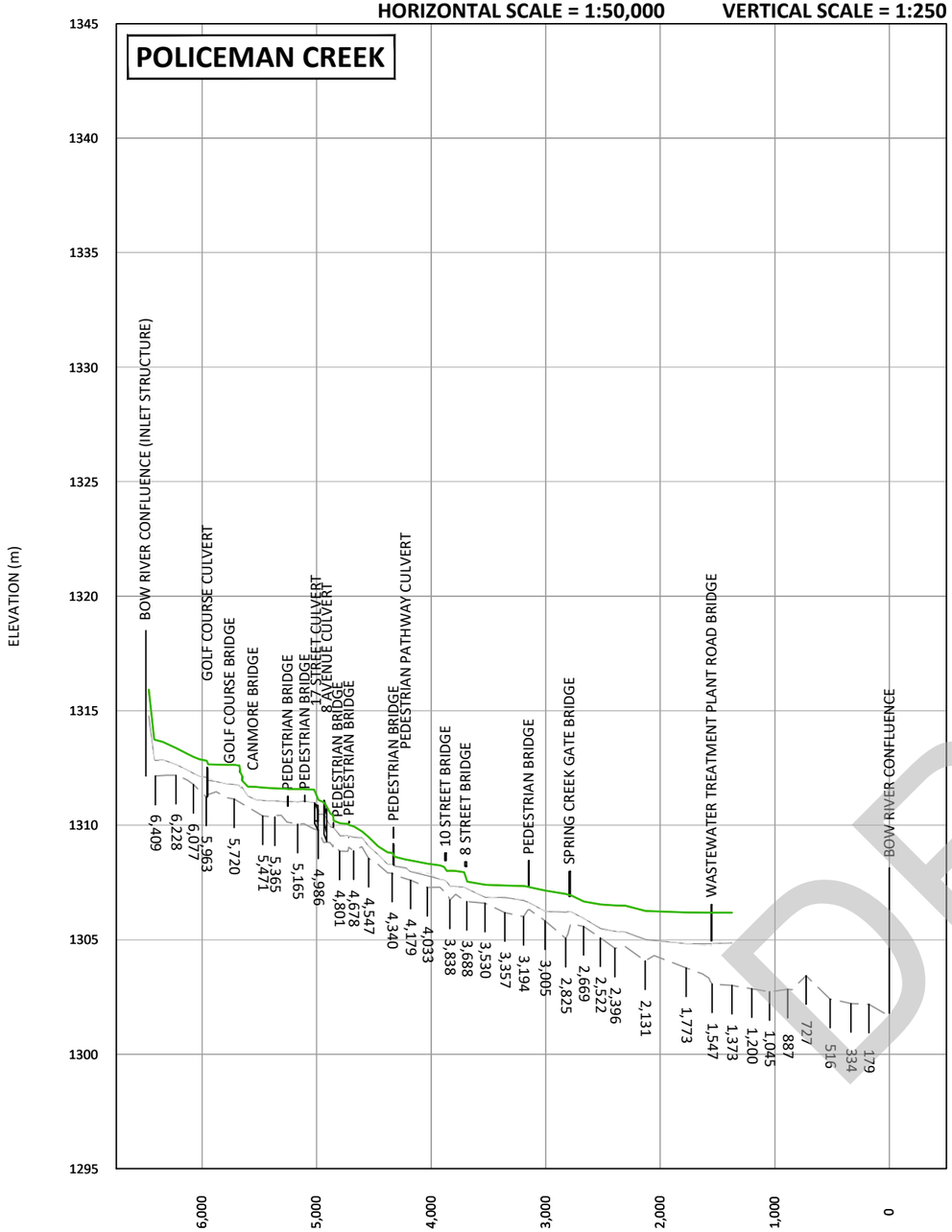
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1008
SHEET NUMBER	8 of 10

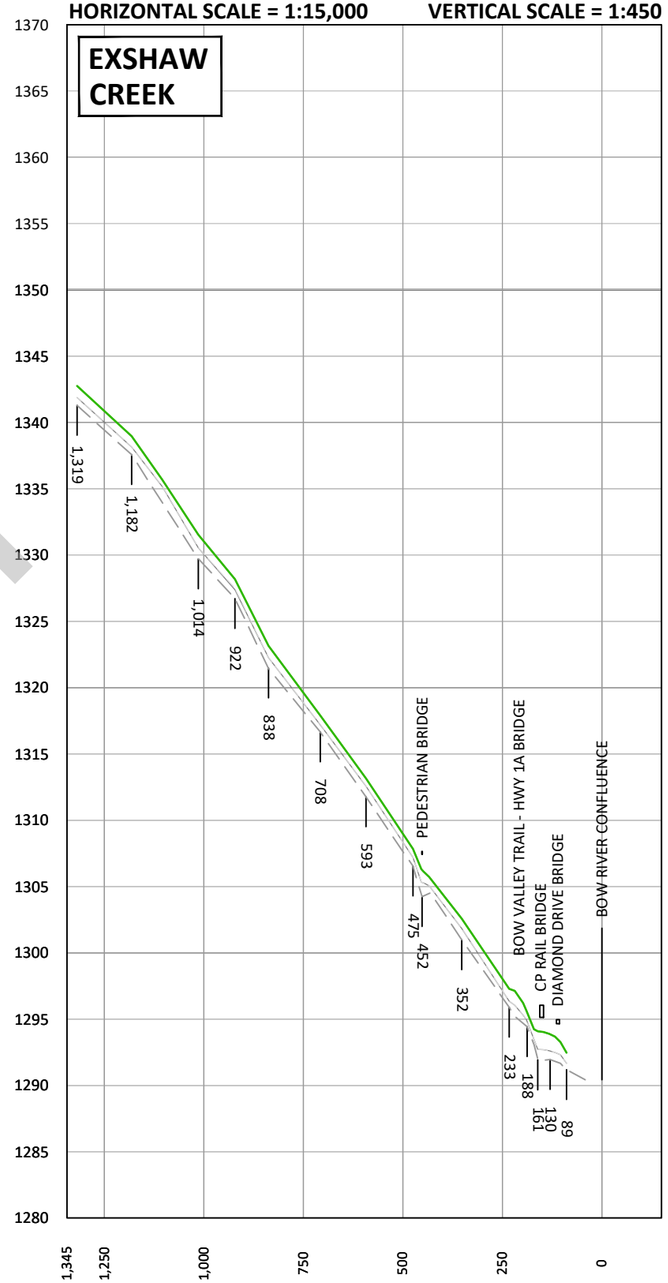
HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO RESERVOIR LEVEL UPPER BOUNDS
- SENSITIVITY TO RESERVOIR LEVEL LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT

HORIZONTAL SCALE = 1:15,000 VERTICAL SCALE = 1:450



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

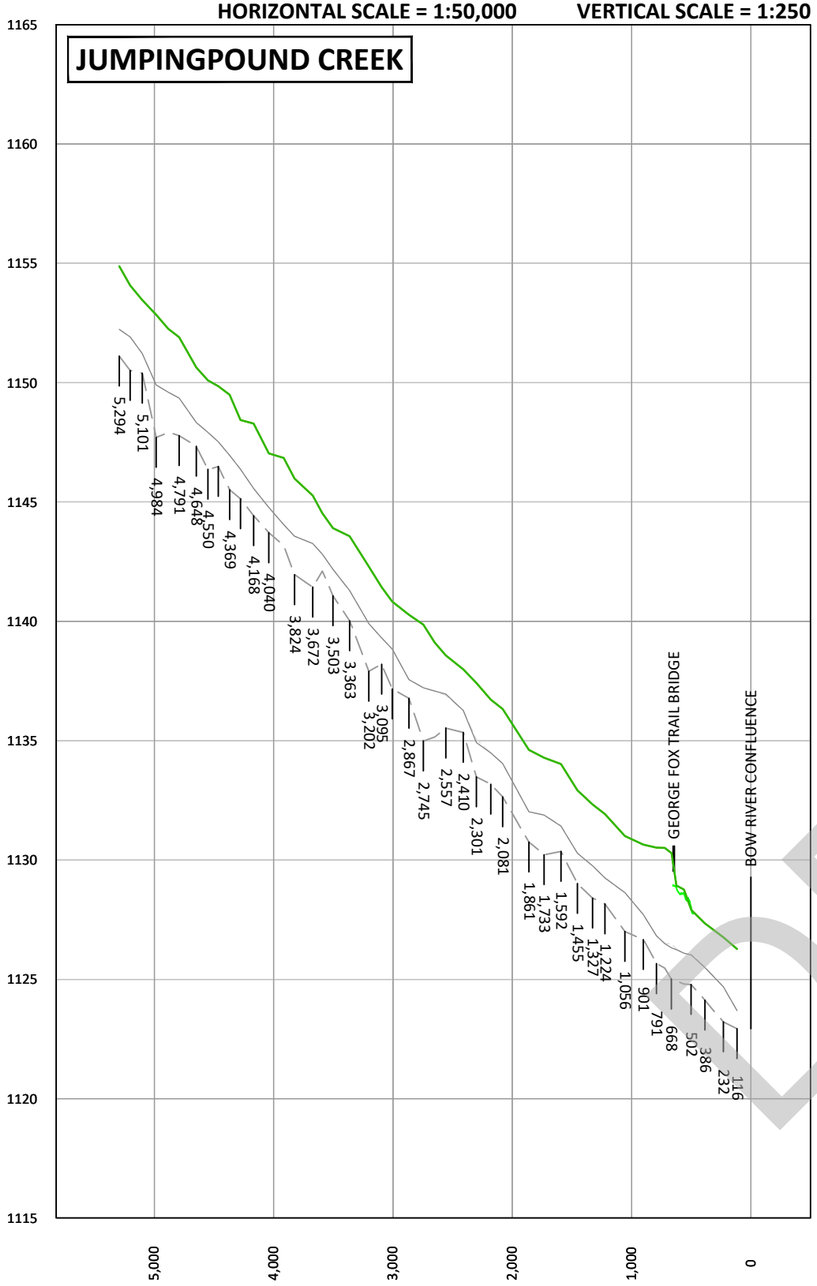
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1009
SHEET NUMBER	9 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

JUMPINGPOUND CREEK

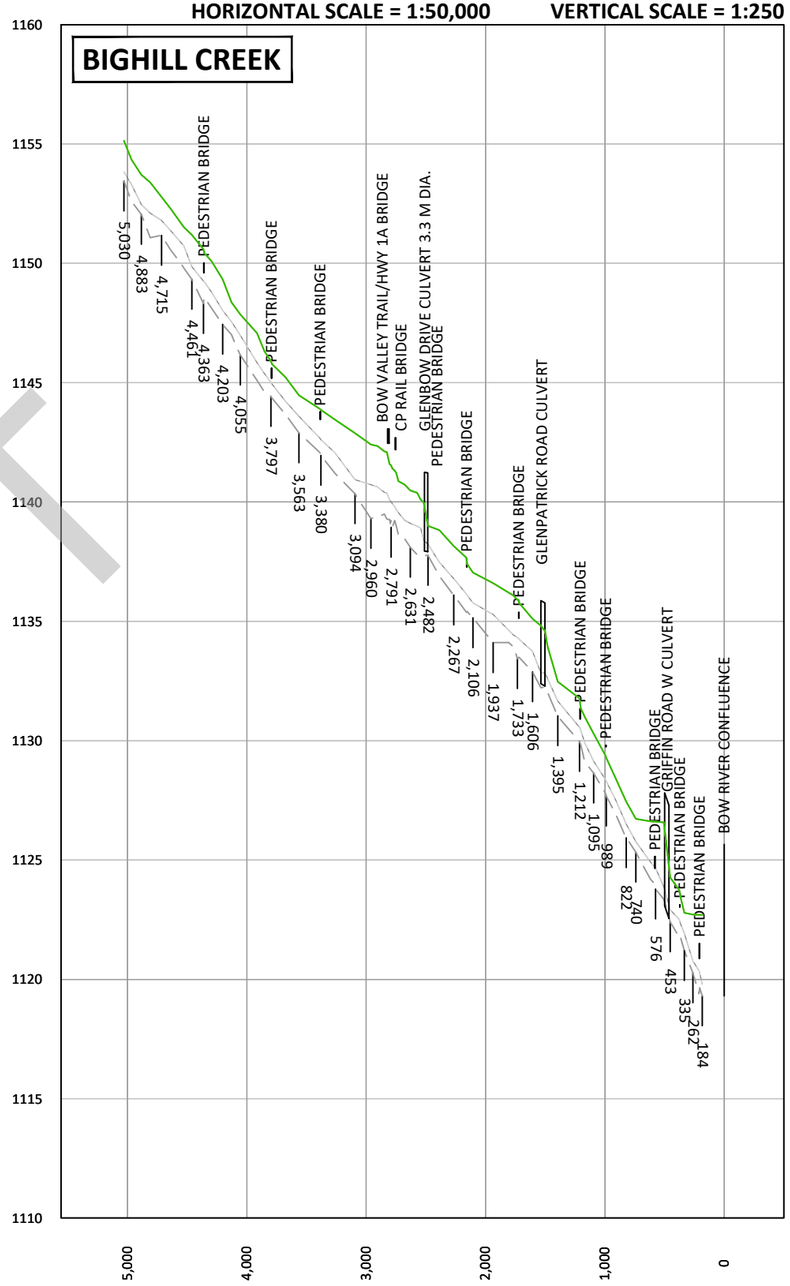


LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO RESERVOIR LEVEL UPPER BOUNDS
- SENSITIVITY TO RESERVOIR LEVEL LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT
- JUMPINGPOUND CREEK DIKE

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BIGHILL CREEK



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

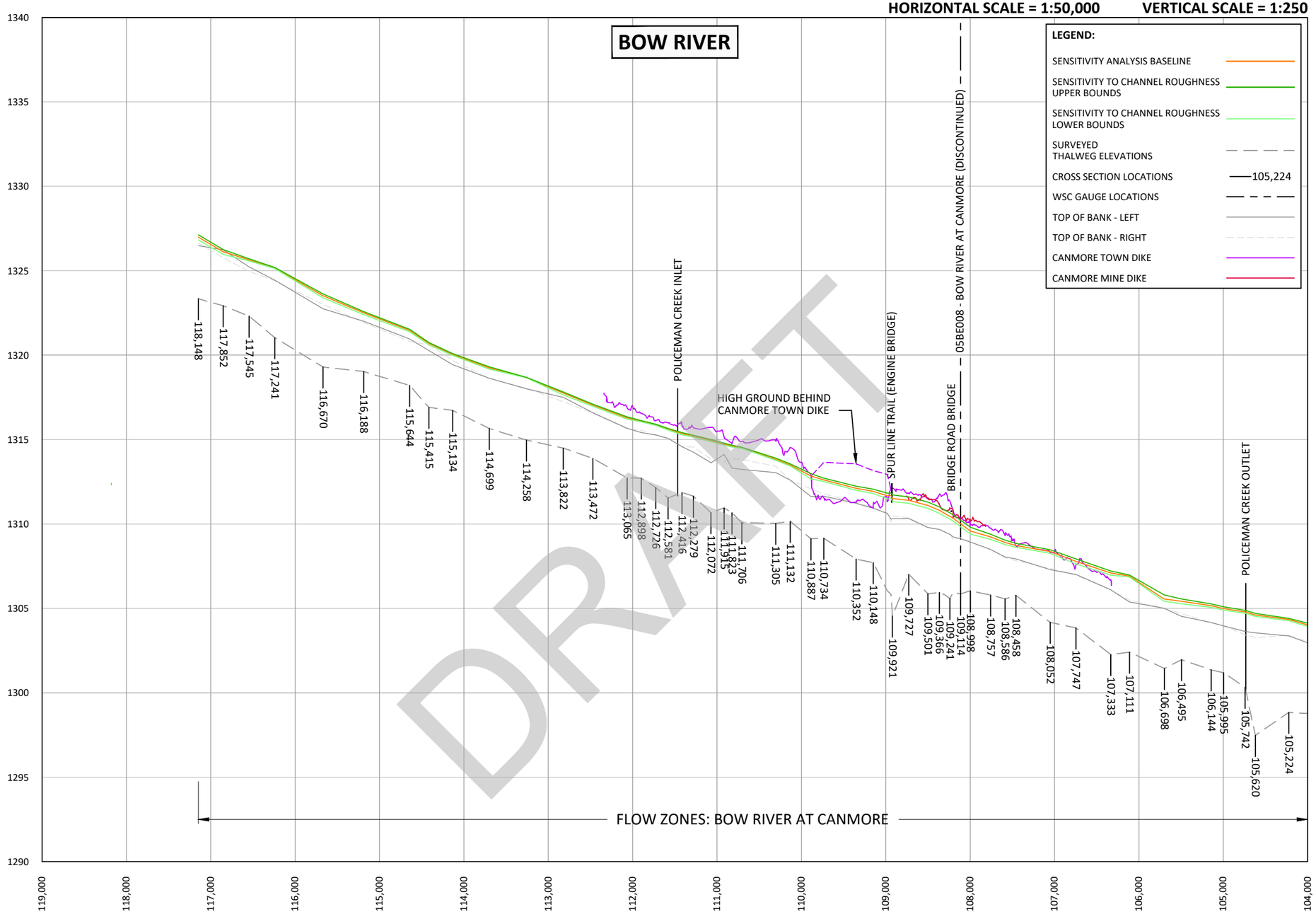
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO RESERVOIR LEVEL

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-1010
SHEET NUMBER	10 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER



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NOTES:

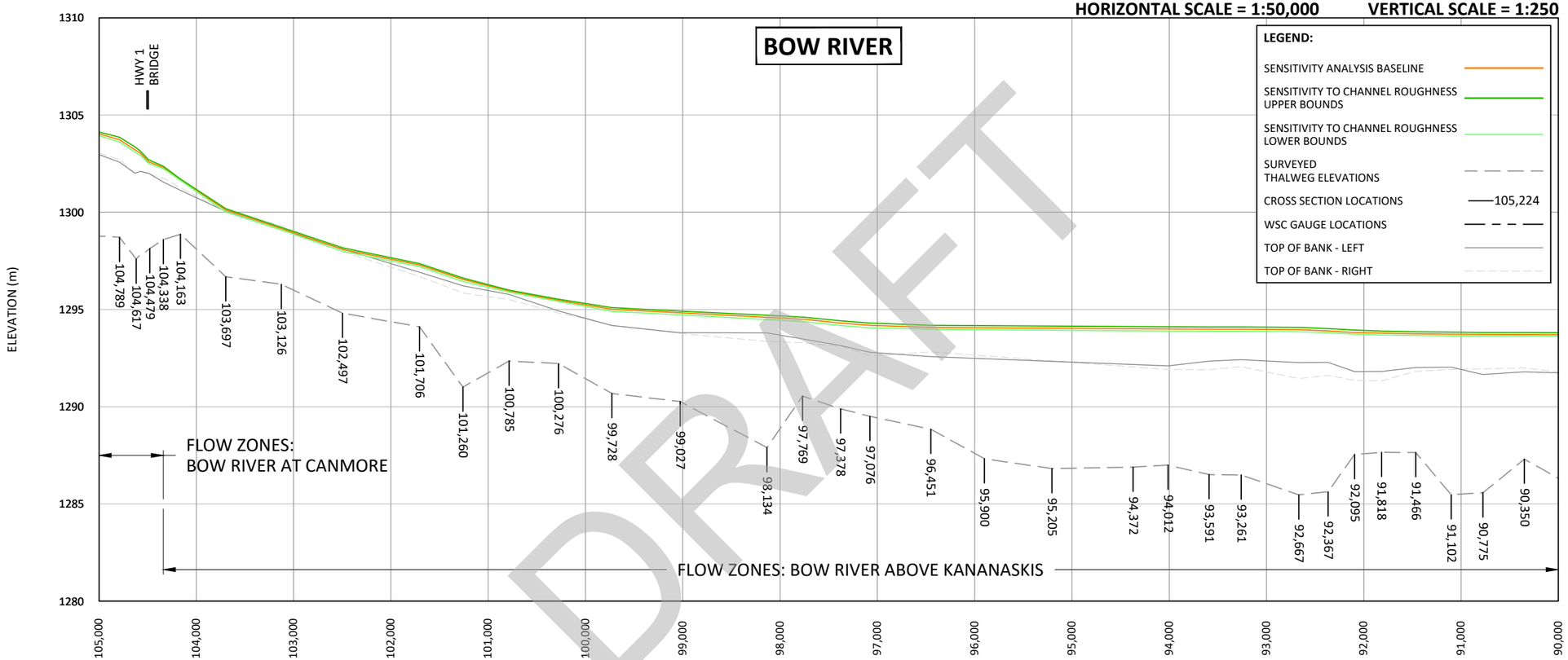
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-801
SHEET NUMBER	1 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

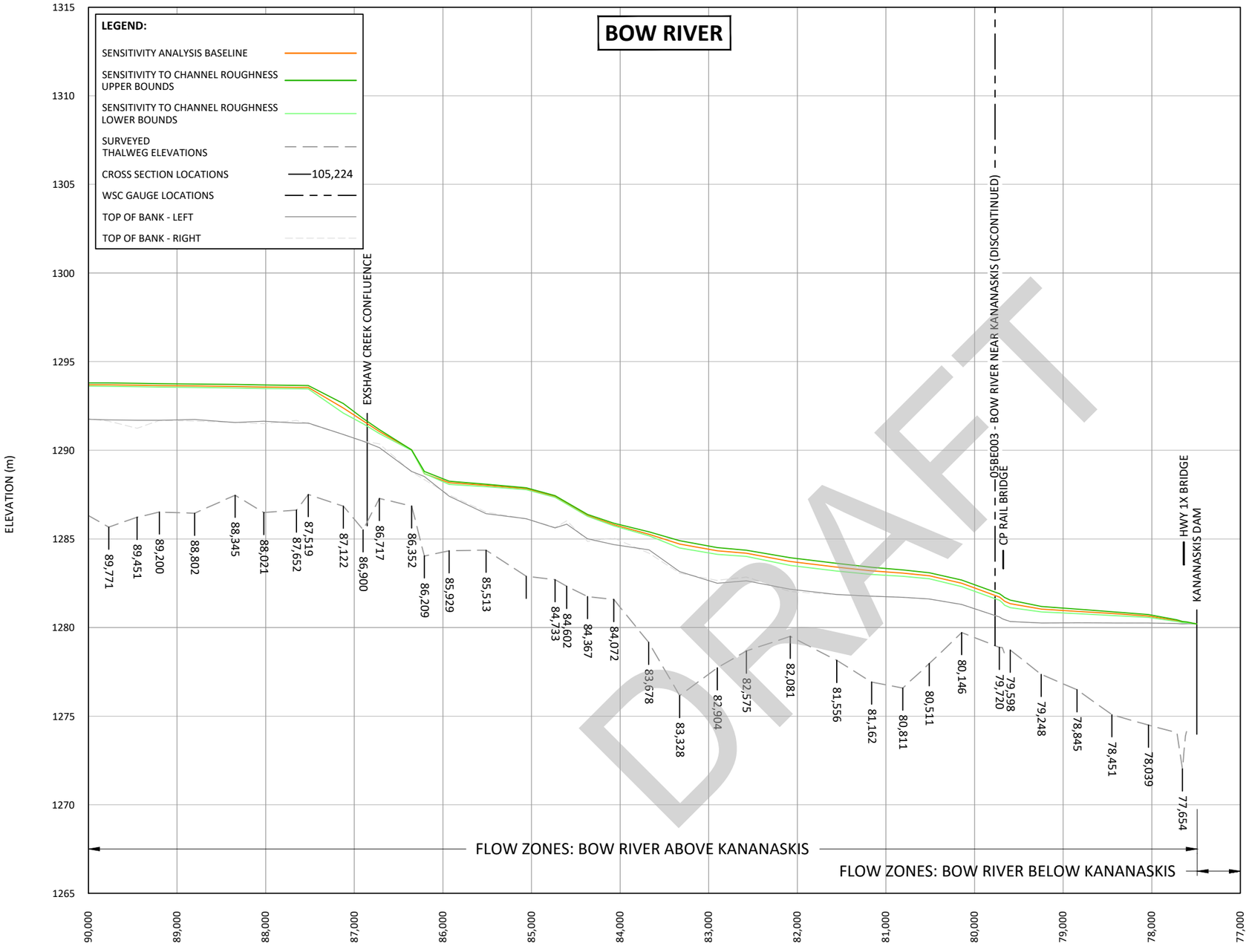
SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-802
SHEET NUMBER	2 of 10

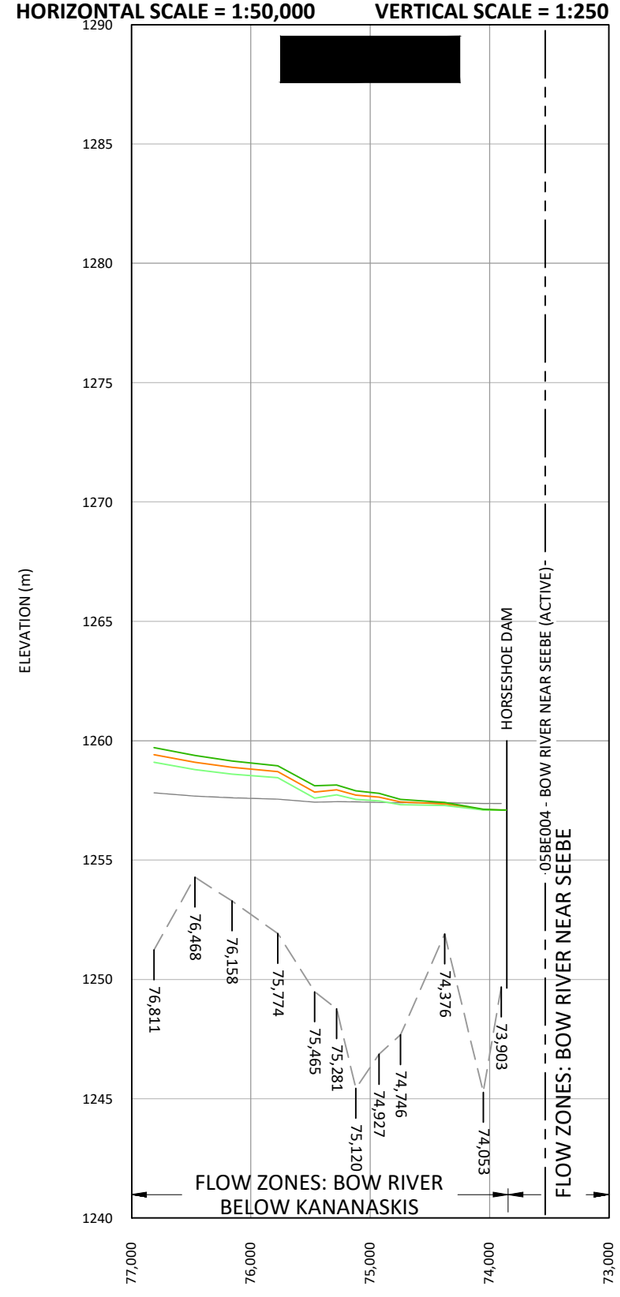
BOW RIVER

LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO CHANNEL ROUGHNESS UPPER BOUNDS
- SENSITIVITY TO CHANNEL ROUGHNESS LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT



HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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NOTES:

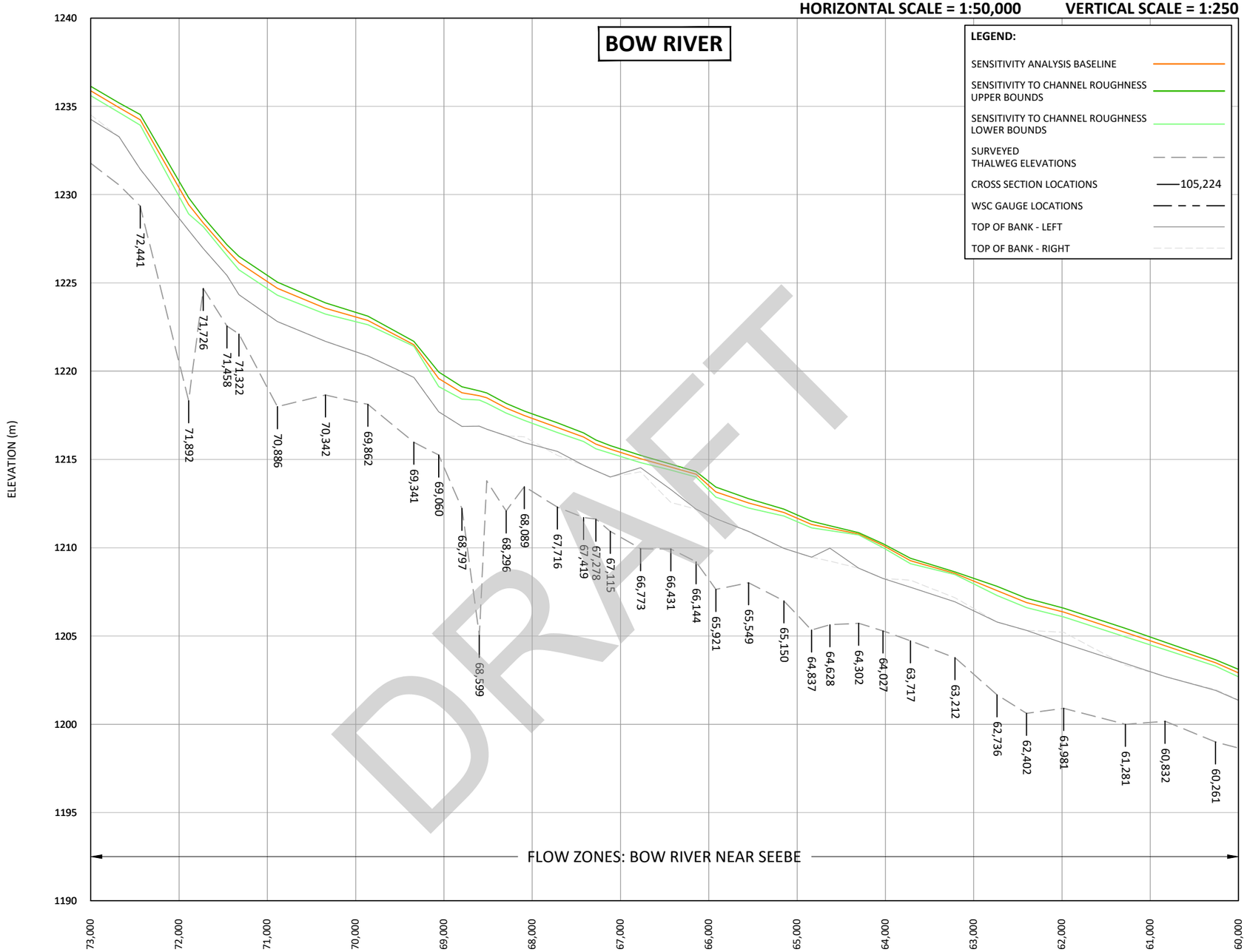
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-803
SHEET NUMBER	3 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

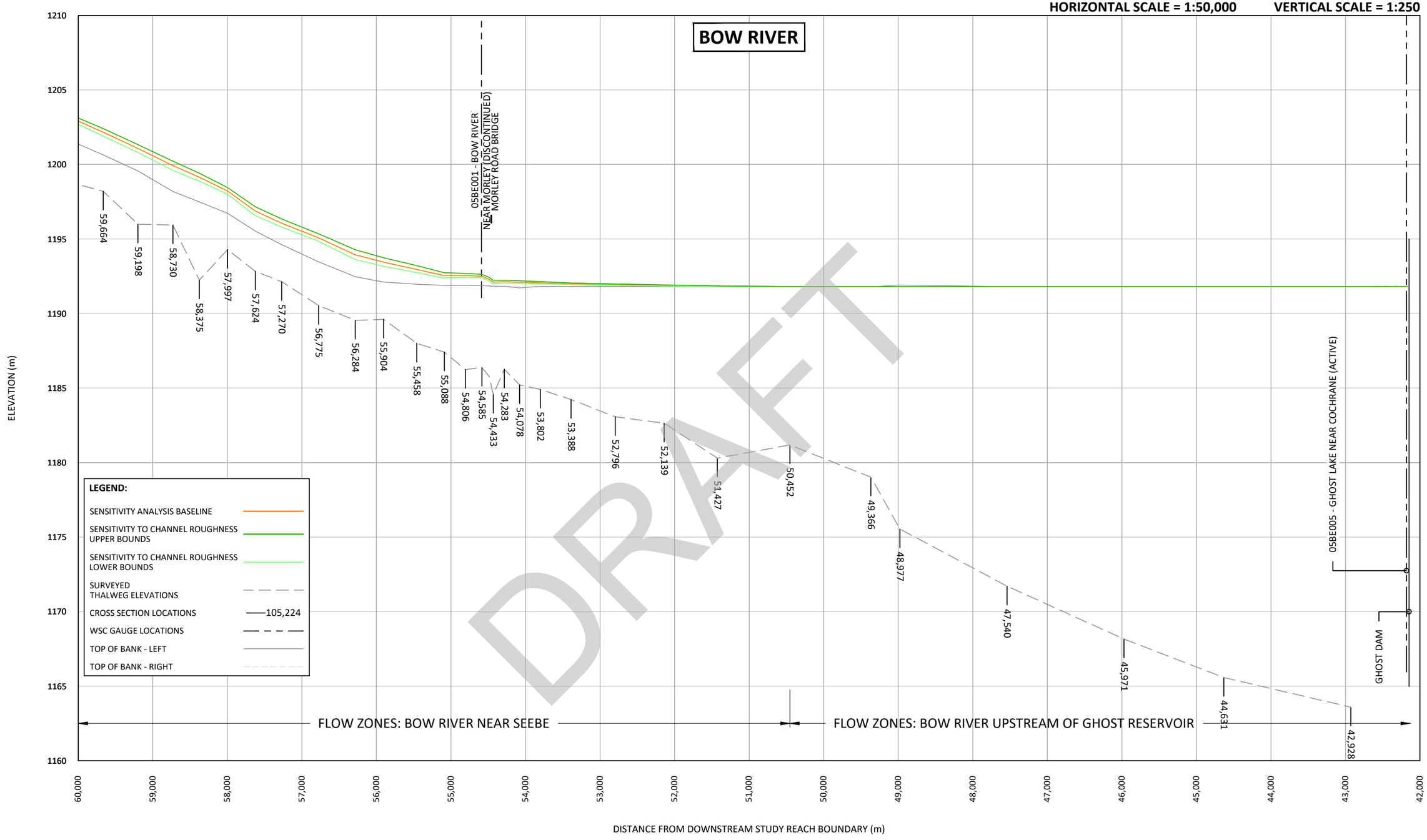
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-804
SHEET NUMBER	4 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER



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NOTES:

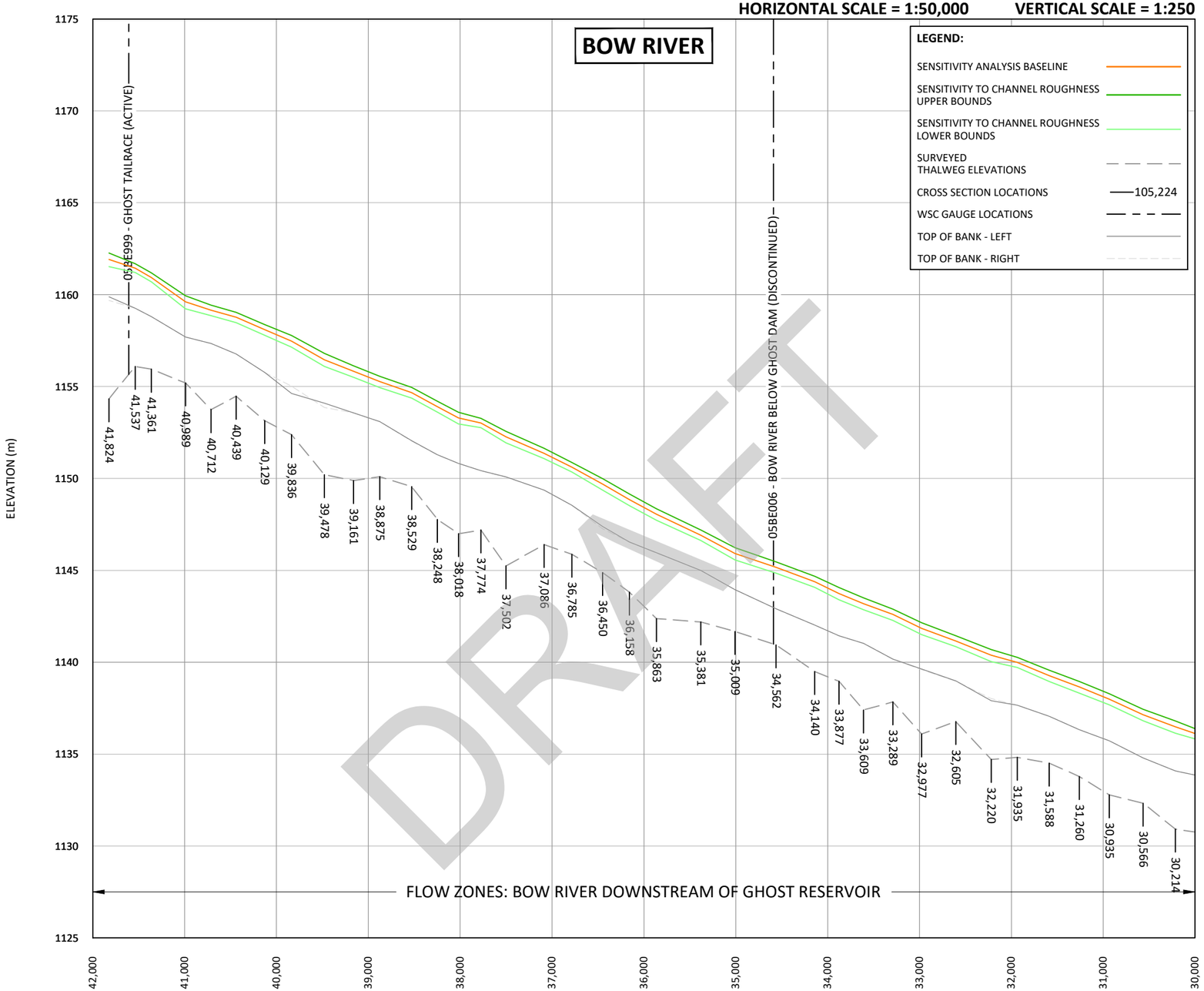
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-805
SHEET NUMBER	5 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

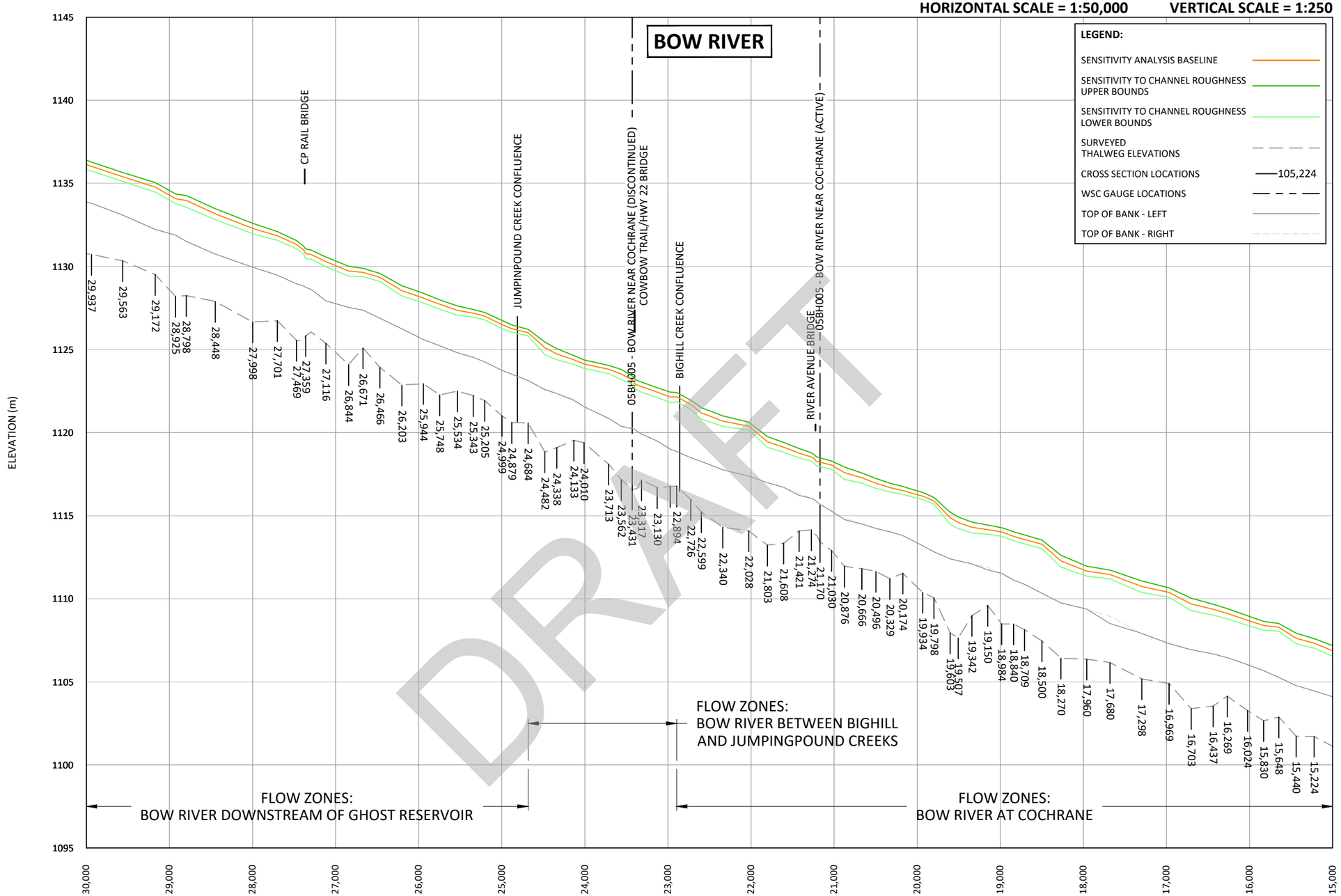
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-806
SHEET NUMBER	6 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

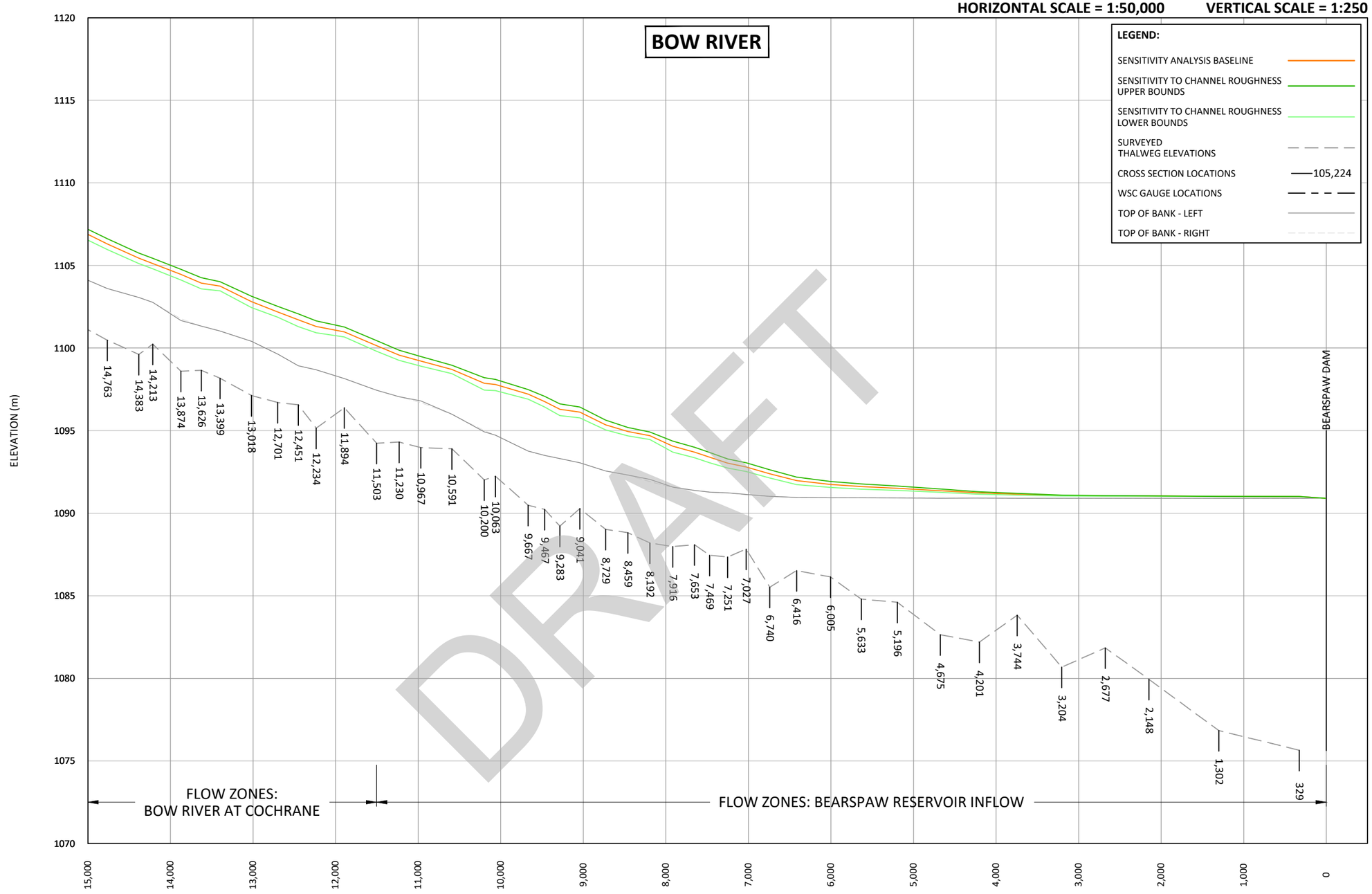
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-807
SHEET NUMBER	7 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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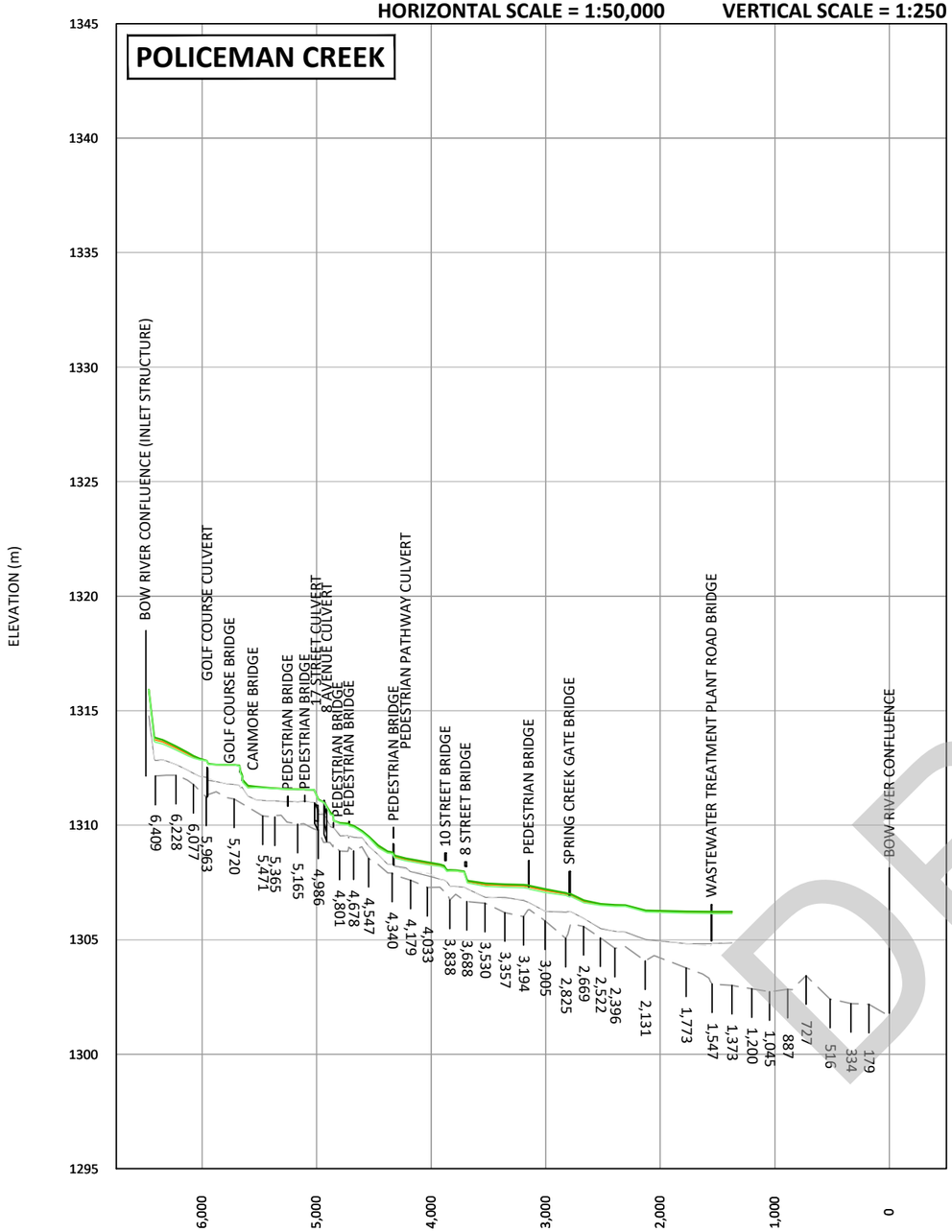
NOTES:
1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-808
SHEET NUMBER	8 of 10

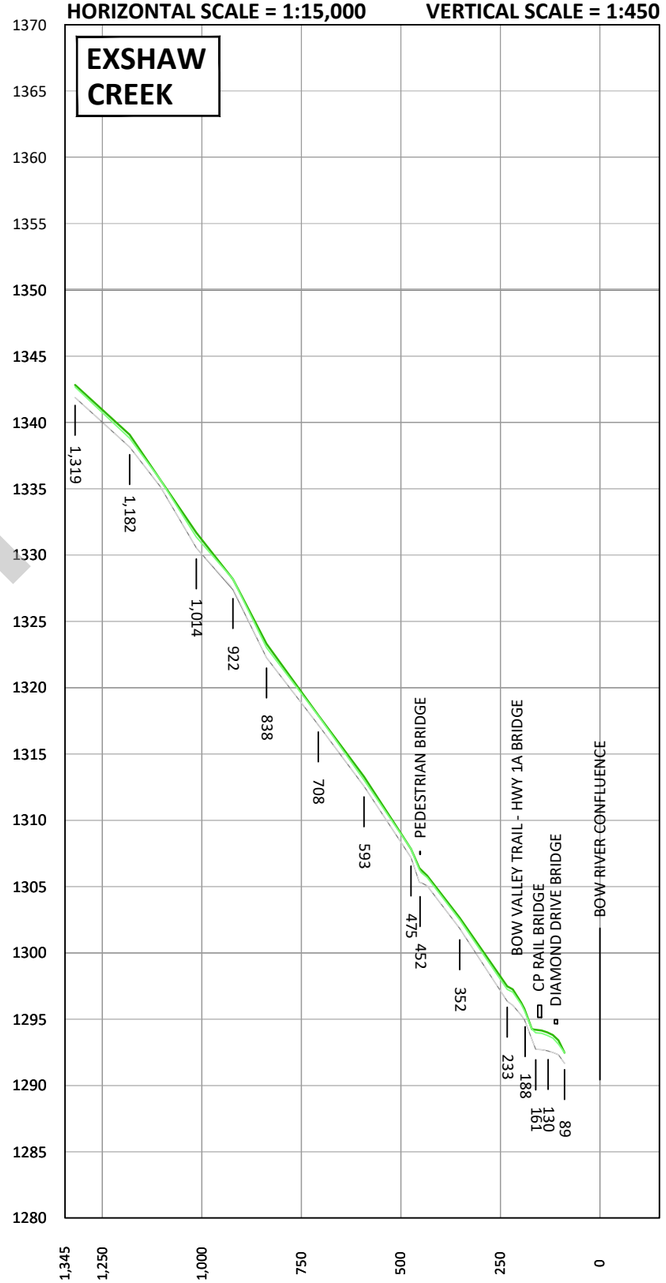
HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO CHANNEL ROUGHNESS UPPER BOUNDS
- SENSITIVITY TO CHANNEL ROUGHNESS LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT

HORIZONTAL SCALE = 1:15,000 VERTICAL SCALE = 1:450



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NOTES:

1. REFER TO MAP SHEETS 1 TO 10 FOR A PLAN VIEW OF THE STUDY REACH FEATURES AND THE SURVEYED CROSS SECTIONS.

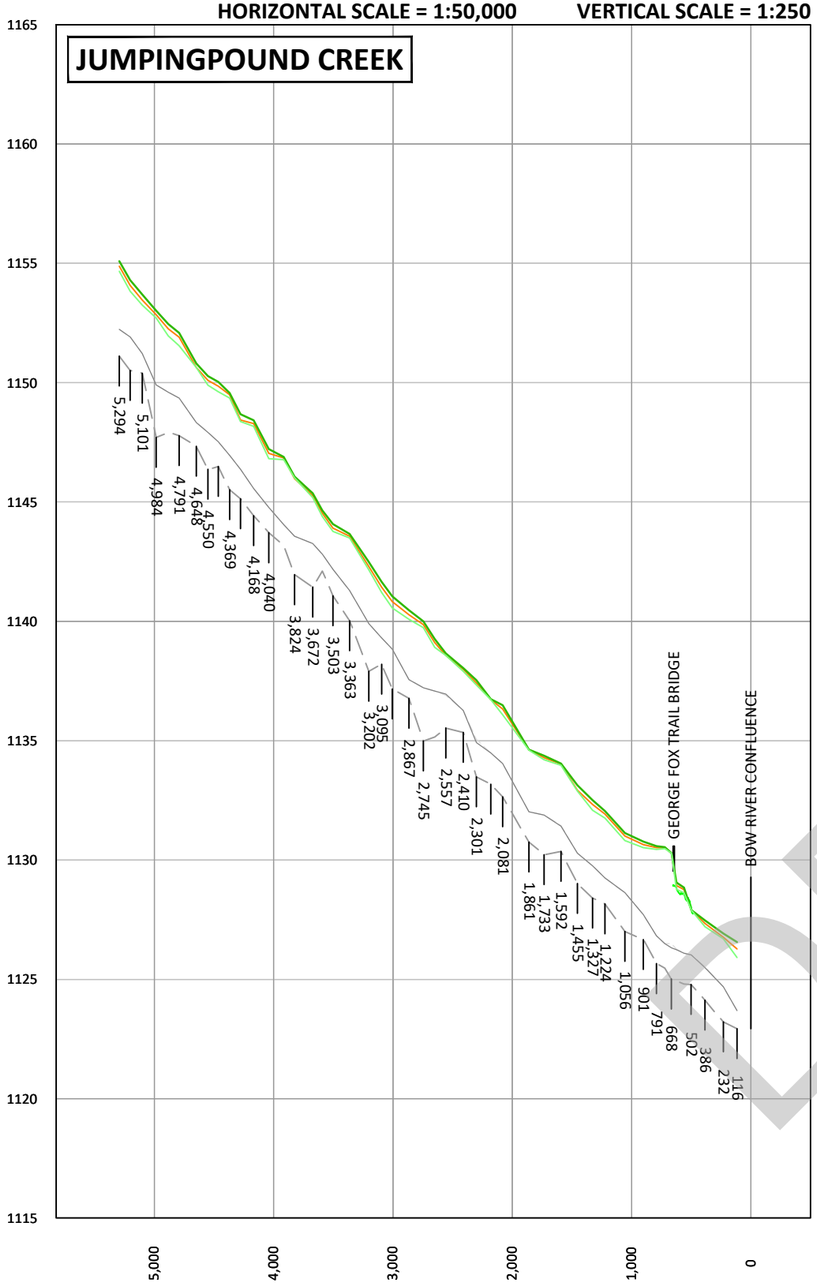
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-809
SHEET NUMBER	9 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

JUMPINGPOUND CREEK

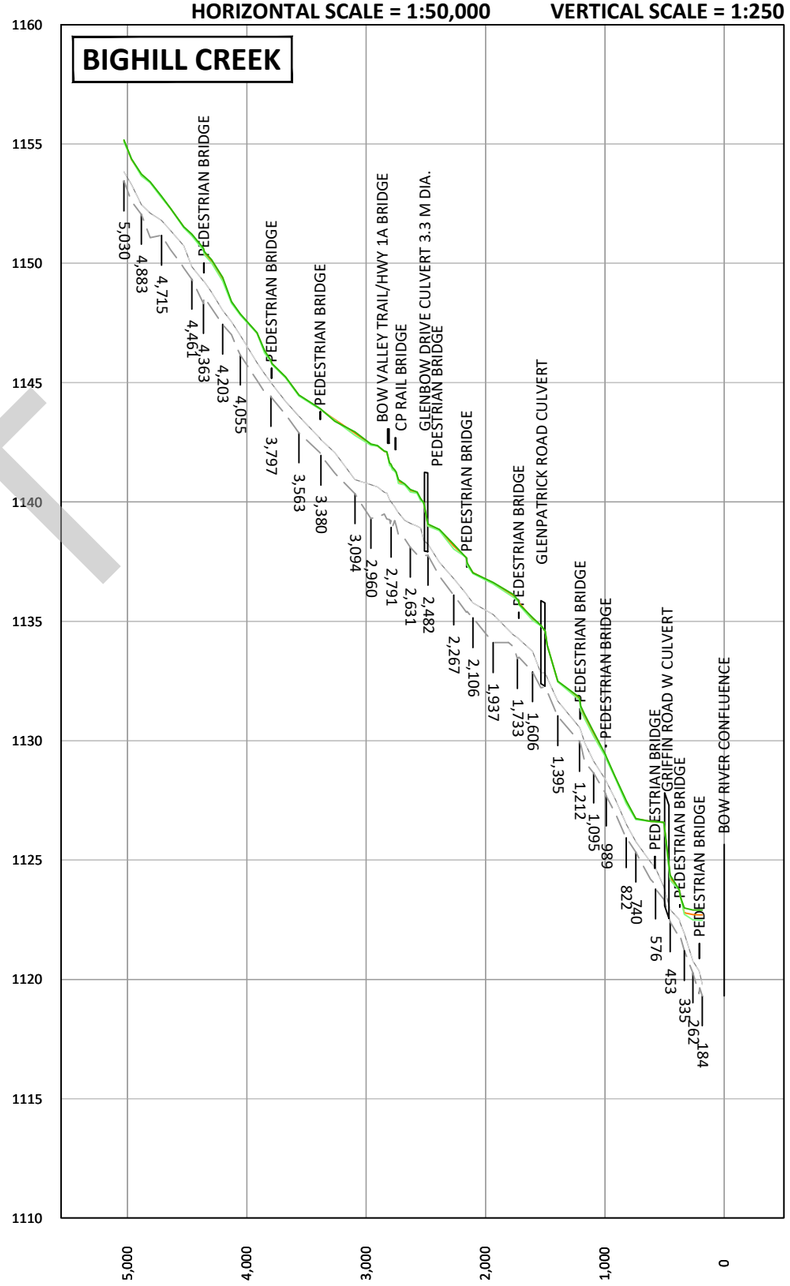


LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO CHANNEL ROUGHNESS UPPER BOUNDS
- SENSITIVITY TO CHANNEL ROUGHNESS LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BIGHILL CREEK



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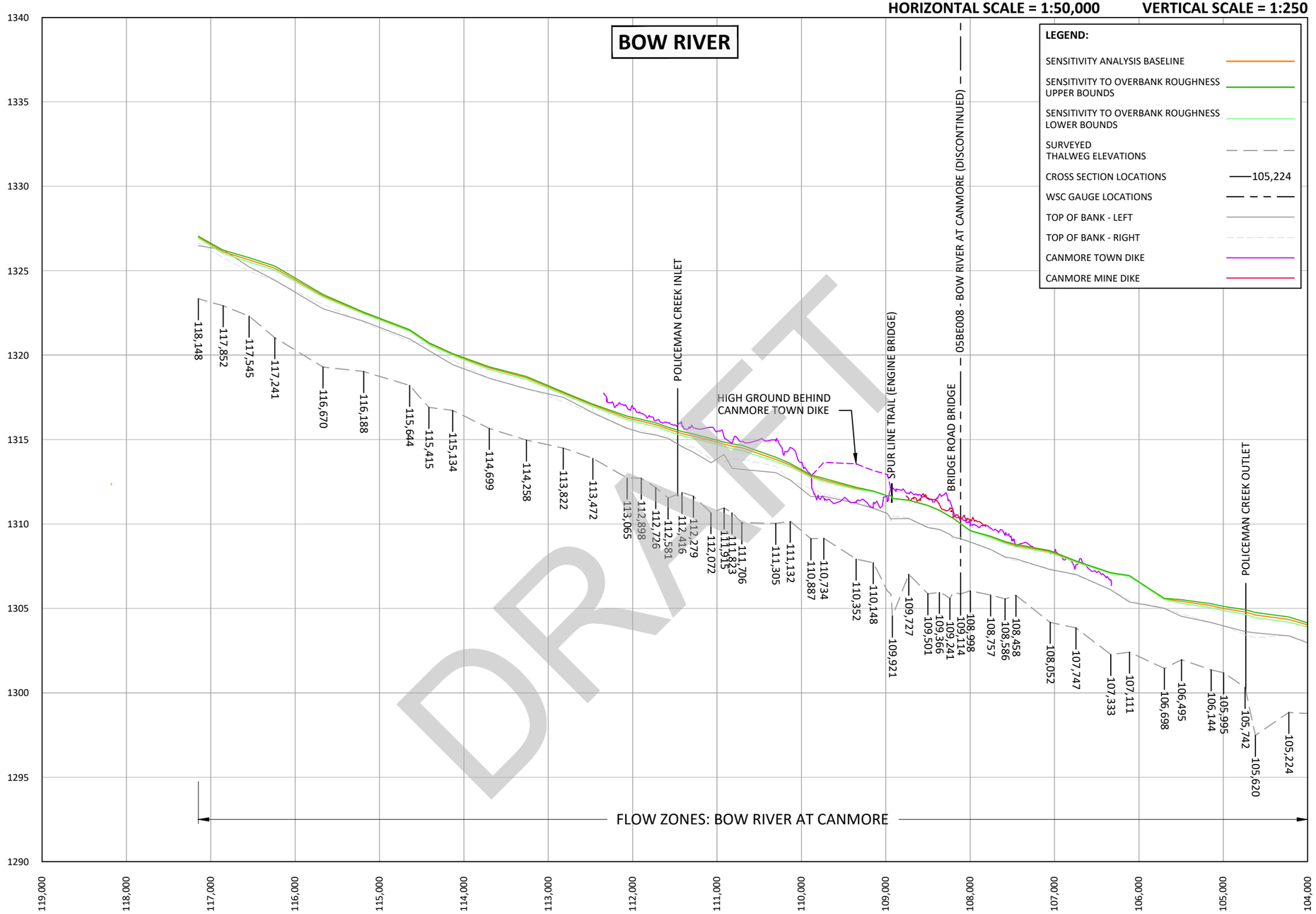
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO CHANNEL ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-810
SHEET NUMBER	10 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BOW RIVER



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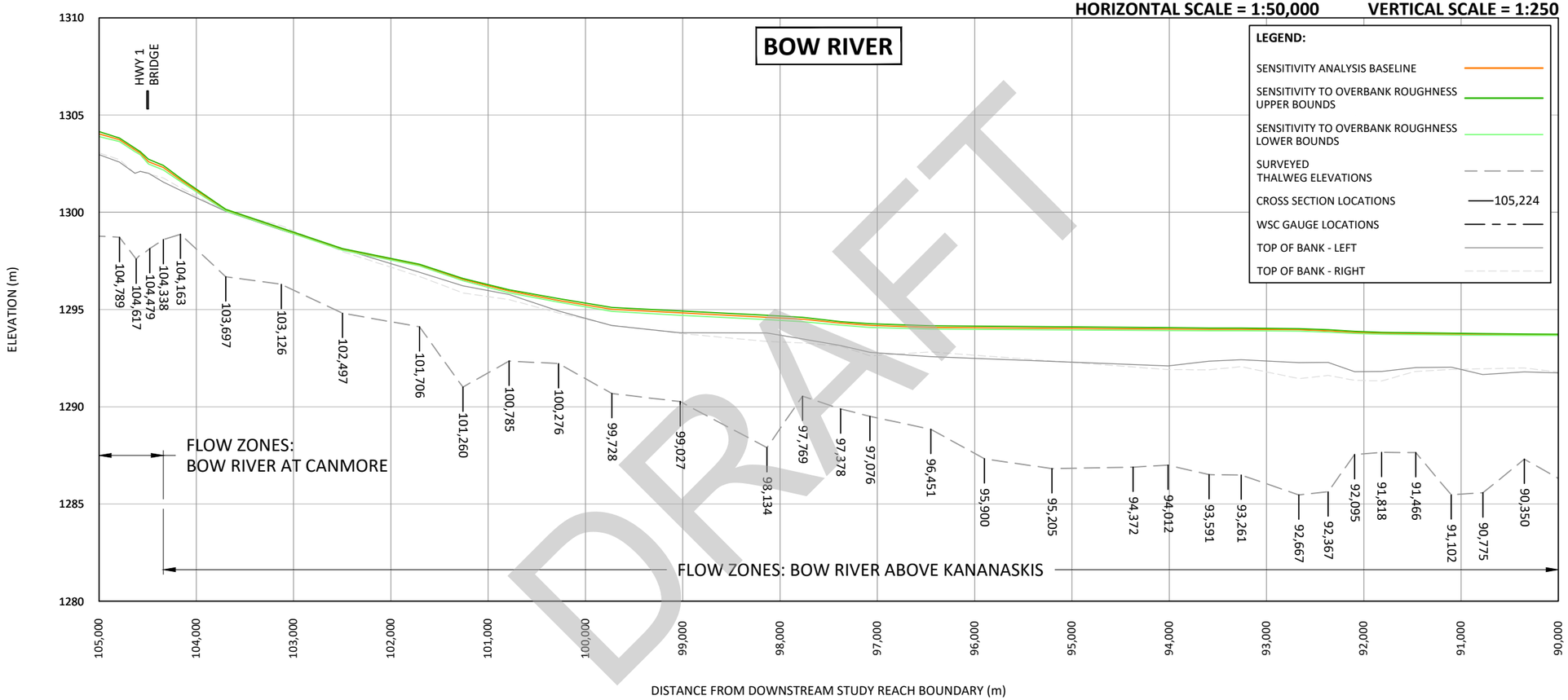
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-901
SHEET NUMBER	1 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-902
SHEET NUMBER	2 of 10

BOW RIVER

LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO OVERBANK ROUGHNESS UPPER BOUNDS
- SENSITIVITY TO OVERBANK ROUGHNESS LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT

ELEVATION (m)

1315, 1310, 1305, 1300, 1295, 1290, 1285, 1280, 1275, 1270, 1265

EXSHAW CREEK CONFLUENCE

05BE003 - BOW RIVER NEAR KANANASKIS (DISCONTINUED)

CP RAIL BRIDGE

HWY 1X BRIDGE

KANANASKIS DAM

89,771 89,451 89,200 88,802 88,345 88,021 87,652 87,519 87,122 86,900 86,717 86,352 86,209 85,929 85,513 84,733 84,602 84,367 84,072 83,678 83,328 82,904 82,575 82,081 81,556 81,162 80,811 80,511 80,146 79,720 79,598 79,248 78,845 78,451 78,039 77,654

FLOW ZONES: BOW RIVER ABOVE KANANASKIS

FLOW ZONES: BOW RIVER BELOW KANANASKIS

90,000 89,000 88,000 87,000 86,000 85,000 84,000 83,000 82,000 81,000 80,000 79,000 78,000 77,000

DISTANCE FROM DOWNSTREAM STUDY REACH BOUNDARY (m)

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**

ELEVATION (m)

1290, 1285, 1280, 1275, 1270, 1265, 1260, 1255, 1250, 1245, 1240

HORSESHOE DAM

05BE004 - BOW RIVER NEAR SEEBE (ACTIVE)

76,811 76,468 76,158 75,774 75,465 75,281 75,120 74,927 74,746 74,376 74,053 73,903

FLOW ZONES: BOW RIVER BELOW KANANASKIS

FLOW ZONES: BOW RIVER NEAR SEEBE

77,000 76,000 75,000 74,000 73,000

DISTANCE FROM DOWNSTREAM STUDY REACH BOUNDARY (m)

Alberta Government

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NOTES:

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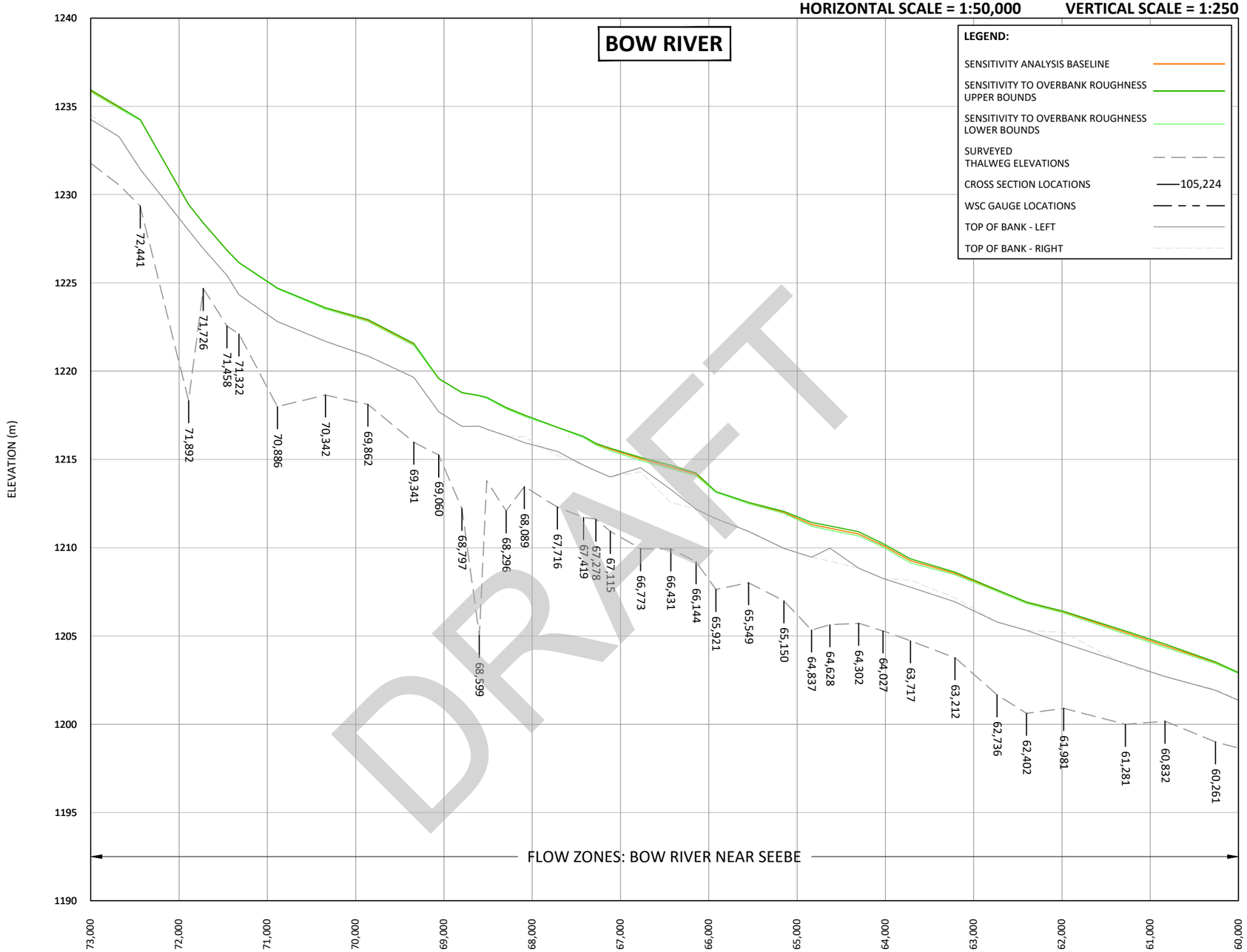
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-903
SHEET NUMBER	3 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

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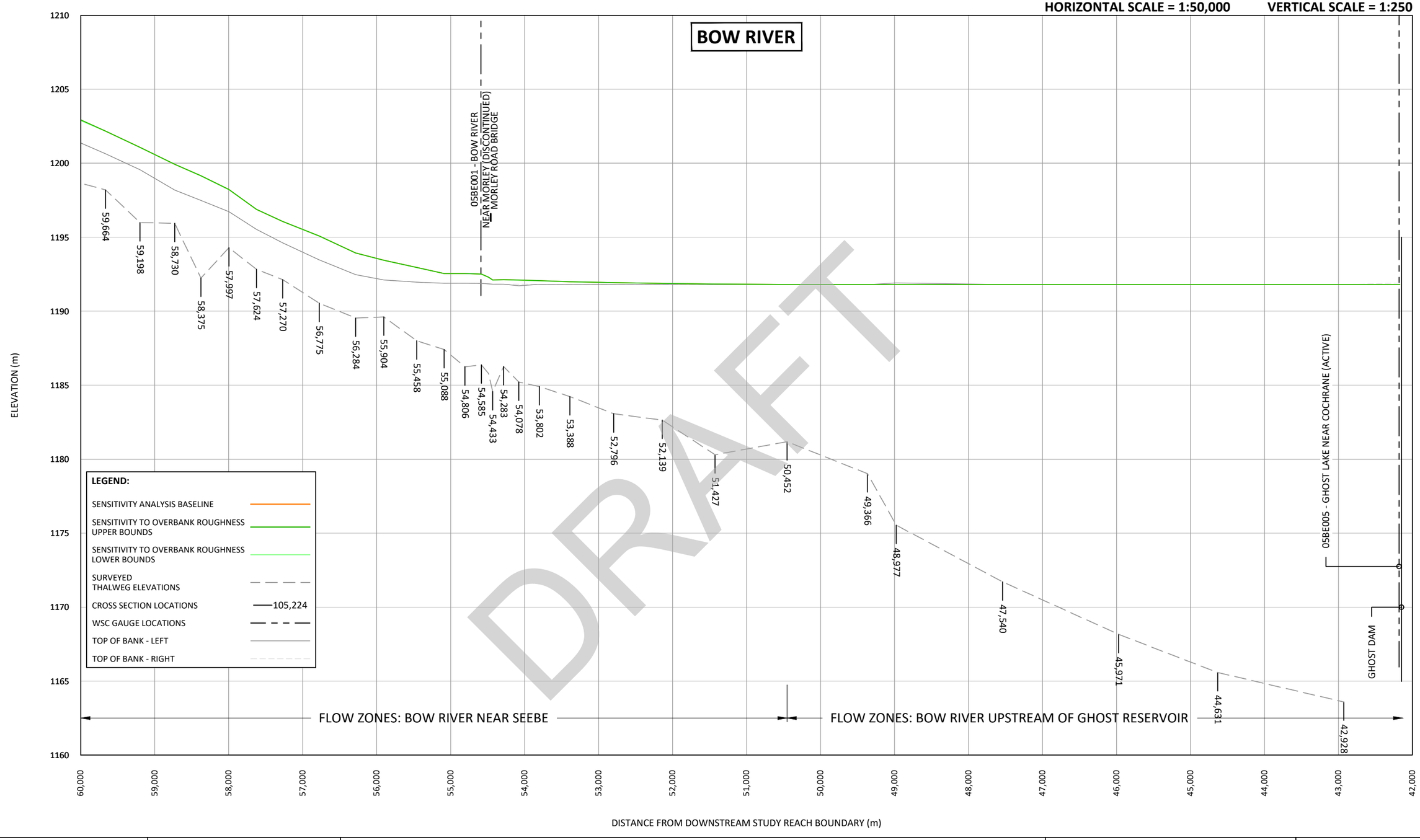
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-904
SHEET NUMBER	4 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

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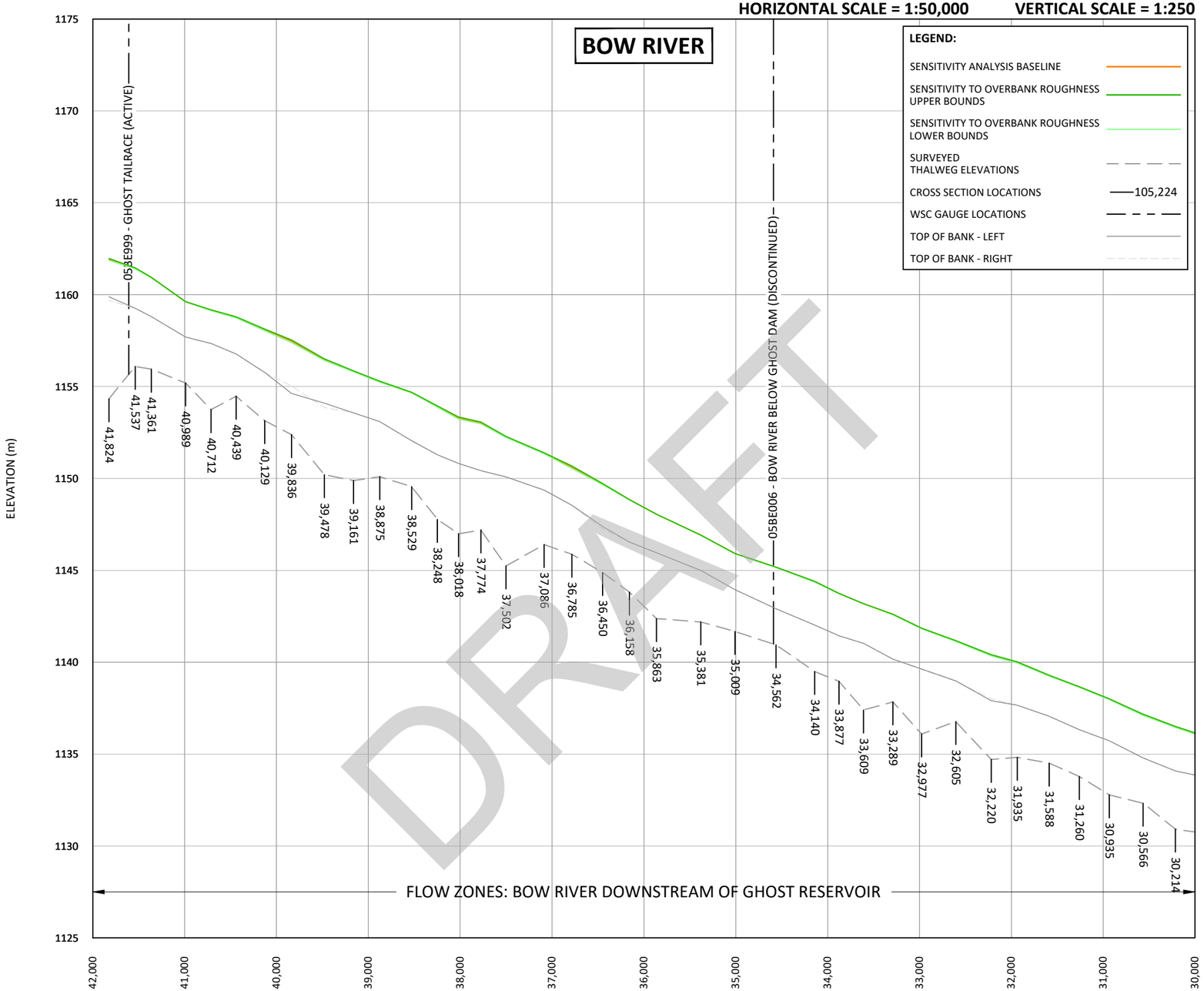
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-905
SHEET NUMBER	5 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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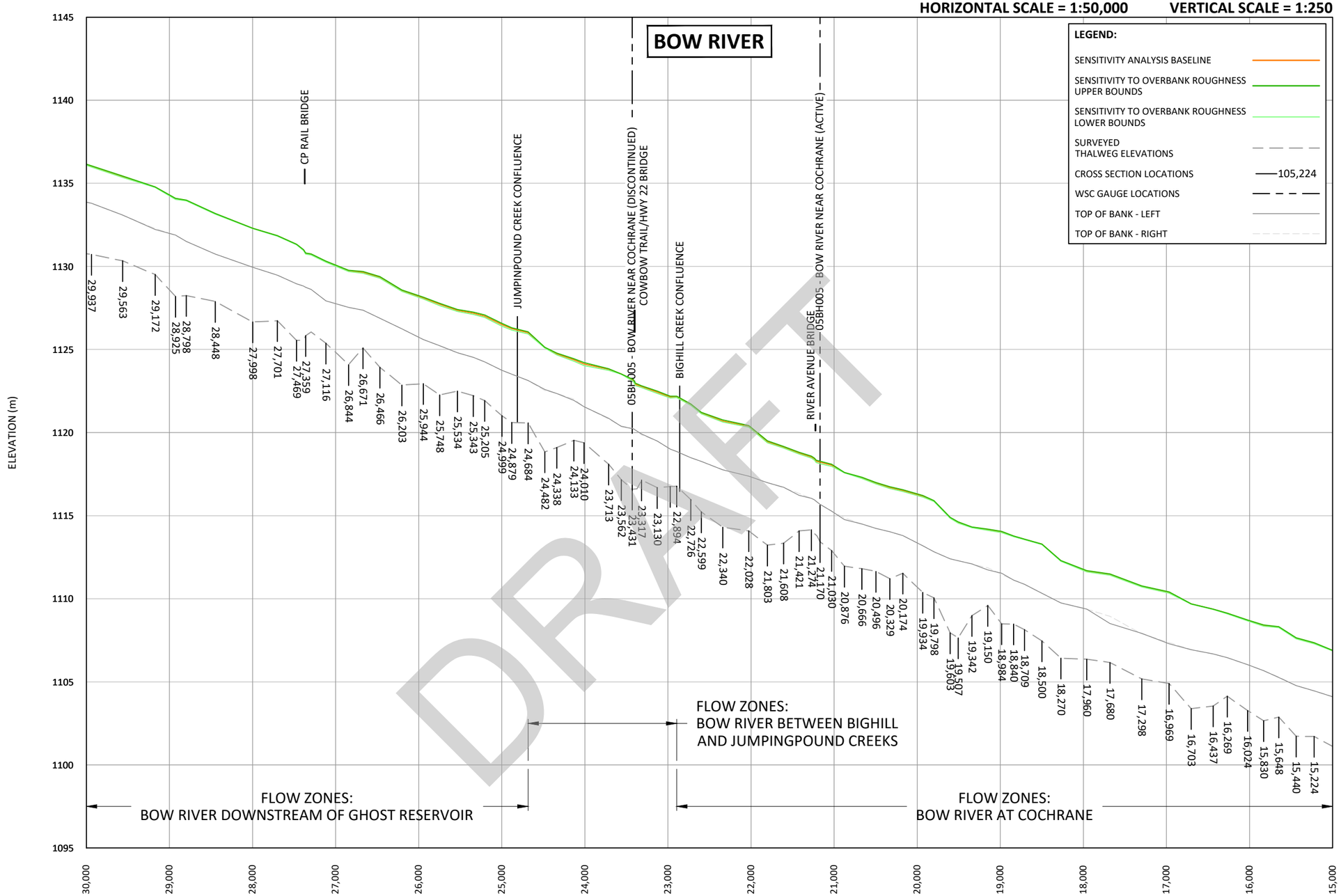
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-906
SHEET NUMBER	6 of 10

HORIZONTAL SCALE = 1:50,000 **VERTICAL SCALE = 1:250**



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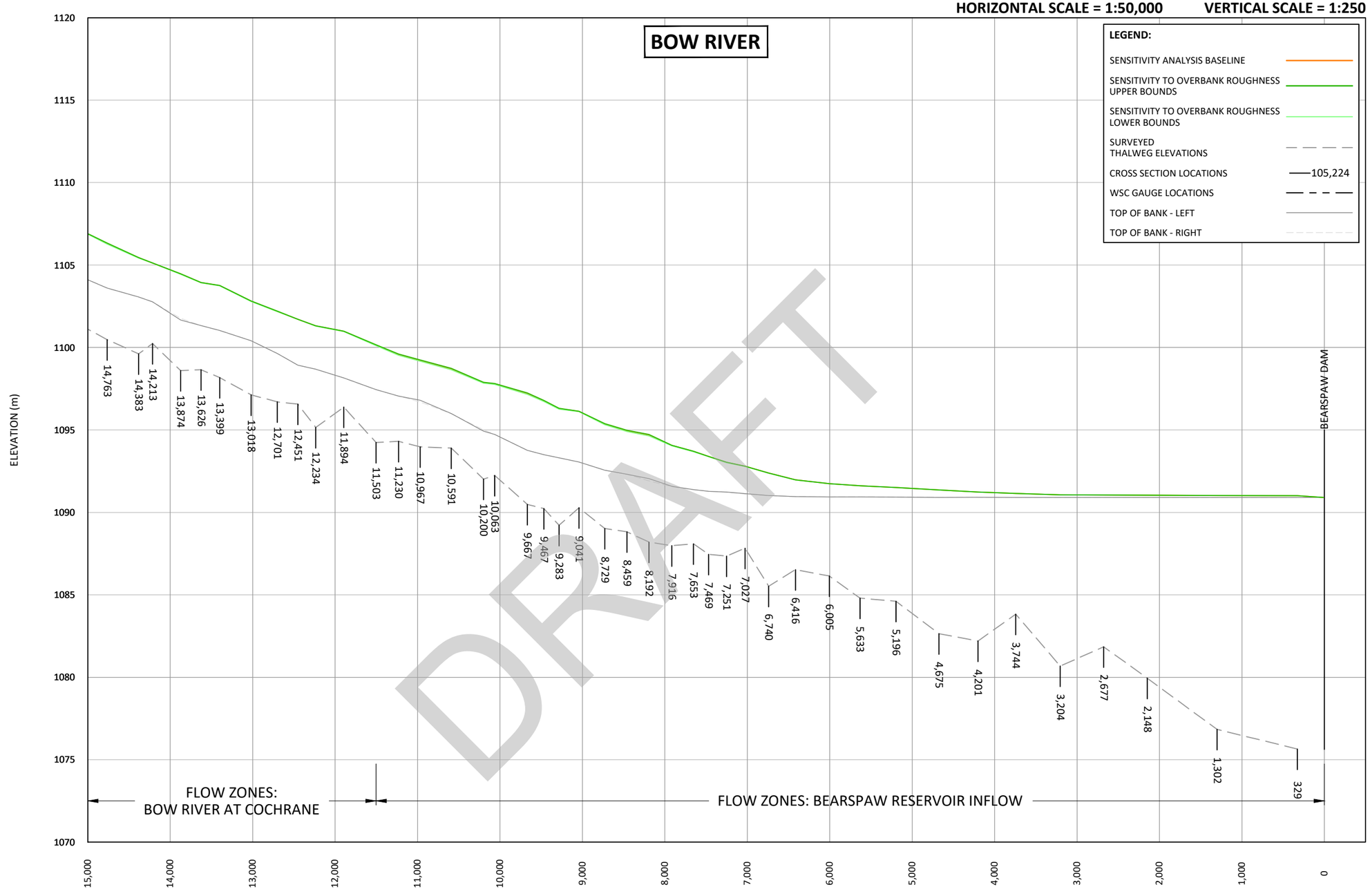
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-907
SHEET NUMBER	7 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



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NOTES:

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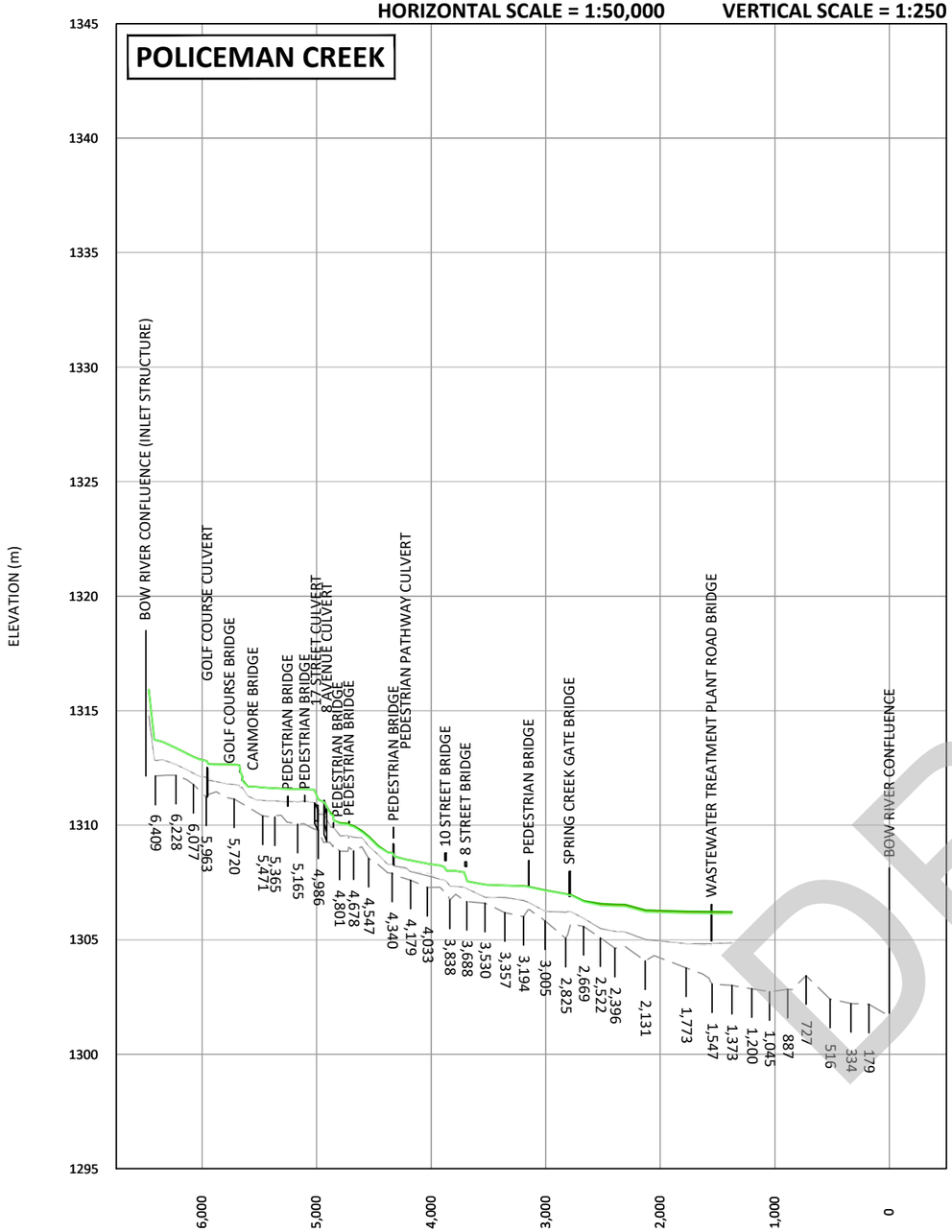
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-908
SHEET NUMBER	8 of 10

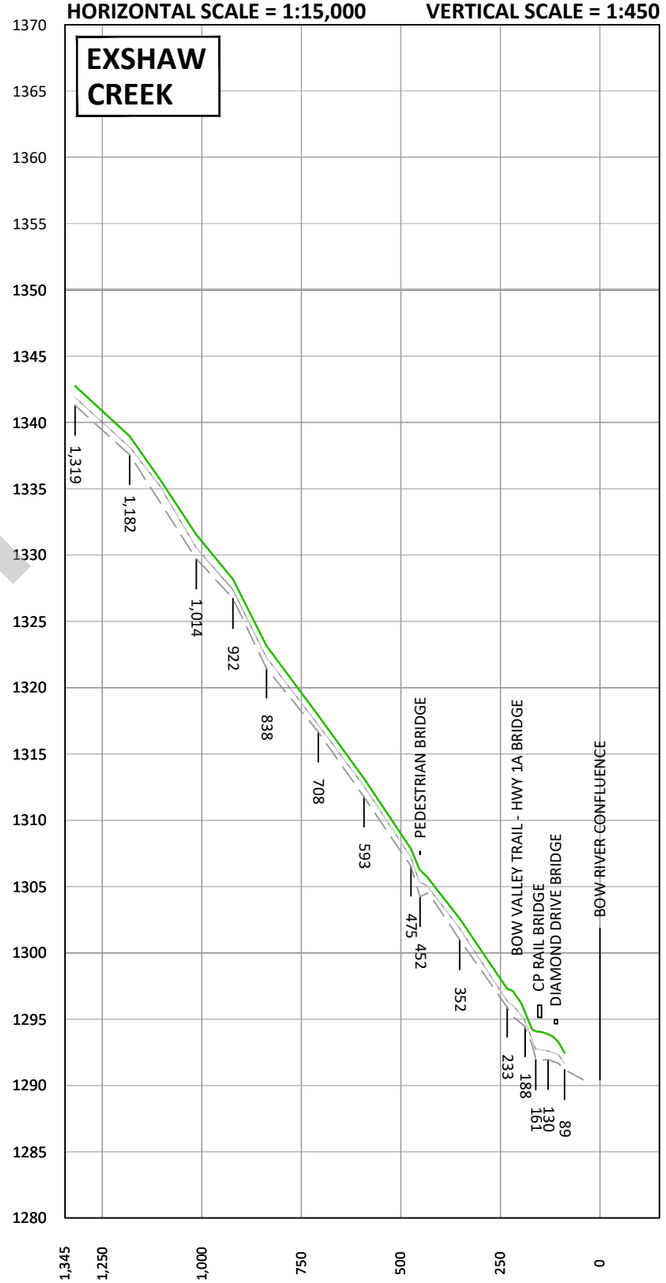
HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250



LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO OVERBANK ROUGHNESS UPPER BOUNDS
- SENSITIVITY TO OVERBANK ROUGHNESS LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT

HORIZONTAL SCALE = 1:15,000 VERTICAL SCALE = 1:450



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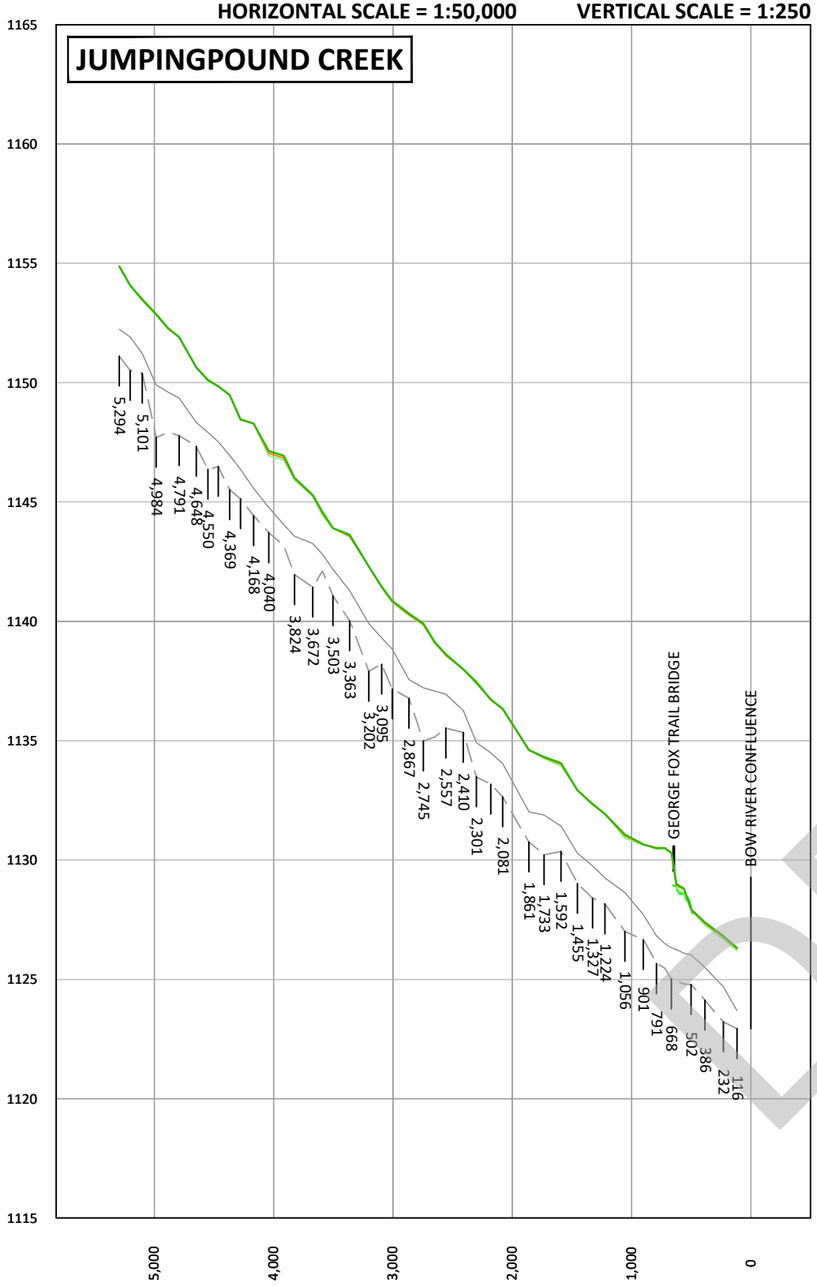
UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-909
SHEET NUMBER	9 of 10

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

JUMPINGPOUND CREEK

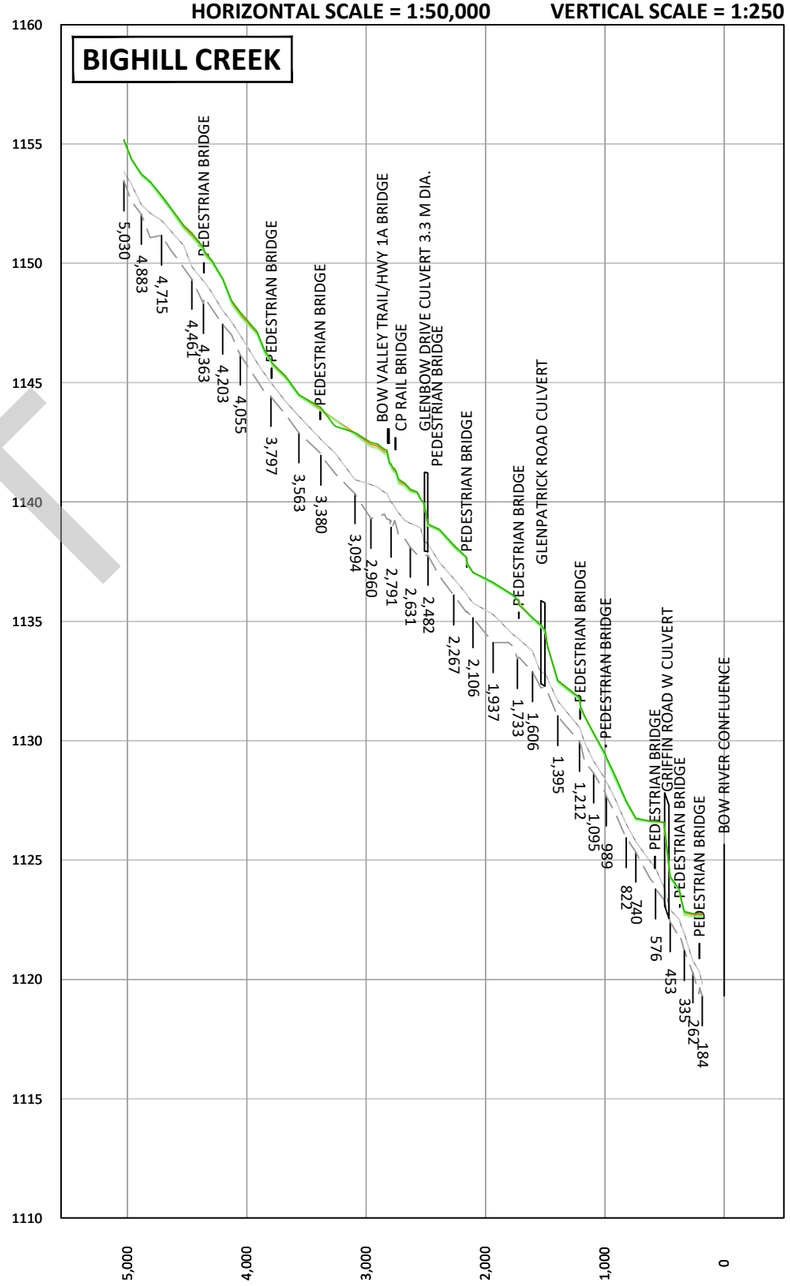


LEGEND:

- SENSITIVITY ANALYSIS BASELINE
- SENSITIVITY TO OVERBANK ROUGHNESS UPPER BOUNDS
- SENSITIVITY TO OVERBANK ROUGHNESS LOWER BOUNDS
- SURVEYED THALWEG ELEVATIONS
- CROSS SECTION LOCATIONS — 105,224
- WSC GAUGE LOCATIONS
- TOP OF BANK - LEFT
- TOP OF BANK - RIGHT
- JUMPINGPOUND CREEK DIKE

HORIZONTAL SCALE = 1:50,000 VERTICAL SCALE = 1:250

BIGHILL CREEK



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NOTES:

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UPPER BOW RIVER HAZARD STUDY

SENSITIVITY ANALYSIS PROFILES
SENSITIVITY TO OVERBANK ROUGHNESS

PROJECT NUMBER	3001178
DRAWING NUMBER	3001178-910
SHEET NUMBER	10 of 10

APPENDIX A
FLOOD HISTORY

APPENDIX A FLOOD HISTORY

Table A- 1 Historic and Observed Floods

HISTORIC AND OBSERVED FLOODS

1879 (June)	
Weather Conditions	▪ Preceded by heavy rains in June (AEWRMS 1983).
Flow and Water Levels	▪ The flood of 1879 is considered by Water Survey Canada (WSC) to be the largest known flood at Calgary (AEWRMS, 1983). ▪ The estimated peak flow is 2,270 m^3/s on Bow River at Calgary (based on magnitude of the 1897 flood (AEWRMS, 1983).
Damages	▪ Reported to be very destructive (AEWRMS, 1983). ▪ Caused damage in the Canmore area (AEWRMS, 1983). ▪ Damage and flooding reported for entire study area and Calgary (AEWRMS, 1990).
1884 (July 15th)	
Weather Conditions	▪ According to the Calgary Herald, 23 July 1884: "From early in June up to the middle of July, the area has been blessed with an abundance of rain mostly in the form of heavy showers, which did wonders to hurry forward the crops all through the North West and proved on the whole welcome. But lately we got more rain than was desirable. At 4 p.m. on July 15th, a steady down pour commenced and lasted 42 hours during which time nearly three inches fell".
Flow and Water Levels	▪ "The Bow and Elbow rivers [in Calgary] were swollen larger than at any time during the past ten years" (Calgary Herald, 23 July 1884). ▪ "Experts said the cresting of both rivers [Bow and Elbow] at the same time was so rare, it would happen only once in a hundred years, but it happened again in 1902." (Calgary Herald, 12 June 2005)
Damages	▪ Large washouts along the C.P.R rail and two bridges were carried away. ▪ Caused damage in the Canmore area (AEPREB, 1993). ▪ No homes were damaged in Calgary but all of Calgary's bridges were "brutally damaged" (Calgary Herald, 23 July 1884).
1897 (June 18th)	
Weather Conditions	▪ "During recent years much of the heavy timber which covered the sides of the mountains has been burnt off and when the cloud burst between the Gap and Castle Mountain, the steep slopes of the mountains and foothills became chutes along which the floods rushed." (Calgary Herald, 24 June 1897) ▪ Recorded air temperatures were above the freezing point for more than one month before the flood, indicating flooding was mainly caused by high rainfall with only minor contribution from snowmelt (Golder, 2016).

HISTORIC AND OBSERVED FLOODS

	▪ Heavy rains reported in the Canmore / Banff area, with approximately 100 mm of rain recorded at the Calgary Airport and Kneehill stations from June 14 to 18, 1897 (Golder, 2016). Total precipitation at Banff station over same period was 63 mm (Golder, 2016). ▪ Precipitation amounts suggest a noticeable areal variation in precipitation with more in the watershed upstream of Banff (Golder, 2016).
Flow and Water Levels	▪ Estimated peak flow of 2,265 m^3/s on Bow River Above Elbow River confluence. (Determined using recorded high water marks taken at the existing Langevin bridge gauging site. The peak flows were estimated from the extrapolation of the existing stage-discharge relationship measured at the bridge (AEWRMS, 1990). ▪ The following high water elevations were recorded in Calgary (AEWRMS, 1983, Vol. 2): - 1071.16 m at Twin Bridges - 1042.57 m at Langevin Bridge.
Damages	▪ "Stoney Creek, half way between Canmore and Anthracite, like all other mountain streams filled its bed up with gravel and took several new courses" (Calgary Herald, 24 June 1897). ▪ The bridge at fifth crossing gave out and "quite a stretch of [C.P.R] track was swept out near Canmore" (Globe and Mail 25 June 1897). ▪ Community of Anthracite (a small mining town located on the Cascade River, a tributary of the Bow) and Anthracite mines flooded completely (Calgary Herald, 24 June 1897). "Mules and horses working underground were drowned, miners were fortunate to just escape with their lives" (Globe and Mail 25 June 1897). ▪ "Between Kananaskis and Canmore the damage is very great." (Calgary Herald, 24 June 1897) ▪ Several washouts to rail line reported between Calgary and Canmore and several bridges washed out including Jumpingpound Creek bridge. (Calgary Herald, 24 June 1897). ▪ In Calgary, "twelve houses and stables were carried away and 50 houses partly submerged." (The Globe and Mail, 19 June 1897). Losses in Calgary were estimated to be nearly a quarter million dollars (Calgary Herald, 24 June 1897). "Bow River rises about five metres turning downtown [Calgary] into a lake, washing out bridges, shortcircuiting electricity and cutting Canadian Pacific's line to Vancouver." (Calgary Herald, 21 June 2013).
1902 (July 2nd to July 4th)	
Weather Conditions	▪ Snowmelt combined with heavy rainfall (AEPREB, 1993). ▪ Snow, melted by a deluge of rain, filled the channels of the Bow and its tributaries (AE and CFCAC, 1977).

HISTORIC AND OBSERVED FLOODS

	▪ Recorded air temperatures were higher than freezing point for more than two months before the flood, indicating flooding mainly from large rainfall (Golder, 2016). ▪ The flood occurred during a very wet summer, with the country side around Calgary saturated (NHC and Queen's University, 2001). ▪ Annual total precipitation recorded in 1902 (more than 870 mm at Calgary and more than 770 mm at Banff) is highest amount on record since 1885 (Golder, 2016). ▪ Total precipitation over a period of three months (May to July) in 1902 (approx. 580 mm at Calgary, approx. 400 mm at Banff, and approximately 360 mm at Kneehill) is higher than the 1897 precipitation over the same three month period (Golder, 2016). ▪ Precipitation amounts suggest a noticeable areal variation in precipitation in the Bow River watershed with more rain downstream of Banff (Golder, 2016).
Flow and Water Levels	▪ Estimated peak flow of 1,560 m^3/s on Bow River Above Elbow River confluence. (Determined using recorded high water marks taken at the existing Langevin bridge gauging site. The peak flows were estimated from the extrapolation of the existing stage-discharge relationship measured at the bridge (AEWRMS, 1983) ▪ High water elevations were recorded as follows in Calgary (AEWRMS, 1983, Vol. 2): - 1070.03 m at Twin bridges - 1041.84 m at Langevin Bridge S/B - 1037.91 m at C and E Bridge - 1030.22 m at C.P.R. Bridge, upstream of Bonnybrook Bridge.
Damages	▪ Damage and flooding reported all the way down to Calgary (AEWRMS, 1983). ▪ Railways and bridges between Banff and Canmore were damaged (AEWRMS, 1993) ▪ Significant damages were mostly to roadways and bridges between Anthracite and Canmore (AE and CFCAC, 1977). ▪ In Calgary, damage to the big iron bridge and the Twin bridges and all bridges out of the city were impassable. (Edmonton Bulletin, 7 July 1902). ▪ The low lying ground on the south side of the Langevin Bridge in Calgary was underwater on July 2nd, 1902. Natural ditch formed during the flood and drained to the Bow River near Abbot Street (Calgary Herald, July 2, 1902).
1904 (Spring)	
Weather Conditions	▪ Not known.
Flow and Water Levels	▪ Not known.

HISTORIC AND OBSERVED FLOODS

Damages	▪ A spring flood washed away the traffic bridge connecting the Town of Canmore with the houses on the mine side of the river. Not much damage was recorded in the actual town site of Canmore (AE and CFCAC, 1977). ▪ Most damage occurred in Anthracite, a coalmining town approximately fourteen miles west of Canmore on the Cascade River. Many of its buildings were washed away by floods (AE and CFCAC, 1977).

Table A- 2 Recent and Recorded Floods

RECENT AND RECORDED FLOODS

1909 (July 7th)	
Weather Conditions	▪ A combination of warm weather and heavy rains near Banff (AE, 1980). ▪ "The hot sunshine of last week, and the heavy rains of the early part of this week caused the Bow River to rise rapidly again." (Banff Crag and Canyon, 10 July 1909)
Flow and Water Levels	▪ Max discharge of 329 m^3/s at Banff
Damages	▪ Not known.
1915 (June 26st)	
Weather Conditions	▪ "An exceptionally bad rain storm visited Cochrane district commencing Friday afternoon and continuing till Saturday morning" (Cochrane Advocate, 1 July 1915). ▪ Heavy rainfall at Banff was observed for 60 hours almost without a pause (Banff Crag and Canyon, July 3 1915). ▪ "The rainfall in Calgary during a brief period broke all records…. This gives a total rainfall of 1.32 inches in less than 48 hours." (Calgary Herald, 26 June 1915).
Flow and Water Levels	▪ "The old Bow River carried an awful load up to noon on Saturday and overflowed the banks in many places" (Cochrane Advocate, 1 July 1915). ▪ "All rivers in the district are roaring torrents and water from rainfall in the mountains continues to cause them to rise" (Calgary Herald, 26 June 1915). ▪ "The Bow river in the most extraordinary flood conditions since thirteen years ago, and still rising at the rate of four inches per hour" (Calgary Herald, 26 June 1915). ▪ The 1915 event had a reliable discharge on the Bow River in Calgary (AEWRMS, 1983, Vol. 1). ▪ The high water marks were recorded as follows (AEWRMS, 1983, Vol. 2): - 1041.44 m at Langevin Bridge S/B - 1028.9 m at C.P.R. Bridge and upstream of Bonny Brook Bridge.

RECENT AND RECORDED FLOODS

	▪ "The Dominion water power branch in Calgary state that in the high water of 1915, it took about a day for the high water at Banff to reach Calgary" (Calgary Herald, 13 June 1923). "In 1915, said one of the officials, the Bow river reached the highest flood mark in its history at Banff, yet it was not excessively in flood in Calgary" (Calgary Herald, 13 June 1923).
Damages	▪ In Exshaw, one person drowned (Alexander and Cooper, 2005). ▪ In Cochrane, "the only damage reported is on low flat farms, where drainage is poor. Our hillside and sloping fields are none the worse for the big drenching. The old Bow River carried an awful load up to noon on Saturday and overflowed the banks in many places" (Cochrane Advocate, 1st July 1915). ▪ "It was here that the greatest inconvenience to Calgary residents resulted through the washing out of the Calgary Gas company's big main line from Bow Island" (Calgary Herald, 26 June 1915). "The Bow washes away Centre Street Bridge, nearly downing two city officials" (Calgary Herald, 21 June, 2013).
1916 (June 15th)	
Weather Conditions	▪ "Warm weather, six weeks behind the usual time of melting, brought on a rapid snowmelt in the mountains near Banff" (Banff Crag and Canyon, 24 June 1916). ▪ Heavy continuous rains combined with snowmelt in the spring (AE and CFCAC, 1977).
Flow and Water Levels	▪ "The Bow is higher at Banff than it has been for years." (Calgary Herald, 19 June 1916). ▪ "Bow commenced to rise Saturday and by Tuesday noon the high water mark from 1915 had been topped by some nine inches." (Banff Crag and Canyon, 24 June 1916). ▪ "Water has exceeded last year's high water marks at Banff and Kananaskis." (Calgary Herald, 19 June 1916). ▪ "The western rivers are still booming. The Ghost has risen, Cascade creek is a big river, and every mountain trickle is a roaring torrent." (Calgary Herald, 21 June 1916).
Damages	▪ Flooding of low ground and streets in Banff (Banff Crag and Canyon, 24 June 1916). ▪ Canadian Pacific Railway (CPR) was washed out two miles west of Banff, and the automobile road west of Banff was submerged several feet under water and in other places washed out completely. (Banff Crag and Canyon, 24 June 1916). ▪ Some residences in Canmore town side were flooded (AEPREB, 1993). ▪ A railway bridge near Canmore was threatened by high water (AE and CFCAC, 1977). ▪ All mountain streams were over their banks, and serious flooding was reported from Fernie and Golden, where trains were stopped (Calgary Herald, June 19 1916).

RECENT AND RECORDED FLOODS

	▪ "At several points between Canmore and Kananaskis the trains crawl along through tracks which are practically under water. The long bridge at Kananaskis is not over five feet above the flood, and the narrow gorge of the Kananaskis is chocked full of water". (Calgary Herald, 19 June 1916)
1918	
Weather Conditions	▪ Not known.
Flow and Water Levels	▪ In Banff, the HWM on measuring stick planted at Mr. Mathers' boathouse was 6' 8" (4" higher than in 1916).
Damages	▪ In Banff, roads, yards, gardens and bypaths were flooded (AE, 1980)
1923 (June 7th - June 15th)	
Weather Conditions	▪ Spring snowmelt and heavy rains in the upper valley above Canmore (AE and CFCAC, 1977) ▪ "…the heaviest rainfall Banff had ever experienced continued throughout Tuesday night and was still raining without cessation at 11 o' clock Wednesday morning. At Seebe, …, the rainfall was equally heavy." (Calgary Herald, 13 June 1923) ▪ At the Calgary rain gauge, 0.56 inches of rain was recorded between Monday night and 6 a.m. on Tuesday morning and recorded temperatures ranged between 16 and 28 °C. (Calgary Herald, 13 June 1923)
Flow and Water Levels	▪ In Banff, "Bow river on Wednesday morning had risen higher than it was in the flood of 1915." (Calgary Herald, 13 June 1923) ▪ In Calgary, "the Dominion water power branch records show that the Bow river rose seven inches between 9 am Wednesday and 1 pm …was 20 inches under the peak flood level of 1915." (Calgary Herald, 13 June 1923). Early Thursday morning, peak water levels still 16 inches under high mark of 1915. (Calgary Herald, 14 June 1923) ▪ "The heavy rainfall throughout the Banff area points to swelling of the tributaries also" (Calgary Herald, 13 June 1923)
Damages	▪ In Banff, the river overtopped its banks, covering the area from the river to Cave Avenue under several feet of water (AE, 1980). Houses in the loop (now the Banff Spring Golf Course), directly south of the road bridge, were cut off from the rest of the Town as low-lying roads were inundated. ▪ In Canmore, transportation between the town side and mine side of the river was made over the railway trestle bridges, which were still operable (AE, 1980). ▪ Damage in Canmore was reported to have been more extensive than in 1916 (AEWRMS, 1990).

RECENT AND RECORDED FLOODS

	▪ In Cochrane, "The Bow River and its tributaries were very high last weekend and though the Bow had not caused any trouble in the immediate neighborhood of Cochrane, floods were reported along the Elbow and Little Red Deer rivers. The north approach to the Cochrane bridge would probably have caved in had not the bridge gang been on hand when the flood water came down. Heavy timbers and piles were used as supports and in spite of the extremely high water, the traffic across the bridge was not hindered." – Cochrane Advocate, June 7, 1923 ▪ In Calgary, "no damage of any material nature has been done up to date by the flood, though the water was within a few inches of Sunnyside boulevard in places. None of the bridges was threatened." (Calgary Herald, 14 June 1923).
1929 (June 3rd)	
Weather Conditions	▪ Heavy rainfall in the foothills west of the Upper Bow River (NHC and Queen's University 2001, P. 32). ▪ Rainfall starting on May 31 and continuing for 3 days resulted in the flood peak on June 3 at 11 am (AEWRMS, 1983, Vol. 2). ▪ In Banff, "cold rain, leaving snow on the mountains, was falling heavily here [in Calgary] on Monday afternoon" (Calgary Herald, 3 June 1929)
Flow and Water Levels	▪ Jumpingpound Creek carried approximately 285 m^3/s (AEWRMS, 1983, Vol. 2). ▪ In Calgary, the recorded flood was 1322 m^3/s and the recorded water levels were: - 1069.67 m at Twin bridges - 1041.64 m at Langevin Bridge S/B - 1037.61 m at C and E Bridge - 1029.68 m at C.P.R. Bridge, upstream of Bonnybrook Bridge ▪ In Calgary, "the Bow River rose from 5.08 ft Saturday morning to 11 ft Monday afternoon, and still rising. Danger level, 9 ft." (Calgary Herald, 3 June 1929)
Damages	▪ "Roads east and west of Banff washed out." (Calgary Herald, 3 June 1929) ▪ "Construction bridge at Ghost River washed out and damage done to houses situated below the dam." (Calgary Herald, 3 June 1929) ▪ "Jumpingpound Creek was on the rampage on Monday tearing up its banks and swamping buildings on all sides." (Calgary Herald, 3 June 1929) ▪ In Calgary, "all residential areas near rivers are completely covered Monday" (Calgary Herald, 3 June 1929). "Electric power in Calgary Flood caused "thousands of dollars' worth of damage" in Calgary and considered "worst floods since '02 ravage" (Calgary Herald, 3 June 1929). "Southwest and northwest city districts are under a metre of muddy water. It takes a heavy toll on zoo animals." (Calgary Herald, 21 June 2013)
1932 (June 2nd)	

RECENT AND RECORDED FLOODS

Weather Conditions	▪ Heavy precipitation in May saturated the soil and then a storm on June 1st and 2nd resulted in flooding on the Bow River (AEWRMS, 1983, Vol. 2) ▪ "Heavy rainfall in the mountains for the past five days has caused high water". (Calgary Herald, 3 June 1932) ▪ In Banff, "there has been no cloudburst in the mountains, but nearly a week's steady rain has made the water in the rivers very high, and in several places water is running across the road." (Calgary Herald, 3 June 1932) ▪ In Calgary, "On June 1, Calgary receives 7.2 mm of rain over a 24-hour period, just 0.6 mm less than the average rainfall for the whole month. (Calgary Herald, 21 June 2013)
Flow and Water Levels	▪ In Calgary, the Bow River discharge peaked at 2:00 am on June 3rd at 1518 m^3/s, and the following elevations were taken (AEWRMS, 1983, Vol. 2): - 1044.09 m at Center Street Bridge - 1041.84 m at Langevin Bridge S/B ▪ In Calgary, 1932 flood was very similar in discharge as 1902 flood but greater amount of information available for the 1932 flood (AEWRMS, 1983, Vol. 2). ▪ In Calgary, "the river rose nearly four metres above normal". (Calgary Herald, June 2013)
Damages	▪ In Banff, "roads drying in Banff District" (Calgary Herald, 3 June 1932). ▪ In Canmore, "more than twelve homes in the lower sections of the mining town of Canmore were surrounded by water Thursday evening and Friday morning and the road through town covered with about six to eight inches of water." (Calgary Herald, 3 June 1932) ▪ In Exshaw, "A bridge was washed out" (Calgary Herald, 3 June 1932). ▪ In Calgary, "Bowness Park was under nearly two metres of water and a log jam at the lumber company in Eau Claire diverted the river's course south into the city's downtown" (Calgary Herald, 3 June 1932). "Hundreds of Calgarians, who were forced to vacate their homes in both the south and north sides of the city during the night when flood water from both rivers poured into their basements, were able to return Friday morning with only a minimum amount of damage done" (Calgary Herald, 3 June 1932).
1948 (June 9th)	
Weather Conditions	▪ Heavy precipitation led to flash flood (AE, 1980) ▪ Rapid snowmelt from the mountains kept river levels high for a two week period (AE, 1980). ▪ Rainstorm combined with a melting snowpack (Acres, 1996)

RECENT AND RECORDED FLOODS

Flow and Water Levels	▪ The estimated instantaneous discharge at the flow gauge station on the Bow River at Banff (WSC 05BB001) was 303 m^3/s (W-E-R ARGA Ltd., 1993).
Damages	▪ In Banff, the recreation grounds, the road on Bow Avenue and basements in low-lying areas were flooded (AE, 1980). In the fall of 1948, a six-foot dike was constructed near the Cave and Basin to alleviate flooding in low-lying lands at Banff. ▪ In Exshaw, high flows in the creek caused extensive erosion of the banks and some buildings adjacent to the creek were damaged when the footings were undermined (Acres, 1996).
1974 (June 26th)	
Weather Conditions	▪ Cold spring and heavy snowfalls in early June were followed by rapid increase in temperature (24°C during the day) that remained well above the freezing temperature. and subsequent snow melt (AE and CFCAC, 1977). ▪ No precipitation occurred during the flood to further increase the flows (AE and CFCAC, 1977). ▪ "An unusually heavy snow pack melts in the surrounding mountains" (Calgary Herald, 26 June 1974).
Flow and Water Levels	▪ The flood event had a high flow recorded in Banff of 320 m^3/s and an estimated peak discharge of 370 m^3/s in Canmore (AE and CFCAC, 1977).
Damages	▪ Canmore experienced two forms of flooding, overland flow and groundwater flooding with approx. 95% of homes in Canmore damaged. (AE and CFCAC, 1977). ▪ Approximately 20 Canmore residences were flooded from overland flow and the placement of 35,000 sand bags prevented more from being flooded. A total of 250 residences and businesses experienced some form of groundwater flooding. (AE and CFCAC, 1977). ▪ In Canmore, a community of 2,000 residents, "about 30 houses and cabins were damaged and water poured into almost every basement in town." (The Globe and Mail, 25 June, 1974). ▪ Sandbagging prevented direct flow from the Bow River but Policeman Creek flooded due to high groundwater table. A portion of the sewage system flooded, and dike seepage was observed. This flood lead to channel modifications, diking and protection along the Canmore lengths of the river (AE and CFCAC, 1977).
1986 (June 3rd)	
Weather Conditions	▪ "Heavy winter snowfall, coupled with a cool spring allowing little early runoff, and then subsequent war water." (Banff Crag and Canyon, 4 June 1986)

RECENT AND RECORDED FLOODS

	▪ In Calgary, "about 25,000 people took refuge from record-breaking temperatures Sunday at Sikome Lake." (Calgary Herald, 3 June 1986).
Flow and Water Levels	▪ Highwater marks were measured on May 30, 1986 (2 days before the event) along the Bow River from Duthill to Dead Man's Flat (W-E-R ARGA Ltd., 1993), for example highwater mark at a road bridge in Canmore was 1309.142 m. ▪ The estimated flow of Bow River at Banff (WSC 08BB001) was 317 m^3/s, Bow River above Cougar Creek confluence was 313 m^3/s and 318 m^3/s downstream of the confluence (W-E-R ARGA Ltd., 1993). ▪ TransAlta "reservoir levels were so low that this helped enable the shutdown… [and] brought the river level down by 900 cubic feet per second." (Canmore Leader, 4 June 1986) ▪ In Canmore "water peaked on the weekend and is expected to remain high for the next few days" (Calgary Herald, 3 June 1986)
Damages	▪ In Canmore, "at least 50 homes have water in their basements or crawl spaces" (Calgary Herald, 3 June 1986) and "the hardest hit by the rise in water levels is the local golf course [with] more than a metre of water… in some places". (Calgary Herald, 4 June 1986) ▪ In Calgary, minimal flooding was observed. A bicycle path and parks were inundated but no homes were flooded. (Calgary Herald, 3 June 1986)
1990 (June 2nd, 26th)	
Weather Conditions	▪ "There's still a lot of snow in the mountains […] the snowpack in the mountains is the largest in 10 years" (Calgary Herald, 1 June, 1990) ▪ "Spring has been cold and unusually slow this year, so the snow hasn't started to melt as early as in other years […] about half the mountain snowpack is left to come down." (Calgary Herald, 26 June 1990)
Flow and Water Levels	▪ Flood magnitude was considered similar to the 1986 May flood event. The highwater mark at the same road bridge in Canmore was 1309.15 m (compared to 1309.14 m in 1986). ▪ High water levels surveyed in study area by AEP and AT. ▪ "The situation Monday was that flow rates in the Bow [in Canmore] were higher than they were during the widespread flooding earlier this month." (Calgary Herald, 26 June 1990)
Damages	▪ In Canmore, "Flooding of the Bow River here Tuesday forced the Canmore Golf Club to close the back nine on the 18-hole course, but the front nine is expected to remain open despite rising water levels. Despite the problems on the golf course, […] no overland flooding is expected in the residential areas of Canmore". (Calgary Herald, 27 June 1990)

RECENT AND RECORDED FLOODS

	▪ "High flows in Exshaw Creek were reported forcing the MD of Bighorn to use heavy machinery to prevent the creek from flowing over its banks." (BGC, 2015) ▪ "TransAlta Utilities' workers at the Ghost Reservoir have been draining the lake in anticipation of the increased river flows". (Calgary Herald, 1 June, 1990)
2005 (June 17th)	
Weather Conditions	▪ Heavy rain and flooding in region. (Calgary Herald, 19 June 2005) ▪ A recorded 248 mm of rain in Calgary, three times June's monthly average, drenched the region in three large rain storms (June 6-9, June 18-19, and June 26-28). "While the moist weather systems were not unusual, they stalled and even tracked westward instead of following their usual west-to-east movement." (EC, 2005). ▪ The lack of winter snowfall in the southwest foothills (the lowest in four decades), left little melt water to add to the rain. (EC, 2005) ▪ The saturation of the soils by the first two storms enhanced the hydrologic response of the third. (Golder, 2016)
Flow and Water Levels	▪ "Dams and other hydrologic structures helped to limit some of the damage." (EC, 2005)
Damages	▪ Washout of major roads, damages to highway and railway infrastructure (EC, 2005). ▪ Infrastructure damage and flooding seen in Canmore along Bow River and Cougar Creek (Town of Canmore, 2005). ▪ In Exshaw, "high flows were also observed in 2005, although there are no reports that Exshaw Creek overflowed its channel." (BGC, 2015) ▪ Cochrane was among the hardest-hit regions and saw the Trans-Canada Highway close near the community for much of the day. (Calgary Herald, 19 June 2005). In Cochrane, emergency response cost and pathways repairs totaled $369,000. (Flood 2013 Update, report to council, 12 August 2013) ▪ In Calgary, one in ten dwellings reported damage (EC, 2005) and the "floods killed three people and caused more than $400 million in damages. The government paid out more than $165 million in flood damage costs." (CBC, 24 June 2013)
2012 (June 7th)	
Weather Conditions	▪ Likely due to rainfall on snowmelt (NHC, 2013) ▪ "Earlier this year, officials with the [AESRD] department said a rain-on-snow event in 2012 was the first of its kind in the Canmore area since 1923. It landed on top of a near record snowfall, with ski resorts reporting up to 10 metres of snow." (Calgary Herald, June 2013)

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	▪ "Snow blanketed Canmore Saturday as groundwater seeped into the basements of some unlucky homes and businesses" (Calgary Herald, 10 June 2012)
Flow and Water Levels	▪ High flows were experienced on the Bow in Canmore but significant flooding in Cougar Creek. (Calgary Herald, 14 June 2012).
Damages	▪ In Banff, "two temporary berms have been built along the Bow River near downtown". (Calgary Herald, 8 June 2012) ▪ "The flooding in 2012 caused millions of dollars worth of damage – including at least $1.3 million in Canmore, with the high stream flows eroding the banks and damaging pathways along Cougar Creek." (Calgary Herald, 14 June 2012)
2013 (June 19th to 21st)	
Weather Conditions	▪ "It began snowing in southern Alberta before Thanksgiving 2012 and didn't stop until a month after Easter" (EC, 2013). Snowpack existed in the mountain areas of the catchments of interest at the onset of the June 2013 event (AMEC, 2014). ▪ "The spring was wet leaving the ground saturated and streams and rivers bloated. Weeks before, satellite imagery had revealed basin groundwater to be higher than average leaving the land with little capacity to take up additional water from rain and melting snow." (EC, 2013) ▪ Temperature and the thermal effect of rainfall falling on the snowpack contributed to accelerated and augmented runoff (AMEC, 2014). ESRD data from multiple sites indicate between 29 and 131 mm of snow water equivalent was lost to the snowpack and contributed to runoff during the event (AMEC, 2014). ▪ "The storm featured an intense and slow-moving moist upper low that parked itself over southern Alberta, delivering three days of torrential rains." (EC, 2013). ▪ "Calgary received 68 mm over 48 hours, but the rainfall west of the city in the elevated headwaters of the Bow and Elbow rivers was exceptionally heavy and torrential – more typical of a tropical storm in quantity and intensity. Rainfall rates of 3 to 5 mm/h are considered high; rates from this storm were 10 to 20 mm/h in the higher elevations, with several stations reporting 50 to 70 per cent of their storm rainfall in the first 12 hours. Totals averaged 75 to 150 mm over two and a half days, with Burns Creek (west of High River at 1,800 m elevation) recording a phenomenal 345 mm. At Canmore, over 200 mm of rain fell – ten times that of a typical summer rainfall. Also contributing to the flood, the warm air and rain melted up to 60 cm of snowpack, which was about 25 per cent above normal for that time of year, instantly engorging streams and rivulets." (EC, 2013) ▪ Greatest rain occurred in the foothills and mountain areas, while little rainfall occurred on the Prairies. Marshall (2013) showed a west (Banff) to east (Calgary)

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	rainfall gradient with the trend in accumulated rainfall depth closely matching the ground elevations (AMEC, 2014).
Flow and Water Levels	▪ The flow at Banff reached a record high peak discharge of 401 m^3/s at 17:00 on 21 June 2013, based on preliminary data received from WSC. The previous historical high discharge was 399 m^3/s on 14 June 1923. The 2013 peak discharge at Banff is estimated to have an annual exceedance probability of less than 0.5%. ▪ The flow in the Bow River at Calgary (upstream of the Elbow River confluence) reached a record high peak discharge of 1,780 m^3/s at 02:45 on 21st June 2013, based on preliminary data received from WSC. The previous historical maximum recorded discharge was 1,520 m^3/s on 3rd June 1932. The 2013 peak discharge for the Bow River at Calgary is estimated to have an annual exceedance probability of less than 1%, based on a frequency analysis provided in Golder Associates (Golder) 2010 (Golder, 2016).
Damages	▪ Mudslides and flood waters caused washouts of major roads, damages to highway and railway infrastructure and isolated Canmore and Banff. (Calgary Herald, 26 June 2013). The Trans-Canada Highway was shut down for 7 days. (Global News, 19 June 2014) Power, transit, roadways, and bridges were also damaged throughout the region. (Global News, 19 June 2014) ▪ In Canmore, the most damage was along Cougar Creek, where 44 homes were damaged or destroyed and estimated damage to homes along Cougar Creek was $6 million. (Global News, 19 June 2014) The Canmore Hospital "has taken on water, [but] is still operating" (Calgary Herald, 22 June 2013). Estimated total damage to the town of Canmore was $30 million. (Global News, 19 June 2014). ▪ In Exshaw, "the nearly 400 residents… have started cleaning up after floodwater damaged 78 per cent of the hamlet's homes." (CBC News, 25 June 2013) "as the waters rose, Lafarge hauled in 10,000 tonnes of rock over 24 hours to build up the banks of Exshaw Creek," so saving the fire hall and Heart Mountain store and café. ▪ "Some Stoney Nation residents in …Bighorn and Morley remain under an evacuation order." "RCMP said there has been no widespread flooding from the Bow River in Morley, but noted rain water has washed out some remote roads, backed up sewers and filled up basements" (Calgary Herald, 24 June 2013) resulting in about 60 per cent of the 1,000 homes affected by flood damage. (CBC News, 18 June 2014). • In Cochrane, no homes were damaged and for the most part, "damage was confined to Cochrane's parks and pathways adjacent to the Bow River, Jumpingpound Creek and Bighill Creek". (Cochrane Times, 14 August 2013) Cost to repair the damage was estimated at $1 million. (Flood 2013 Update report to Council, 12 August 2013).

	• "In Calgary's downtown, 4,000 businesses were impacted and 3,000 buildings were flooded. Water rose at the Saddledome up to the 10th row. In Stampede Park, stables and barns were under more than two metres of water". (EC, 2013)

Table A- 3 Open Water Highwater Mark Data

#	Location Name	Source and Site ID		Stream	River Station (m)	Event Year	HWM Elev. (m)
1	Bow River near Banff Park Gate	AEP	BOWCAN-01	Bow River	117,485	1986	1323.84
2	Bow River at Harvie Heights, 2km d/s from Park Gates	AEP	BOWCAN-02	Bow River	114,700	1986	1318.94
3	Bow River at Harvie Heights; 0.8 km d/s of BOWCAN-02	AEP	BOWCAN-03	Bow River	113,979	1990	1317.82
4	Bow River at Harvie Heights; 0.8 km d/s of BOWCAN-02	AEP	BOWCAN-03	Bow River	113,979	1986	1317.82
5	Bow River 0.2km d/s of BOWCAN-03	AEP	BOWCAN-04	Bow River	113,842	1986	1317.34
6	Bow River at Canmore Golf Course	AEP	BOWCAN-05	Bow River	112,959	1990	1315.43
7	Bow River at Canmore Golf Course	AEP	BOWCAN-05	Bow River	112,959	1986	1315.45
8	Bow River at control structure for Policeman Creek	AT	ATBOW-01	Bow River	112,459	1986	1314.70
9	Bow River at 16th Street and 12th Avenue	AEP	BOWCAN-07	Bow River	110,823	1990	1311.25
10	Bow River at 16th Street and 12th Avenue	AEP	BOWCAN-07	Bow River	110,807	2013	1312.30
11	Bow River at 16th Street and 12th Avenue	AEP	BOWCAN-07	Bow River	110,805	2012	1311.78
12	Bow River at 16th Street and 12th Avenue	AEP	BOWCAN-07	Bow River	110,790	1986	1311.36
13	Bow River near 15th Street	AEP	BOWCAN-08	Bow River	110,680	1986	1311.09
14	Bow River near 14th Street	AEP	BOWCAN-09	Bow River	110,153	1986	1310.97
15	Bow River at Engine Bridge - 50m u/s	AT	ATBOW-02	Bow River	109,981	1986	1310.16
16	Bow River at Engine Bridge - 20 m u/s of u/s side	AEP	BOWCAN-10.1	Bow River	109,957	2012	1310.63
17	Bow River at Engine Bridge - 20m u/s of u/s side	AEP	BOWCAN-10.1	Bow River	109,957	1986	1310.48
18	Bow River at Engine Bridge - u/s side	AEP	BOWCAN-10.2	Bow River	109,935	2013	1310.94
19	Bow River at Engine Bridge	AEP	BOWCAN-10	Bow River	109,935	1990	1310.17
20	Bow River at Engine Bridge - u/s side	AEP	BOWCAN-10.2	Bow River	109,935	1986	1310.17
21	Bow River at Engine Bridge - d/s side	AEP	BOWCAN-10.3	Bow River	109,924	1986	1310.11
22	Bow River at Engine Bridge - d/s side	AEP	BOWCAN-10.4	Bow River	109,914	2013	1310.98
23	Bow River at Engine Bridge - 10m d/s of d/s side	AEP	BOWCAN-10.4	Bow River	109,914	2012	1310.42
24	Bow River at Engine Bridge - 20m d/s of d/s side	AEP	BOWCAN-10.4	Bow River	109,904	1986	1310.19
25	Bow River near 8th Street	AEP	BOWCAN-11	Bow River	109,640	1986	1309.90
26	Bow River at Bridge Road - 140 m u/s from centreline	AT	167	Bow River	109,366	1990	1309.40
27	Bow River at Bridge Road - 25m u/s of u/s side of bridge	AEP	BOWCAN-12.1	Bow River	109,250	1986	1309.14
28	Bow River at Bridge Road - 20m u/s	AEP	BOWCAN-12.2	Bow River	109,247	2013	1309.91
29	Bow River at Bridge Road - 12m u/s	AEP	BOWCAN-12.1	Bow River	109,242	2013	1310.00
30	Bow River at Bridge Road - 12m u/s	AEP	BOWCAN-12.1	Bow River	109,242	2012	1309.37
31	Bow River at Bridge Road - 10m u/s from centreline	AT	167	Bow River	109,235	1990	1309.15
32	Bow River at Bridge Road - 20m d/s of d/s side of bridge	AEP	BOWCAN-12.4	Bow River	109,233	1986	1309.10
33	Bow River at Bridge Road - d/s side of traffic bridge	AEP	BOWCAN-12.3	Bow River	109,233	1986	1309.14
34	Bow River at Bridge Road - u/s side of traffic bridge	AEP	BOWCAN-12.2	Bow River	109,233	1986	1309.10
35	Bow River at Bridge Rd in Canmore	AT	167	Bow River	109,230	2013	1310.52
36	Bow River at Bridge Rd in Canmore	AT	ATBOW-3	Bow River	109,230	1986	1309.11
37	Bow River at Bridge Rd in Canmore	AT	167	Bow River	109,221	2013	1310.30
38	Bow River at Bridge Rd in Canmore	AT	167	Bow River	109,219	2013	1310.70

#	Location Name	Source and Site ID		Stream	River Station (m)	Event Year	HWM Elev. (m)
39	Bow River at Bridge Road - d/s	AEP	BOWCAN-12	Bow River	109,219	1990	1309.15
40	Bow River at Bridge Road - 10m d/s of walking bridge	AEP	BOWCAN-12.4	Bow River	109,202	2013	1309.79
41	Bow River at Bridge Road - 10m d/s of walking bridge	AEP	BOWCAN-12.4	Bow River	109,202	2012	1309.19
42	Bow River at Bridge Road - 20 m d/s from traffic bridge centreline	AT	167	Bow River	109,202	1990	1309.01
43	Bow River at Bridge Rd in Canmore	AT	167	Bow River	109,192	2013	1309.47
44	Bow River at Bridge Road - 110 m u/s from centreline	AT	167	Bow River	109,114	1990	1309.00
45	Bow River at Bridge Road - 110 m u/s from centreline	AT	167	Bow River	108,998	1990	1308.80
46	Bow River near lift station 4	AEP	BOWCAN-13	Bow River	108,757	1986	1308.36
47	Bow River 50 m u/s of XS13	AEP	BOWCAN-14	Bow River	108,508	1990	1307.87
48	Bow River 50 m u/s of XS13	AEP	BOWCAN-14	Bow River	108,508	1986	1308.02
49	Bow River 95 m u/s of XS12	AEP	BOWCAN-15	Bow River	108,150	1990	1307.22
50	Bow River 95 m u/s of XS12	AEP	BOWCAN-15	Bow River	108,150	1986	1307.36
51	Bow River high water channel at proposed SR 742 crossing	AEP	POL-04	Bow River	107,891	1986	1306.86
52	Bow River at proposed SR 742 crossing	AEP	POL-05	Bow River	107,891	1986	1307.12
53	Bow River near WWTP	AEP	BOWCAN-16	Bow River	107,503	1990	1306.24
54	Bow River near WWTP	AEP	BOWCAN-16	Bow River	107,503	1986	1306.15
55	Bow River at Hwy 1	AT	74353	Bow River	104,700	1990	1301.60
56	Bow River at Hwy 1 Bridge - 25m u/s of u/s side of eastbound bridge	AEP	BOWCAN-17.1	Bow River	104,590	1990	1301.68
57	Bow River at Hwy 1 Bridge - 25m u/s of u/s side of eastbound bridge	AEP	BOWCAN-17.1	Bow River	104,590	1986	1301.53
58	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,572	2013	1302.40
59	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,570	1990	1301.42
60	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,565	2013	1302.20
61	Bow River at Hwy 1 Bridge - u/s side of eastbound bridge	AEP	BOWCAN-17.2	Bow River	104,562	1990	1301.63
62	Bow River at Hwy 1 Bridge - u/s side of eastbound bridge	AEP	BOWCAN-17.2	Bow River	104,562	1986	1301.50
63	Bow River at Hwy 1 Bridge - d/s side of eastbound bridge	AEP	BOWCAN-17.3	Bow River	104,540	1990	1301.69
64	Bow River at Hwy 1 Bridge - d/s side of eastbound bridge	AEP	BOWCAN-17.3	Bow River	104,540	1986	1301.44
65	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,530	1990	1301.37
66	Bow River at Hwy 1 Bridge - u/s side of westbound bridge	AEP	BOWCAN-17.4	Bow River	104,525	1990	1301.56
67	Bow River at Hwy 1 Bridge - u/s side of westbound bridge	AEP	BOWCAN-17.4	Bow River	104,525	1986	1301.41
68	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,515	2013	1302.10
69	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,513	2013	1301.80
70	Bow River at Hwy 1 Bridge	AT	74353	Bow River	104,510	1990	1301.37
71	Bow River at Hwy 1 Bridge - d/s side of west bound bridge	AEP	BOWCAN-17.5	Bow River	104,495	1990	1301.47
72	Bow River at Hwy 1 Bridge - d/s side of west bound bridge	AEP	BOWCAN-17.5	Bow River	104,495	1986	1301.35
73	Bow River at Hwy 1 Bridge - 20m d/s of d/s side of west bound bridge	AEP	BOWCAN-17.6	Bow River	104,479	1990	1301.38
74	Bow River at Hwy 1 Bridge - 30m d/s of d/s side of west bound bridge	AEP	BOWCAN-17.6	Bow River	104,479	1986	1301.30

#	Location Name	Source and Site ID		Stream	River Station (m)	Event Year	HWM Elev. (m)
75	Bow River at Hwy 1	AT	74353	Bow River	104,455	1990	1301.37
76	Bow River at Bow River campground d/s of Trans Canada Bridge	AT	Trans 4	Bow River	104,208	1986	1301.08
77	Bow River near 'Old Camp' picnic area	AT	Trans 2	Bow River	101,540	1986	1296.37
78	Bow River at Deadman Flats (Three Sisters) Campground	AT	Trans 3	Bow River	98,320	1986	1294.03
79	Bow River at u/s of Gap Lake	AEP	BOWCAN-18	Bow River	94,715	1990	1292.20
80	Bow River at u/s of Gap Lake	AT	Trans 1	Bow River	94,715	1986	1292.33
81	Bow River at u/s of Gap Lake	AEP	BOWCAN-18	Bow River	94,715	1986	1292.05
82	Bow River in Exshaw	AEP	LACDES-01	Bow River	87,298	2013	1292.24
83	Bow River at Morley Road Bridge	AT	611	Bow River	54,450	2013	1192.00
84	Bow River Bridge at Morley	AT	611	Bow River	54,450	2013	1192.10
85	Bow River at Morley Road Bridge - 20m d/s of bridge	AEP	BOWMOR-01-a	Bow River	54,433	2013	1191.82
86	Bow River at Hwy 22 near Cochrane	AT	76609	Bow River	23,410	2013	1123.15
87	Bow River at Hwy 22 near Cochrane	AT	76609	Bow River	23,393	2005	1121.45
88	Bow River at Hwy 22 near Cochrane	AT	76609	Bow River	23,393	1990	1120.40
89	Bow River at HWY 22 Bridge - 10m d/s of d/s side	AEP	BOWCOCH-03-a	Bow River	23,390	2013	1122.94
90	Bow River at River Ave Bridge - 25m u/s	AEP	BOWCOCH-02-b	Bow River	21,256	2013	1118.40
91	Bow River at River Ave Bridge in Cochrane	AT	111	Bow River	21,221	2005	1117.70
92	Bow River at River Ave Bridge - 10m d/s	AEP	BOWCOCH-02-a	Bow River	21,210	2013	1118.16
93	Bow River near Cochrane sewage lagoons	AEP	BOWCOCH-01-a	Bow River	20,069	2013	1116.00
94	Jumpingpound Creek Bridge near Cochrane	AT	283	Jumpingpound Creek	654	2005	1128.60
95	Policeman Creek Headgate	AEP	BOWCAN-06	Policeman Crk	6,465	1986	1314.60
96	Policeman Creek Headgate	AEP	BOWCAN-06	Policeman Crk	6,465	1986	1314.60
97	Policeman Creek at control structure on Bow River	AT	POL-06	Policeman Crk	6,418	1986	1312.57
98	Policeman Creek at vacant lot near 400 Larch Drive	AT	POL-07	Policeman Crk	5,550	1986	1311.21
99	Pond near 101 Larch Avenue at bend in road	AT	POL-23	Policeman Crk	5,163	1986	1311.00
100	Policeman Creek at 17th Street Culverts - Inlet	AT	POL-08.1	Policeman Crk	5,023	1986	1310.93
101	Policeman Creek at 17th Street Culverts - Outlet	AT	POL-08.2	Policeman Crk	4,985	1986	1310.67
102	Policeman Creek at 8 Avenue Culverts - Inlet	AT	POL-09.1	Policeman Crk	4,936	1986	1310.43
103	Policeman Creek at 8 Avenue Culverts - Outlet	AT	POL-09.2	Policeman Crk	4,907	1986	1310.43
104	Side Channel at 8 Avenue Culverts - Inlet	AT	POL-22.1	Policeman Crk	4,880	1986	1309.81
105	Side Channel at 8 Avenue Culverts - Outlet	AT	POL-22.2	Policeman Crk	4,860	1986	1309.71
106	Policeman Creek at Birchwood Place off of Railway Avenue	AT	POL-10	Policeman Crk	4,550	1986	1309.27
107	Policeman Creek at old CPR line	AT	POL-11.1	Policeman Crk	4,337	1986	1308.43
108	Small Channel at old CPR line - Inlet	AT	POL-11.2	Policeman Crk	4,337	1986	1308.47
109	Side Channel at old CPR line culverts - Inlet	AT	POL-21.1	Policeman Crk	4,337	1986	1308.98
110	Small Channel at old CPR line - Outlet	AT	POL-11.3	Policeman Crk	4,320	1986	1308.19
111	Side Channel at old CPR line culverts - Outlet	AT	POL-21.2	Policeman Crk	4,320	1986	1308.97
112	Side Channel at 7 Avenue Culverts - Inlet	AT	POL-20.1	Policeman Crk	4,184	1986	1308.96
113	Side Channel at 7 Avenue Culverts - Outlet	AT	POL-20.2	Policeman Crk	4,154	1986	1308.46

#	Location Name	Source and Site ID		Stream	River Station (m)	Event Year	HWM Elev. (m)
114	Policeman Creek at proposed 10 Street Crossing	AT	POL-12	Policeman Crk	3,862	1986	1307.65
115	Policeman Creek at 8th Street Crossing - u/s of bridge	AT	POL-13	Policeman Crk	3,715	1986	1307.57
116	Policeman Creek at 8th Street Crossing - d/s of bridge	AT	POL-14	Policeman Crk	3,679	1986	1307.26
117	Policeman Creek at trailer court near office	AT	POL-15	Policeman Crk	3,389	1986	1306.76
118	Spring Creek at trailer court near office	AT	POL-19	Policeman Crk	3,389	1986	1306.53
119	Policeman Creek at trailer court 300m d/s of office	AT	POL-16	Policeman Crk	3,093	1986	1306.66
120	Spring Creek at trailer court 300m d/s of office	AT	POL-18	Policeman Crk	3,093	1986	1306.49
121	Policeman Creek at proposed SR 742 Crossing	AT	POL-17	Policeman Crk	1,885	1986	1305.02
122	Bighill Creek at Highway 1A	AT	-	Bighill Creek	2,820	2013	1140.20

APPENDIX B
DETAILED MODEL DATA

APPENDIX B DETAILED MODEL DATA

Table B-1 Cross section details

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
1	Bow River	KM 112	118,148	survey/DTM	1323.34	158.0	
2	Bow River	KM 112	117,852	survey/DTM	1322.93	370.6	
3	Bow River	KM 112	117,547	survey/DTM	1322.32	742.3	
4	Bow River	KM 112	117,241	survey/DTM	1321.04	904.4	
5	Bow River	KM 112	116,670	survey/DTM	1319.30	662.0	
6	Bow River	KM 112	116,188	survey/DTM	1319.03	813.9	
7	Bow River	KM 112	115,644	survey/DTM	1318.21	717.8	
8	Bow River	KM 112	115,415	survey/DTM	1316.91	1011.3	
9	Bow River	KM 112	115,134	survey/DTM	1317.94	1276.0	
10	Bow River	KM 112	114,700	survey/DTM	1315.69	1307.0	
11	Bow River	KM 112	114,258	survey/DTM	1314.97	1203.4	
12	Bow River	KM 112	113,821	survey/DTM	1314.50	1204.5	
13	Bow River	KM 112	113,472	survey/DTM	1313.89	1106.8	
14	Bow River	KM 112	113,065	survey/DTM	1312.73	1026.8	Canmore Town Dike
15	Bow River	KM 112	112,898	survey/DTM	1312.71	1018.1	Canmore Town Dike
16	Bow River	KM 112	112,726	survey/DTM	1312.17	1189.7	Canmore Town Dike
17	Bow River	KM 112	112,580	survey/DTM	1311.54	1160.1	Cross section U/S of Bow River and Policeman Creek junction; Canmore Town Dike
18	Bow River	KM 106	112,416	survey/DTM	1311.86	1030.3	Cross section D/S of Bow River and Policeman Creek junction; Canmore Town Dike
19	Bow River	KM 106	112,279	survey/DTM	1311.64	994.0	Canmore Town Dike
20	Bow River	KM 106	112,071	survey/DTM	1310.67	744.2	Canmore Town Dike
21	Bow River	KM 106	111,915	survey/DTM	1310.95	588.8	Canmore Town Dike
22	Bow River	KM 106	111,823	survey/DTM	1310.66	443.0	Canmore Town Dike
23	Bow River	KM 106	111,706	survey/DTM	1310.10	522.1	Canmore Town Dike
24	Bow River	KM 106	111,305	survey/DTM	1310.04	515.0	Canmore Town Dike
25	Bow River	KM 106	111,132	survey/DTM	1310.15	489.3	Canmore Town Dike
26	Bow River	KM 106	110,887	survey/DTM	1309.12	438.6	Canmore Town Dike
27	Bow River	KM 106	110,734	survey/DTM	1309.32	398.4	Canmore Town Dike
28	Bow River	KM 106	110,352	survey/DTM	1307.92	499.2	Canmore Town Dike
29	Bow River	KM 106	110,148	survey/DTM	1307.71	488.8	Canmore Town Dike
30	Bow River	KM 106	109,981	survey/DTM	1306.03	491.7	Canmore Town Dike
31	Bow River	KM 106	109,938	survey/DTM	1305.83	567.2	U/S Cross section of Spur Line Trail (Engine Bridge); Canmore Town Dike

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
32	Bow River	KM 106	109,921	survey/DTM	1304.55	471.2	D/S Cross section of Spur Line Trail (Engine Bridge); Canmore Town Dike
33	Bow River	KM 106	109,727	survey/DTM	1307.03	332.7	Canmore Town and Mine Dikes
34	Bow River	KM 106	109,501	survey/DTM	1305.87	147.6	Canmore Town and Mine Dikes
35	Bow River	KM 106	109,366	survey/DTM	1305.94	95.2	Canmore Town and Mine Dikes
36	Bow River	KM 106	109,235	survey/DTM	1305.58	73.4	U/S Cross Section of Bridge Road Bridge; Canmore Town and Mine Dikes
37	Bow River	KM 106	109,202	survey/DTM	1305.97	95.6	D/S Cross Section of Bridge Road Bridge; Canmore Town and Mine Dikes
38	Bow River	KM 106	109,114	survey/DTM	1305.85	99.1	Canmore Town and Mine Dikes
39	Bow River	KM 106	108,998	survey/DTM	1306.04	77.6	Canmore Town and Mine Dikes
40	Bow River	KM 106	108,757	survey/DTM	1305.79	259.7	Canmore Town and Mine Dikes
41	Bow River	KM 106	108,586	survey/DTM	1305.56	421.2	Canmore Town Dike
42	Bow River	KM 106	108,458	survey/DTM	1305.78	471.9	Canmore Town Dike
43	Bow River	KM 106	108,052	survey/DTM	1304.17	711.7	Canmore Town Dike
44	Bow River	KM 106	107,747	survey/DTM	1303.84	438.6	Canmore Town Dike
45	Bow River	KM 106	107,333	survey/DTM	1302.27	445.3	Canmore Town Dike
46	Bow River	KM 106	107,113	survey/DTM	1302.41	446.1	
47	Bow River	KM 106	106,702	survey/DTM	1301.44	338.0	Cross section U/S of modelled Bow River and Policeman Creek confluence
48	Bow River	KM 087	106,497	survey/DTM	1301.98	720.3	Cross section D/S of modelled Bow River and Policeman Creek confluence
49	Bow River	KM 087	106,143	survey/DTM	1301.36	778.2	
50	Bow River	KM 087	105,995	survey/DTM	1301.19	752.1	
51	Bow River	KM 087	105,742	survey/DTM	1300.32	665.6	Bow River and Policeman Creek confluence at low flows
52	Bow River	KM 087	105,620	survey/DTM	1297.49	540.5	
53	Bow River	KM 087	105,224	survey/DTM	1298.84	616.2	
54	Bow River	KM 087	104,790	survey/DTM	1298.71	318.9	
55	Bow River	KM 087	104,631	survey/DTM	1297.59	108.0	
56	Bow River	KM 087	104,575	survey/DTM	1297.83	125.3	U/S Cross section of Highway 1 Bridge

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
57	Bow River	KM 087	104,490	survey/DTM	1298.14	134.0	D/S Cross section of Highway 1 Bridge
58	Bow River	KM 087	104,338	survey/DTM	1298.60	1347.8	
59	Bow River	KM 087	104,163	survey/DTM	1298.87	1459.7	
60	Bow River	KM 087	103,697	survey/DTM	1296.68	1505.2	
61	Bow River	KM 087	103,126	survey/DTM	1297.33	1643.9	
62	Bow River	KM 087	102,497	survey/DTM	1295.33	1280.9	
63	Bow River	KM 087	101,706	survey/DTM	1293.17	1377.7	
64	Bow River	KM 087	101,260	survey/DTM	1291.01	1259.1	
65	Bow River	KM 087	100,785	survey/DTM	1292.35	1480.4	
66	Bow River	KM 087	100,276	survey/DTM	1292.47	1516.1	
67	Bow River	KM 087	99,728	survey/DTM	1291.59	1726.2	
68	Bow River	KM 087	99,027	survey/DTM	1290.49	1755.7	
69	Bow River	KM 087	98,134	survey/DTM	1287.90	1293.5	
70	Bow River	KM 087	97,769	survey/DTM	1290.55	975.2	
71	Bow River	KM 087	97,378	survey/DTM	1289.89	806.2	
72	Bow River	KM 087	97,076	survey/DTM	1289.52	831.3	
73	Bow River	KM 087	96,451	survey/DTM	1288.84	1045.5	
74	Bow River	KM 087	94,012	survey/DTM	1287.04	1338.9	
75	Bow River	KM 087	93,591	survey/DTM	1286.51	1223.2	
76	Bow River	KM 087	93,261	survey/DTM	1286.49	1078.4	
77	Bow River	KM 087	92,667	survey/DTM	1285.47	491.0	
78	Bow River	KM 087	92,367	survey/DTM	1285.63	291.3	
79	Bow River	KM 087	92,095	survey/DTM	1287.55	260.4	
80	Bow River	KM 087	91,818	survey/DTM	1287.66	432.2	
81	Bow River	KM 087	91,466	survey/DTM	1287.66	815.7	Lac Des Arcs (east), dust control dike
82	Bow River	KM 087	91,102	survey/DTM	1285.48	1047.8	Lac Des Arcs (east), dust control dike
83	Bow River	KM 087	90,778	survey/DTM	1285.58	897.5	Lac Des Arcs
84	Bow River	KM 087	90,350	survey/DTM	1287.31	1126.1	Lac Des Arcs
85	Bow River	KM 087	89,770	survey/DTM	1285.67	1108.4	Lac Des Arcs
86	Bow River	KM 087	89,451	survey/DTM	1286.22	1050.7	Lac Des Arcs
87	Bow River	KM 087	89,200	survey/DTM	1286.52	958.7	Lac Des Arcs
88	Bow River	KM 087	88,802	survey/DTM	1286.44	1163.3	Lac Des Arcs
89	Bow River	KM 087	88,345	survey/DTM	1287.46	1084.6	Lac Des Arcs (west), dust control dike
90	Bow River	KM 087	88,021	survey/DTM	1286.48	876.3	Lac Des Arcs (west), dust control dike

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
91	Bow River	KM 087	87,652	survey/DTM	1286.62	757.1	Lac Des Arcs (west), dust control dike
92	Bow River	KM 087	87,519	survey/DTM	1287.51	413.6	Lac Des Arcs (west), dust control dike
93	Bow River	KM 087	87,122	survey/DTM	1286.84	67.6	
94	Bow River	KM 087	86,899	survey/DTM	1285.51	62.3	Cross section U/S of Bow River and Exshaw Creek confluence
95	Bow River	KM 025	86,717	survey/DTM	1287.28	282.8	Cross section D/S of Bow River and Exshaw Creek confluence
96	Bow River	KM 025	86,352	survey/DTM	1286.85	464.0	
97	Bow River	KM 025	86,209	survey/DTM	1284.03	499.6	
98	Bow River	KM 025	85,929	survey/DTM	1284.33	1006.2	
99	Bow River	KM 025	85,513	survey/DTM	1284.39	955.2	
100	Bow River	KM 025	85,060	survey/DTM	1282.89	500.8	
101	Bow River	KM 025	84,733	survey/DTM	1282.70	263.7	
102	Bow River	KM 025	84,602	survey/DTM	1282.32	164.9	
103	Bow River	KM 025	84,367	survey/DTM	1281.74	291.4	
104	Bow River	KM 025	84,072	survey/DTM	1281.58	321.7	
105	Bow River	KM 025	83,674	survey/DTM	1279.16	576.9	
106	Bow River	KM 025	83,328	survey/DTM	1276.16	835.3	
107	Bow River	KM 025	82,904	survey/DTM	1277.75	524.9	
108	Bow River	KM 025	82,575	survey/DTM	1278.67	586.9	
109	Bow River	KM 025	82,081	survey/DTM	1279.51	312.4	
110	Bow River	KM 025	81,556	survey/DTM	1278.14	212.7	
111	Bow River	KM 025	81,162	survey/DTM	1276.92	126.9	
112	Bow River	KM 025	80,811	survey/DTM	1276.58	214.0	
113	Bow River	KM 025	80,511	survey/DTM	1277.96	248.9	
114	Bow River	KM 025	80,146	survey/DTM	1279.71	230.1	
115	Bow River	KM 025	79,719	survey/DTM	1278.88	171.2	
116	Bow River	KM 025	79,688	survey/DTM	1278.87	195.7	U/S Cross section of CP Rail Bridge
117	Bow River	KM 025	79,662	survey/DTM	1278.56	175.0	D/S Cross section of CP Rail Bridge
118	Bow River	KM 025	79,598	survey/DTM	1278.73	164.4	
119	Bow River	KM 025	79,245	survey/DTM	1277.35	161.2	
120	Bow River	KM 025	78,845	survey/DTM	1276.49	416.3	
121	Bow River	KM 025	78,451	survey/DTM	1275.08	405.6	
122	Bow River	KM 025	78,039	survey/DTM	1274.49	503.8	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
123	Bow River	KM 025	77,716	survey/DTM	1274.06	176.0	
124	Bow River	KM 025	77,654	survey/DTM	1272.02	118.7	U/S Cross section of Highway 1X Bridge
125	Bow River	KM 025	77,609	survey/DTM	1274.12	147.3	D/S Cross section of Highway 1X Bridge
126	Bow River	KM 025	77,494	Adjusted DTM	1274.12	209.7	Kananaskis Dam
127	Bow River	KM 025	77,488	Adjusted DTM	1263.10	81.4	Kananaskis Dam
128	Bow River	KM 025	76,811	survey/DTM	1251.24	109.4	
129	Bow River	KM 025	76,468	survey/DTM	1254.28	126.0	
130	Bow River	KM 025	76,158	survey/DTM	1253.29	150.4	
131	Bow River	KM 025	75,774	survey/DTM	1251.92	155.6	
132	Bow River	KM 025	75,465	survey/DTM	1249.48	41.0	
133	Bow River	KM 025	75,281	survey/DTM	1248.77	85.2	
134	Bow River	KM 025	75,120	survey/DTM	1245.44	46.7	
135	Bow River	KM 025	74,927	survey/DTM	1246.86	150.6	
136	Bow River	KM 025	74,746	survey/DTM	1247.68	74.0	
137	Bow River	KM 025	74,376	survey/DTM	1251.90	211.0	
138	Bow River	KM 025	74,053	survey/DTM	1245.27	82.0	
139	Bow River	KM 025	73,903	survey/DTM	1249.68	133.9	
140	Bow River	KM 025	73,863	adjusted DTM	1249.68	137.6	Horseshoe Dam
141	Bow River	KM 025	73,845	adjusted DTM	1237.80	66.5	Horseshoe Dam
142	Bow River	KM 025	73,571	survey/DTM	1233.14	83.8	
143	Bow River	KM 025	73,410	survey/DTM	1232.61	114.2	
144	Bow River	KM 025	73,134	survey/DTM	1232.58	157.0	
145	Bow River	KM 025	72,680	survey/DTM	1230.55	130.9	
146	Bow River	KM 025	72,441	survey/DTM	1229.35	140.1	
147	Bow River	KM 025	71,892	survey/DTM	1218.32	24.3	
148	Bow River	KM 025	71,726	survey/DTM	1224.68	77.1	
149	Bow River	KM 025	71,458	survey/DTM	1222.56	116.3	
150	Bow River	KM 025	71,322	survey/DTM	1222.10	106.8	
151	Bow River	KM 025	70,886	survey/DTM	1217.99	85.9	
152	Bow River	KM 025	70,342	survey/DTM	1218.65	128.9	
153	Bow River	KM 025	69,862	survey/DTM	1218.12	135.3	
154	Bow River	KM 025	69,341	survey/DTM	1215.97	94.0	
155	Bow River	KM 025	69,060	survey/DTM	1215.25	99.3	
156	Bow River	KM 025	68,797	survey/DTM	1212.23	85.6	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
157	Bow River	KM 025	68,599	survey/DTM	1205.03	57.8	
158	Bow River	KM 025	68,516	survey/DTM	1213.79	94.5	
159	Bow River	KM 025	68,296	survey/DTM	1212.08	79.8	
160	Bow River	KM 025	68,089	survey/DTM	1213.46	138.8	
161	Bow River	KM 025	67,716	survey/DTM	1212.30	177.3	
162	Bow River	KM 025	67,419	survey/DTM	1211.71	123.1	
163	Bow River	KM 025	67,278	survey/DTM	1211.62	105.5	
164	Bow River	KM 025	67,115	survey/DTM	1210.93	116.3	
165	Bow River	KM 025	66,773	survey/DTM	1209.94	338.4	
166	Bow River	KM 025	66,431	survey/DTM	1209.94	189.6	
167	Bow River	KM 025	66,144	survey/DTM	1209.20	197.9	
168	Bow River	KM 025	65,921	survey/DTM	1207.64	160.3	
169	Bow River	KM 025	65,549	survey/DTM	1208.02	207.0	
170	Bow River	KM 025	65,150	survey/DTM	1206.99	134.3	
171	Bow River	KM 025	64,837	survey/DTM	1205.34	237.4	
172	Bow River	KM 025	64,628	survey/DTM	1205.64	268.8	
173	Bow River	KM 025	64,302	survey/DTM	1205.72	279.6	
174	Bow River	KM 025	64,027	survey/DTM	1205.29	397.3	
175	Bow River	KM 025	63,717	survey/DTM	1204.73	447.3	
176	Bow River	KM 025	63,212	survey/DTM	1203.77	450.2	
177	Bow River	KM 025	62,736	survey/DTM	1201.68	413.1	
178	Bow River	KM 025	62,402	survey/DTM	1200.62	183.7	
179	Bow River	KM 025	61,981	survey/DTM	1200.90	253.9	
180	Bow River	KM 025	61,281	survey/DTM	1200.00	176.1	
181	Bow River	KM 025	60,832	survey/DTM	1200.17	150.7	
182	Bow River	KM 025	60,261	survey/DTM	1199.00	244.6	
183	Bow River	KM 025	59,664	survey/DTM	1198.20	194.0	
184	Bow River	KM 025	59,198	survey/DTM	1195.99	132.9	
185	Bow River	KM 025	58,730	survey/DTM	1195.94	121.7	
186	Bow River	KM 025	58,375	survey/DTM	1192.24	93.3	
187	Bow River	KM 025	57,997	survey/DTM	1194.29	101.8	
188	Bow River	KM 025	57,624	survey/DTM	1192.83	107.1	
189	Bow River	KM 025	57,271	survey/DTM	1192.13	127.0	
190	Bow River	KM 025	56,775	survey/DTM	1190.54	116.3	
191	Bow River	KM 025	56,284	survey/DTM	1189.54	104.5	
192	Bow River	KM 025	55,904	survey/DTM	1189.61	116.5	
193	Bow River	KM 025	55,458	survey/DTM	1188.00	103.3	
194	Bow River	KM 025	55,088	survey/DTM	1187.41	87.5	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
195	Bow River	KM 025	54,806	survey/DTM	1186.24	192.9	
196	Bow River	KM 025	54,585	survey/DTM	1186.38	223.9	
197	Bow River	KM 025	54,487	survey/DTM	1185.78	202.3	U/S Cross section of Morley Road Bridge
198	Bow River	KM 025	54,433	survey/DTM	1184.57	209.2	D/S Cross section of Morley Road Bridge
199	Bow River	KM 025	54,283	survey/DTM	1186.26	231.4	
200	Bow River	KM 025	54,078	survey/DTM	1185.21	333.4	
201	Bow River	KM 025	53,802	survey/DTM	1184.91	281.2	
202	Bow River	KM 025	53,388	survey/DTM	1184.23	199.7	
203	Bow River	KM 025	52,796	survey/DTM	1183.07	381.2	
204	Bow River	KM 025	52,139	survey/DTM	1182.64	440.9	
205	Bow River	KM 025	51,427	survey/DTM	1180.30	483.2	
206	Bow River	KM 025	50,452	survey/DTM	1181.18	320.6	
207	Bow River	KM 025	49,366	survey/DTM	1179.02	589.1	
208	Bow River	KM 025	48,977	survey/DTM	1175.55	913.0	
209	Bow River	KM 025	47,540	survey/DTM	1171.71	1323.5	
210	Bow River	KM 025	45,971	survey/DTM	1168.16	948.4	
211	Bow River	KM 025	44,631	survey/DTM	1165.58	1175.2	
212	Bow River	KM 025	42,928	survey/DTM	1163.59	1279.2	
213	Bow River	KM 025	42,170	Adjusted DTM	1163.59	1235.7	Ghost Dam
214	Bow River	KM 025	42,132	Adjusted DTM	1158.00	77.5	Ghost Dam
215	Bow River	KM 025	41,824	survey/DTM	1154.33	113.7	
216	Bow River	KM 025	41,537	survey/DTM	1156.09	117.4	
217	Bow River	KM 025	41,361	survey/DTM	1155.94	137.9	
218	Bow River	KM 025	40,989	survey/DTM	1155.19	142.5	
219	Bow River	KM 025	40,712	survey/DTM	1153.74	155.8	
220	Bow River	KM 025	40,439	survey/DTM	1154.47	228.3	
221	Bow River	KM 025	40,129	survey/DTM	1153.14	134.2	
222	Bow River	KM 025	39,836	survey/DTM	1152.38	146.8	
223	Bow River	KM 025	39,478	survey/DTM	1150.20	100.0	
224	Bow River	KM 025	39,161	survey/DTM	1149.88	88.8	
225	Bow River	KM 025	38,875	survey/DTM	1150.09	129.0	
226	Bow River	KM 025	38,529	survey/DTM	1149.55	171.1	
227	Bow River	KM 025	38,248	survey/DTM	1147.77	147.3	
228	Bow River	KM 025	38,018	survey/DTM	1146.99	129.5	
229	Bow River	KM 025	37,774	survey/DTM	1147.19	151.2	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
230	Bow River	KM 025	37,502	survey/DTM	1145.24	164.2	
231	Bow River	KM 025	37,086	survey/DTM	1146.40	128.4	
232	Bow River	KM 025	36,785	survey/DTM	1145.87	124.5	
233	Bow River	KM 025	36,450	survey/DTM	1144.88	140.7	
234	Bow River	KM 025	36,158	survey/DTM	1143.81	102.6	
235	Bow River	KM 025	35,863	survey/DTM	1142.37	109.8	
236	Bow River	KM 025	35,381	survey/DTM	1142.19	147.2	
237	Bow River	KM 025	35,009	survey/DTM	1141.67	142.0	
238	Bow River	KM 025	34,562	survey/DTM	1140.94	135.6	
239	Bow River	KM 025	34,140	survey/DTM	1139.49	125.4	
240	Bow River	KM 025	33,877	survey/DTM	1138.96	119.7	
241	Bow River	KM 025	33,609	survey/DTM	1137.40	114.9	
242	Bow River	KM 025	33,289	survey/DTM	1137.84	133.5	
243	Bow River	KM 025	32,977	survey/DTM	1136.09	122.4	
244	Bow River	KM 025	32,605	survey/DTM	1136.77	152.8	
245	Bow River	KM 025	32,220	survey/DTM	1134.71	166.6	
246	Bow River	KM 025	31,935	survey/DTM	1134.82	119.0	
247	Bow River	KM 025	31,588	survey/DTM	1134.51	143.5	
248	Bow River	KM 025	31,260	survey/DTM	1133.78	173.1	
249	Bow River	KM 025	30,935	survey/DTM	1132.78	149.7	
250	Bow River	KM 025	30,566	survey/DTM	1132.33	127.9	
251	Bow River	KM 025	30,214	survey/DTM	1130.92	211.0	
252	Bow River	KM 025	29,937	survey/DTM	1130.72	114.1	
253	Bow River	KM 025	29,563	survey/DTM	1130.34	222.1	
254	Bow River	KM 025	29,172	survey/DTM	1129.51	204.5	
255	Bow River	KM 025	28,925	survey/DTM	1128.19	147.2	
256	Bow River	KM 025	28,798	survey/DTM	1128.25	231.1	
257	Bow River	KM 025	28,448	survey/DTM	1127.89	139.8	
258	Bow River	KM 025	27,998	survey/DTM	1126.66	130.6	
259	Bow River	KM 025	27,701	survey/DTM	1126.73	140.5	
260	Bow River	KM 025	27,469	survey/DTM	1125.55	154.5	
261	Bow River	KM 025	27,386	survey/DTM	1125.57	176.0	U/S Cross section of CP Rail Bridge
262	Bow River	KM 025	27,359	survey/DTM	1125.83	128.3	D/S Cross section of CP Rail Bridge
263	Bow River	KM 025	27,295	survey/DTM	1126.05	130.6	
264	Bow River	KM 025	27,116	survey/DTM	1125.38	144.1	
265	Bow River	KM 025	26,844	survey/DTM	1124.09	148.9	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
266	Bow River	KM 025	26,671	survey/DTM	1125.09	174.9	
267	Bow River	KM 025	26,466	survey/DTM	1123.93	205.6	
268	Bow River	KM 025	26,203	survey/DTM	1122.86	127.1	
269	Bow River	KM 025	25,944	survey/DTM	1122.94	151.0	
270	Bow River	KM 025	25,748	survey/DTM	1122.27	157.1	
271	Bow River	KM 025	25,534	survey/DTM	1122.50	182.5	
272	Bow River	KM 025	25,343	survey/DTM	1122.22	152.6	
273	Bow River	KM 025	25,205	survey/DTM	1121.93	167.0	
274	Bow River	KM 025	24,999	survey/DTM	1121.02	189.6	
275	Bow River	KM 025	24,879	survey/DTM	1120.60	141.3	Cross section U/S of Bow River and Jumpingpound Creek confluence
276	Bow River	KM 023	24,684	survey/DTM	1120.58	226.0	Cross section D/S of Bow River and Jumpingpound Creek confluence
277	Bow River	KM 023	24,482	survey/DTM	1118.84	148.7	
278	Bow River	KM 023	24,338	survey/DTM	1119.10	131.1	
279	Bow River	KM 023	24,132	survey/DTM	1119.53	192.7	
280	Bow River	KM 023	24,010	survey/DTM	1119.38	148.5	
281	Bow River	KM 023	23,713	survey/DTM	1118.09	204.9	
282	Bow River	KM 023	23,562	survey/DTM	1117.16	206.3	
283	Bow River	KM 023	23,415	survey/DTM	1116.59	121.8	U/S Cross section of Cowbow Trail / Highway 22 Bridge
284	Bow River	KM 023	23,391	survey/DTM	1116.61	122.1	D/S Cross section of Cowbow Trail / Highway 22 Bridge
285	Bow River	KM 023	23,317	survey/DTM	1117.14	150.4	Riverfront Park; Riverfront Park nature playground berm
286	Bow River	KM 023	23,130	survey/DTM	1116.68	183.6	Riverfront Park
287	Bow River	KM 023	22,973	survey/DTM	1116.75	204.7	Cross section U/S of Bow River and Bighill Creek confluence
288	Bow River	KM 000	22,894	survey/DTM	1116.77	199.8	Cross section D/S of Bow River and Bighill Creek confluence
289	Bow River	KM 000	22,726	survey/DTM	1115.96	132.2	
290	Bow River	KM 000	22,599	survey/DTM	1115.22	132.3	
291	Bow River	KM 000	22,340	survey/DTM	1114.30	145.6	
292	Bow River	KM 000	22,028	survey/DTM	1114.08	138.2	
293	Bow River	KM 000	21,803	survey/DTM	1113.22	111.3	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
294	Bow River	KM 000	21,608	survey/DTM	1113.34	224.4	
295	Bow River	KM 000	21,421	survey/DTM	1114.08	157.2	
296	Bow River	KM 000	21,274	survey/DTM	1114.14	168.4	
297	Bow River	KM 000	21,235	survey/DTM	1113.94	155.5	U/S Cross section of River Avenue Bridge
298	Bow River	KM 000	21,217	survey/DTM	1113.78	150.8	D/S Cross section of River Avenue Bridge
299	Bow River	KM 000	21,170	survey/DTM	1113.43	156.7	
300	Bow River	KM 000	21,030	survey/DTM	1112.90	177.6	
301	Bow River	KM 000	20,876	survey/DTM	1111.95	164.2	
302	Bow River	KM 000	20,666	survey/DTM	1111.81	136.1	
303	Bow River	KM 000	20,496	survey/DTM	1111.64	134.0	
304	Bow River	KM 000	20,329	survey/DTM	1111.20	139.5	
305	Bow River	KM 000	20,174	survey/DTM	1111.53	143.7	
306	Bow River	KM 000	19,933	survey/DTM	1110.38	218.8	
307	Bow River	KM 000	19,798	survey/DTM	1110.05	208.2	
308	Bow River	KM 000	19,603	survey/DTM	1107.94	117.5	
309	Bow River	KM 000	19,507	survey/DTM	1107.64	138.1	
310	Bow River	KM 000	19,342	survey/DTM	1108.98	139.8	
311	Bow River	KM 000	19,150	survey/DTM	1109.59	238.3	
312	Bow River	KM 000	18,984	survey/DTM	1108.48	283.3	
313	Bow River	KM 000	18,840	survey/DTM	1108.47	228.6	
314	Bow River	KM 000	18,709	survey/DTM	1108.13	214.6	
315	Bow River	KM 000	18,500	survey/DTM	1107.46	179.1	
316	Bow River	KM 000	18,270	survey/DTM	1106.42	101.0	
317	Bow River	KM 000	17,960	survey/DTM	1106.36	151.7	
318	Bow River	KM 000	17,680	survey/DTM	1106.16	250.8	
319	Bow River	KM 000	17,298	survey/DTM	1105.17	270.8	
320	Bow River	KM 000	16,969	survey/DTM	1104.90	157.0	
321	Bow River	KM 000	16,703	survey/DTM	1103.38	155.7	
322	Bow River	KM 000	16,437	survey/DTM	1103.54	159.3	
323	Bow River	KM 000	16,269	survey/DTM	1104.13	159.8	
324	Bow River	KM 000	16,024	survey/DTM	1103.27	146.3	
325	Bow River	KM 000	15,830	survey/DTM	1102.65	147.8	
326	Bow River	KM 000	15,648	survey/DTM	1102.88	214.3	
327	Bow River	KM 000	15,440	survey/DTM	1101.72	196.8	
328	Bow River	KM 000	15,224	survey/DTM	1101.71	170.0	
329	Bow River	KM 000	14,981	survey/DTM	1101.06	205.0	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
330	Bow River	KM 000	14,763	survey/DTM	1100.47	173.1	
331	Bow River	KM 000	14,383	survey/DTM	1099.61	131.1	
332	Bow River	KM 000	14,213	survey/DTM	1100.24	150.6	
333	Bow River	KM 000	13,874	survey/DTM	1098.60	165.6	
334	Bow River	KM 000	13,626	survey/DTM	1098.65	196.4	
335	Bow River	KM 000	13,399	survey/DTM	1098.17	167.6	
336	Bow River	KM 000	13,018	survey/DTM	1097.12	152.1	
337	Bow River	KM 000	12,701	survey/DTM	1096.70	157.2	
338	Bow River	KM 000	12,451	survey/DTM	1096.56	226.3	
339	Bow River	KM 000	12,234	survey/DTM	1095.15	175.2	
340	Bow River	KM 000	11,894	survey/DTM	1096.38	171.9	
341	Bow River	KM 000	11,503	survey/DTM	1094.24	131.3	
342	Bow River	KM 000	11,230	survey/DTM	1094.31	144.1	
343	Bow River	KM 000	10,967	survey/DTM	1093.98	213.1	
344	Bow River	KM 000	10,591	survey/DTM	1093.90	239.5	
345	Bow River	KM 000	10,200	survey/DTM	1092.02	282.2	
346	Bow River	KM 000	10,063	survey/DTM	1092.24	291.9	
347	Bow River	KM 000	9,667	survey/DTM	1090.48	156.4	
348	Bow River	KM 000	9,467	survey/DTM	1090.23	160.3	
349	Bow River	KM 000	9,283	survey/DTM	1089.22	164.8	
350	Bow River	KM 000	9,041	survey/DTM	1090.28	268.5	
351	Bow River	KM 000	8,729	survey/DTM	1089.02	129.9	
352	Bow River	KM 000	8,459	survey/DTM	1088.82	168.8	
353	Bow River	KM 000	8,192	survey/DTM	1088.20	315.8	
354	Bow River	KM 000	7,916	survey/DTM	1087.98	324.8	
355	Bow River	KM 000	7,653	survey/DTM	1088.09	315.5	
356	Bow River	KM 000	7,469	survey/DTM	1087.46	263.3	
357	Bow River	KM 000	7,251	survey/DTM	1087.35	202.2	
358	Bow River	KM 000	7,027	survey/DTM	1087.83	270.1	
359	Bow River	KM 000	6,740	survey/DTM	1085.52	290.1	
360	Bow River	KM 000	6,416	survey/DTM	1086.53	311.4	
361	Bow River	KM 000	6,005	survey/DTM	1086.14	299.2	
362	Bow River	KM 000	5,633	survey/DTM	1084.80	291.2	
363	Bow River	KM 000	5,196	survey/DTM	1084.61	326.4	
364	Bow River	KM 000	4,675	survey/DTM	1082.64	320.0	
365	Bow River	KM 000	4,201	survey/DTM	1082.20	281.2	
366	Bow River	KM 000	3,744	survey/DTM	1083.83	318.7	
367	Bow River	KM 000	3,204	survey/DTM	1080.68	328.0	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
368	Bow River	KM 000	2,677	survey/DTM	1081.85	413.9	
369	Bow River	KM 000	2,148	survey/DTM	1079.94	491.6	
370	Bow River	KM 000	1,302	survey/DTM	1076.84	322.3	
371	Bow River	KM 000	329	survey/DTM	1075.65	352.7	
372	Bow River	KM 000	12	Adjusted DTM	1075.00	115.0	Bearspaw Dam
373	Bighill Creek	KM 000	5,030	survey/DTM	1153.45	97.4	
374	Bighill Creek	KM 000	4,966	survey/DTM	1152.59	37.3	
375	Bighill Creek	KM 000	4,883	survey/DTM	1152.05	63.6	
376	Bighill Creek	KM 000	4,810	survey/DTM	1151.07	62.7	
377	Bighill Creek	KM 000	4,715	survey/DTM	1151.17	76.3	
378	Bighill Creek	KM 000	4,639	survey/DTM	1150.58	77.4	
379	Bighill Creek	KM 000	4,527	survey/DTM	1149.80	80.1	
380	Bighill Creek	KM 000	4,461	survey/DTM	1149.32	45.6	
381	Bighill Creek	KM 000	4,363	survey/DTM	1148.32	25.7	U/S Cross section of pedestrian bridge
382	Bighill Creek	KM 000	4,357	survey/DTM	1148.58	27.0	D/S Cross section of pedestrian bridge
383	Bighill Creek	KM 000	4,295	survey/DTM	1148.12	24.3	
384	Bighill Creek	KM 000	4,203	survey/DTM	1147.45	12.8	
385	Bighill Creek	KM 000	4,129	survey/DTM	1147.01	41.2	
386	Bighill Creek	KM 000	4,055	survey/DTM	1146.16	52.8	
387	Bighill Creek	KM 000	3,915	survey/DTM	1145.10	53.7	
388	Bighill Creek	KM 000	3,851	survey/DTM	1144.59	38.3	
389	Bighill Creek	KM 000	3,797	survey/DTM	1144.44	86.4	U/S Cross section of pedestrian bridge
390	Bighill Creek	KM 000	3,790	survey/DTM	1144.38	73.7	D/S Cross section of pedestrian bridge
391	Bighill Creek	KM 000	3,675	survey/DTM	1143.66	72.7	
392	Bighill Creek	KM 000	3,563	survey/DTM	1142.89	80.9	
393	Bighill Creek	KM 000	3,388	survey/DTM	1142.07	146.9	U/S Cross section of pedestrian bridge
394	Bighill Creek	KM 000	3,382	survey/DTM	1141.96	151.7	D/S Cross section of pedestrian bridge
395	Bighill Creek	KM 000	3,263	survey/DTM	1141.21	169.3	
396	Bighill Creek	KM 000	3,094	survey/DTM	1140.34	208.3	
397	Bighill Creek	KM 000	2,960	survey/DTM	1139.30	18.9	
398	Bighill Creek	KM 000	2,905	survey/DTM	1139.38	55.6	
399	Bighill Creek	KM 000	2,848	survey/DTM	1139.49	23.0	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
400	Bighill Creek	KM 000	2,826	survey/DTM	1139.28	82.9	U/S Cross section of Bow Valley Trail / Highway 1A Bridge
401	Bighill Creek	KM 000	2,804	survey/DTM	1139.26	80.5	D/S Cross section of Bow Valley Trail / Highway 1A Bridge
402	Bighill Creek	KM 000	2,792	survey/DTM	1138.94	204.8	
403	Bighill Creek	KM 000	2,780	survey/DTM	1138.95	256.1	
404	Bighill Creek	KM 000	2,761	survey/DTM	1139.22	453.1	U/S Cross section of CP Rail Bridge
405	Bighill Creek	KM 000	2,748	survey/DTM	1139.01	368.1	D/S Cross section of CP Rail Bridge
406	Bighill Creek	KM 000	2,729	survey/DTM	1138.60	15.1	
407	Bighill Creek	KM 000	2,676	survey/DTM	1138.46	358.6	
408	Bighill Creek	KM 000	2,631	survey/DTM	1138.10	345.3	
409	Bighill Creek	KM 000	2,573	survey/DTM	1137.80	275.1	
410	Bighill Creek	KM 000	2,543	survey/DTM	1137.77	206.4	
411	Bighill Creek	KM 000	2,517	survey/DTM	1137.76	177.2	U/S Cross section of Glenbow Drive Culvert
412	Bighill Creek	KM 000	2,482	survey/DTM	1137.76	11.0	D/S Cross section of Glenbow Drive Culvert
413	Bighill Creek	KM 000	2,387	survey/DTM	1136.89	70.7	
414	Bighill Creek	KM 000	2,267	survey/DTM	1136.10	22.7	
415	Bighill Creek	KM 000	2,161	survey/DTM	1135.38	83.5	U/S Cross section of walking trail bridge
416	Bighill Creek	KM 000	2,154	survey/DTM	1135.41	43.2	D/S Cross section of walking trail bridge
417	Bighill Creek	KM 000	2,106	survey/DTM	1135.15	54.6	
418	Bighill Creek	KM 000	1,937	survey/DTM	1134.11	77.7	
419	Bighill Creek	KM 000	1,769	survey/DTM	1133.95	50.3	
420	Bighill Creek	KM 000	1,723	survey/DTM	1133.44	47.5	U/S Cross section of pedestrian bridge
421	Bighill Creek	KM 000	1,720	survey/DTM	1133.50	41.7	D/S Cross section of walking trail bridge
422	Bighill Creek	KM 000	1,606	survey/DTM	1132.88	172.8	
423	Bighill Creek	KM 000	1,536	survey/DTM	1132.22	94.6	U/S Cross section of Glenpatrick Road Culvert
424	Bighill Creek	KM 000	1,501	survey/DTM	1132.29	103.9	D/S Cross section of Glenpatrick Road Culvert
425	Bighill Creek	KM 000	1,484	survey/DTM	1132.07	31.3	
426	Bighill Creek	KM 000	1,395	survey/DTM	1131.17	89.9	
427	Bighill Creek	KM 000	1,212	survey/DTM	1130.05	55.0	U/S Cross section of pedestrian bridge

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
428	Bighill Creek	KM 000	1,202	survey/DTM	1130.06	33.1	D/S Cross section of pedestrian bridge
429	Bighill Creek	KM 000	1,168	survey/DTM	1129.23	17.8	
430	Bighill Creek	KM 000	1,095	survey/DTM	1128.64	15.2	
431	Bighill Creek	KM 000	995	survey/DTM	1127.88	24.3	U/S Cross section of pedestrian bridge
432	Bighill Creek	KM 000	989	survey/DTM	1127.77	24.2	D/S Cross section of pedestrian bridge
433	Bighill Creek	KM 000	915	survey/DTM	1126.98	46.1	
434	Bighill Creek	KM 000	822	survey/DTM	1126.02	25.8	
435	Bighill Creek	KM 000	740	survey/DTM	1125.32	32.5	
436	Bighill Creek	KM 000	617	survey/DTM	1124.19	56.9	
437	Bighill Creek	KM 000	586	survey/DTM	1124.03	73.5	U/S Cross section of pedestrian bridge
438	Bighill Creek	KM 000	576	survey/DTM	1123.78	74.5	D/S Cross section of pedestrian bridge
439	Bighill Creek	KM 000	505	survey/DTM	1123.35	76.6	U/S Cross section of Griffin Road W Culvert
440	Bighill Creek	KM 000	454	survey/DTM	1122.41	10.5	D/S Cross section of Griffin Road W Culvert
441	Bighill Creek	KM 000	376	survey/DTM	1121.78	42.5	U/S Cross section of pedestrian bridge
442	Bighill Creek	KM 000	369	survey/DTM	1121.88	45.7	D/S Cross section of pedestrian bridge
443	Bighill Creek	KM 000	335	survey/DTM	1121.20	19.2	
444	Bighill Creek	KM 000	262	survey/DTM	1120.39	35.8	
445	Bighill Creek	KM 000	211	survey/DTM	1119.40	62.6	U/S Cross section of pedestrian bridge
446	Bighill Creek	KM 000	206	survey/DTM	1119.65	65.3	D/S Cross section of pedestrian bridge
447	Bighill Creek	KM 000	185	survey/DTM	1119.30	71.2	Cross section upstream of Bow River and Bighill Creek confluence
448	Exshaw Creek	KM 000	1,319	survey/DTM	1341.28	13.9	
449	Exshaw Creek	KM 000	1,182	survey/DTM	1337.57	20.6	
450	Exshaw Creek	KM 000	1,105	survey/DTM	1334.72	27.4	
451	Exshaw Creek	KM 000	1,014	survey/DTM	1329.70	16.0	
452	Exshaw Creek	KM 000	922	survey/DTM	1326.72	187.5	
453	Exshaw Creek	KM 000	838	survey/DTM	1321.44	128.6	
454	Exshaw Creek	KM 000	708	survey/DTM	1316.65	121.7	
455	Exshaw Creek	KM 000	593	survey/DTM	1311.77	116.1	
456	Exshaw Creek	KM 000	475	survey/DTM	1306.54	211.7	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
457	Exshaw Creek	KM 000	454	survey/DTM	1304.52	248.6	U/S Cross section of pedestrian bridge
458	Exshaw Creek	KM 000	449	survey/DTM	1304.10	289.4	D/S Cross section of pedestrian bridge
459	Exshaw Creek	KM 000	434	survey/DTM	1304.51	285.8	
460	Exshaw Creek	KM 000	352	survey/DTM	1300.98	19.8	
461	Exshaw Creek	KM 000	233	survey/DTM	1295.90	11.2	
462	Exshaw Creek	KM 000	219	survey/DTM	1295.21	15.4	U/S Cross section of Bow Valley Trail - Highway 1A
463	Exshaw Creek	KM 000	198	survey/DTM	1294.75	16.3	U/S Cross section of Bow Valley Trail - Highway 1A
464	Exshaw Creek	KM 000	190	survey/DTM	1294.43	13.8	
465	Exshaw Creek	KM 000	171	survey/DTM	1293.04	13.5	
466	Exshaw Creek	KM 000	161	survey/DTM	1291.92	18.8	U/S Cross section of CP Rail Bridge
467	Exshaw Creek	KM 000	147	survey/DTM	1291.91	19.7	D/S Cross section of CP Rail Bridge
468	Exshaw Creek	KM 000	133	survey/DTM	1291.95	19.4	
469	Exshaw Creek	KM 000	118	survey/DTM	1291.69	13.8	U/S Cross section of Diamond Drive Bridge
470	Exshaw Creek	KM 000	104	survey/DTM	1291.67	12.4	D/S Cross section of Diamond Drive Bridge
471	Exshaw Creek	KM 000	89	survey/DTM	1291.20	13.0	Cross section upstream of Bow River and Exshaw Creek confluence
472	Jumpingpound Ck	KM 000	5,294	survey/DTM	1151.11	53.0	
473	Jumpingpound Ck	KM 000	5,202	survey/DTM	1150.51	44.0	
474	Jumpingpound Ck	KM 000	5,101	survey/DTM	1150.40	53.6	
475	Jumpingpound Ck	KM 000	4,984	survey/DTM	1147.73	49.6	
476	Jumpingpound Ck	KM 000	4,882	survey/DTM	1147.92	62.7	
477	Jumpingpound Ck	KM 000	4,791	survey/DTM	1147.78	82.7	
478	Jumpingpound Ck	KM 000	4,648	survey/DTM	1147.33	49.5	
479	Jumpingpound Ck	KM 000	4,550	survey/DTM	1146.37	58.8	
480	Jumpingpound Ck	KM 000	4,463	survey/DTM	1146.48	100.2	
481	Jumpingpound Ck	KM 000	4,369	survey/DTM	1145.51	89.5	
482	Jumpingpound Ck	KM 000	4,277	survey/DTM	1145.13	58.4	
483	Jumpingpound Ck	KM 000	4,168	survey/DTM	1144.43	100.3	
484	Jumpingpound Ck	KM 000	4,040	survey/DTM	1143.71	47.4	
485	Jumpingpound Ck	KM 000	3,915	survey/DTM	1143.18	167.1	
486	Jumpingpound Ck	KM 000	3,824	survey/DTM	1141.95	112.6	
487	Jumpingpound Ck	KM 000	3,672	survey/DTM	1141.44	89.4	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
488	Jumpingpound Ck	KM 000	3,591	survey/DTM	1142.11	79.1	
489	Jumpingpound Ck	KM 000	3,503	survey/DTM	1141.07	109.5	
490	Jumpingpound Ck	KM 000	3,363	survey/DTM	1140.02	109.2	
491	Jumpingpound Ck	KM 000	3,202	survey/DTM	1137.90	62.1	
492	Jumpingpound Ck	KM 000	3,095	survey/DTM	1138.21	54.0	
493	Jumpingpound Ck	KM 000	3,006	survey/DTM	1137.17	61.1	
494	Jumpingpound Ck	KM 000	2,867	survey/DTM	1136.77	88.6	
495	Jumpingpound Ck	KM 000	2,745	survey/DTM	1134.99	70.1	
496	Jumpingpound Ck	KM 000	2,650	survey/DTM	1135.15	75.1	
497	Jumpingpound Ck	KM 000	2,557	survey/DTM	1135.53	148.8	
498	Jumpingpound Ck	KM 000	2,410	survey/DTM	1135.35	190.1	
499	Jumpingpound Ck	KM 000	2,301	survey/DTM	1133.75	165.3	
500	Jumpingpound Ck	KM 000	2,181	survey/DTM	1133.18	133.4	
501	Jumpingpound Ck	KM 000	2,081	survey/DTM	1132.64	144.3	
502	Jumpingpound Ck	KM 000	1,861	survey/DTM	1130.75	43.5	
503	Jumpingpound Ck	KM 000	1,733	survey/DTM	1130.22	125.2	
504	Jumpingpound Ck	KM 000	1,592	survey/DTM	1130.60	107.2	
505	Jumpingpound Ck	KM 000	1,455	survey/DTM	1129.02	104.6	
506	Jumpingpound Ck	KM 000	1,327	survey/DTM	1128.41	83.2	
507	Jumpingpound Ck	KM 000	1,224	survey/DTM	1128.16	86.9	
508	Jumpingpound Ck	KM 000	1,056	survey/DTM	1127.01	166.8	
509	Jumpingpound Ck	KM 000	901	survey/DTM	1126.67	133.6	
510	Jumpingpound Ck	KM 000	791	survey/DTM	1125.66	129.5	
511	Jumpingpound Ck	KM 000	722	survey/DTM	1125.47	184.8	
512	Jumpingpound Ck	KM 000	665	survey/DTM	1125.01	163.4	U/S Cross section of George Fox Trail Bridge
513	Jumpingpound Ck	KM 000	625	survey/DTM	1124.93	111.3	D/S Cross section of George Fox Trail Bridge; Jumpingpound Creek Dyke
514	Jumpingpound Ck	KM 000	562	survey/DTM	1124.81	104.3	Jumpingpound Creek Dyke
515	Jumpingpound Ck	KM 000	501	survey/DTM	1124.78	101.9	Jumpingpound Creek Dyke
516	Jumpingpound Ck	KM 000	386	survey/DTM	1124.13	113.6	
517	Jumpingpound Ck	KM 000	232	survey/DTM	1123.21	144.1	
518	Jumpingpound Ck	KM 000	116	survey/DTM	1122.94	135.2	Cross section U/S of Bow River and Jumpingpound Ck confluence
519	Policeman Creek	KM 000	6,465	survey/DTM	1312.84	140.4	Cross section D/S of Bow River and Policeman Creek junction and Cross Section U/S of inline structure

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
520	Policeman Creek	KM 000	6,418	survey/DTM	1312.25	12.1	Cross section D/S of inline structure (shortened)
521	Policeman Creek	KM 000	6,410	survey/DTM	1312.21	10.9	Spill #1 from Bow River (RS 112725)
522	Policeman Creek	KM 000	6,344	survey/DTM	1312.17	11.7	
523	Policeman Creek	KM 000	6,312	survey/DTM	1312.18	11.1	
524	Policeman Creek	KM 000	6,227	survey/DTM	1312.07	11.8	
525	Policeman Creek	KM 000	6,126	survey/DTM	1311.77	62.4	
526	Policeman Creek	KM 000	6,075	survey/DTM	1311.59	66.5	
527	Policeman Creek	KM 000	6,023	survey/DTM	1311.46	37.1	
528	Policeman Creek	KM 000	5,960	survey/DTM	1311.50	60.8	U/S Cross section of golf course culvert
529	Policeman Creek	KM 000	5,946	survey/DTM	1311.34	61.4	U/S Cross section of golf course culvert
530	Policeman Creek	KM 000	5,877	survey/DTM	1311.46	56.3	
531	Policeman Creek	KM 000	5,782	survey/DTM	1311.20	60.8	
532	Policeman Creek	KM 000	5,719	survey/DTM	1311.15	63.1	
533	Policeman Creek	KM 000	5,673	survey/DTM	1311.02	290.0	U/S Cross section of golf course bridge
534	Policeman Creek	KM 000	5,666	survey/DTM	1310.84	232.7	D/S Cross section of golf course bridge
535	Policeman Creek	KM 000	5,651	survey/DTM	1310.87	157.6	U/S Cross section of pedestrian bridge
536	Policeman Creek	KM 000	5,646	survey/DTM	1310.89	113.8	D/S Cross section of pedestrian bridge
537	Policeman Creek	KM 000	5,599	survey/DTM	1310.79	37.5	
538	Policeman Creek	KM 000	5,531	survey/DTM	1310.48	41.9	
539	Policeman Creek	KM 000	5,468	survey/DTM	1310.41	34.7	
540	Policeman Creek	KM 000	5,364	survey/DTM	1310.36	100.3	
541	Policeman Creek	KM 000	5,257	survey/DTM	1310.08	73.8	U/S Cross section of pedestrian bridge
542	Policeman Creek	KM 000	5,248	survey/DTM	1310.14	99.6	D/S Cross section of pedestrian bridge
543	Policeman Creek	KM 000	5,163	survey/DTM	1310.00	95.3	
544	Policeman Creek	KM 000	5,110	survey/DTM	1310.06	208.9	U/S Cross section of pedestrian bridge; Spill #2 from Bow River (RS 110147)
545	Policeman Creek	KM 000	5,101	survey/DTM	1309.97	230.7	D/S Cross section of pedestrian bridge
546	Policeman Creek	KM 000	5,023	survey/DTM	1309.75	367.6	U/S Cross section of 17 Street culvert
547	Policeman Creek	KM 000	4,985	survey/DTM	1309.73	210.8	D/S Cross section of 17 Street culvert

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
548	Policeman Creek	KM 000	4,936	survey/DTM	1309.60	224.7	U/S Cross section of 8 Avenue culvert
549	Policeman Creek	KM 000	4,907	survey/DTM	1309.28	113.8	D/S Cross section of 8 Avenue culvert
550	Policeman Creek	KM 000	4,880	survey/DTM	1309.24	78.3	
551	Policeman Creek	KM 000	4,855	survey/DTM	1309.19	108.1	U/S Cross section of pedestrian bridge
552	Policeman Creek	KM 000	4,852	survey/DTM	1309.16	86.1	D/S Cross section of pedestrian bridge
553	Policeman Creek	KM 000	4,796	survey/DTM	1308.87	163.9	
554	Policeman Creek	KM 000	4,726	survey/DTM	1308.86	164.8	
555	Policeman Creek	KM 000	4,720	survey/DTM	1308.96	149.9	U/S Cross section of pedestrian bridge
556	Policeman Creek	KM 000	4,714	survey/DTM	1308.96	127.5	D/S Cross section of pedestrian bridge
557	Policeman Creek	KM 000	4,675	survey/DTM	1308.93	94.4	
558	Policeman Creek	KM 000	4,603	survey/DTM	1308.97	83.6	
559	Policeman Creek	KM 000	4,544	survey/DTM	1308.55	67.8	
560	Policeman Creek	KM 000	4,463	survey/DTM	1308.21	42.8	
561	Policeman Creek	KM 000	4,380	survey/DTM	1307.92	71.5	
562	Policeman Creek	KM 000	4,337	survey/DTM	1307.91	118.3	U/S Cross section of pedestrian bridge
563	Policeman Creek	KM 000	4,320	survey/DTM	1307.77	77.8	D/S Cross section of pedestrian bridge
564	Policeman Creek	KM 000	4,220	survey/DTM	1307.72	50.8	
565	Policeman Creek	KM 000	4,184	survey/DTM	1307.69	61.4	
566	Policeman Creek	KM 000	4,030	survey/DTM	1307.28	29.8	
567	Policeman Creek	KM 000	3,921	survey/DTM	1307.29	39.8	
568	Policeman Creek	KM 000	3,888	survey/DTM	1307.13	17.6	U/S Cross section of 10 Street bridge
569	Policeman Creek	KM 000	3,862	survey/DTM	1307.09	33.7	D/S Cross section of 10 Street bridge
570	Policeman Creek	KM 000	3,835	survey/DTM	1306.73	61.1	
571	Policeman Creek	KM 000	3,784	survey/DTM	1307.00	49.4	
572	Policeman Creek	KM 000	3,713	survey/DTM	1306.94	60.5	U/S Cross section of 8 Street bridge
573	Policeman Creek	KM 000	3,685	survey/DTM	1306.66	80.9	D/S Cross section of 8 Street bridge
574	Policeman Creek	KM 000	3,527	survey/DTM	1306.59	147.8	Spill #3 from Bow River (RS 108585)
575	Policeman Creek	KM 000	3,354	survey/DTM	1306.18	85.4	
576	Policeman Creek	KM 000	3,191	survey/DTM	1306.01	128.4	

No	River	HE-RAS Model Sub-Reach	River Station (m)	Source data for Main Channel/ Floodplain	Thalweg Elev. (m)	Channel Width (m)	Notes
577	Policeman Creek	KM 000	3,154	survey/DTM	1306.29	54.6	U/S Cross section of pedestrian bridge
578	Policeman Creek	KM 000	3,141	survey/DTM	1306.32	56.5	D/S Cross section of pedestrian bridge
579	Policeman Creek	KM 000	3,002	survey/DTM	1305.82	103.1	
580	Policeman Creek	KM 000	2,822	survey/DTM	1305.06	48.8	
581	Policeman Creek	KM 000	2,804	survey/DTM	1305.24	40.4	U/S Cross section of Spring Creek Gate Bridge
582	Policeman Creek	KM 000	2,782	survey/DTM	1305.70	50.5	D/S Cross section of Spring Creek Gate Bridge
583	Policeman Creek	KM 000	2,666	survey/DTM	1305.58	39.6	
584	Policeman Creek	KM 000	2,518	survey/DTM	1305.08	121.0	Spill #4 from Bow River (RS 108051)
585	Policeman Creek	KM 000	2,394	survey/DTM	1304.63	13.1	
586	Policeman Creek	KM 000	2,306	survey/DTM	1304.71	273.9	
587	Policeman Creek	KM 000	2,128	survey/DTM	1304.07	357.2	
588	Policeman Creek	KM 000	1,771	survey/DTM	1303.82	387.4	
589	Policeman Creek	KM 000	1,560	survey/DTM	1303.17	414.5	
590	Policeman Creek	KM 000	1,544	survey/DTM	1303.07	406.4	
591	Policeman Creek	KM 000	1,373	survey/DTM	1303.99	401.7	Cross section U/S of Bow River and Policeman Creek confluence (modelled).

Table B-1 Bridge details

NHC ID	Stream Name	River Station (m)	Municipality	Road/Trail	Owner	Owner ID	Design Drawing /Info	Type of Bridge	Descrip.	Span (m)	Width (m)	Number of Piers	Skew (°)	Elevation (m GD)			Survey Status	Survey by	In Model	Model Comment
														Top Chord	Deck	Low Chord				
12	Bow River	21,225	Cochrane	River Avenue	Alberta Transportation	111	yes	Paved road bridge	steel truss bridge	145	7.49	1	0	1,121.20	1,121.20	1,119.95	NHC Surveyed 2015	Crew 1	YES	pipe crossing on downstream side, approx. 0.3 m above deck but not used
15	Bow River	23,403	Cochrane	Cowbow Trail/Hwy 22	Alberta Transportation	76609	yes	Highway bridge	steel beam bridge	150	11.78	3	25	1,128.10	1,127.70	1,125.70	NHC Surveyed 2015	Crew 1	YES	
17	Bow River	27,374	near Cochrane	CP Rail	CP Rail	mile 25.7	yes	Rail bridge	steel truss bridge	120.6	6.3	1	32	1,136.24	1,136.24	1,134.74	NHC Surveyed 2015	Crew 3	YES	
11	Bow River	54,457	Morley	Morley Road	Alberta Transportation	611	yes	Highway bridge	steel truss bridge	93	10.8	2	15	1,197.65	1,197.45	1,196.08	NHC Surveyed 2016	Crew 5	YES	
8	Bow River	77,639	Seebe	Hwy 1X	Alberta Transportation	75111	yes	Highway bridge	concrete beam bridge	135.3	10.64	3	0	1,285.44	1,285.22	1,283.20	NHC Surveyed 2015	Crew 3	YES	
30	Bow River	79,676	Seebe	CP Rail	CP Rail	mile 53.1	yes	Rail bridge	steel truss bridge	144.3	7.5	2	0	1,284.35	1,284.35	1,283.40	NHC Surveyed 2015	Crew 3	YES	
42	Bow River	104,509	Canmore	Hwy 1 E	Alberta Transportation	74353	yes	Highway bridge	concrete arch bridge	137.6	15.4	3	30	1,306.55	1,306.55	1,302.58	NHC Surveyed 2015	Crew 3	YES	
32	Bow River	104,549	Canmore	Hwy 1 W	Alberta Transportation	74353	yes	Highway bridge	concrete arch bridge	137.6	15.4	3	30	1,306.55	1,306.55	1,302.58	NHC Surveyed 2015	Crew 3	YES	
70	Bow River	109,212	Canmore	Bow River Pedestrian Bridge	Canmore	BG03	no	Pedestrian bridge	timber beam bridge	73.8	4.17	2	0	1,312.50	1,312.20	1,311.21	NHC Surveyed 2015	Crew 3	YES	
31	Bow River	109,223	Canmore	Bridge Road	Alberta Transportation	00167 (BG02)	yes	Paved road bridge	steel beam bridge	86	8.66	2	0	1,312.47	1,312.20	1,310.92	NHC Surveyed 2015	Crew 3	YES	
51	Bow River	109,929	Canmore	Spur Line Trail (Engine Bridge)	Canmore	81692 (BG20)	yes	Pedestrian bridge	steel truss bridge	95.2	8.3	1	0	1,313.15	1,313.13	1,312.33	NHC Surveyed 2015	Crew 3	YES	
74	side channel (Bow River)	25,010	Cochrane	Walking Trail	Cochrane	-	no	Replaced 2015	timber beam bridge	7.33	2.76	0	0	1,126.87	1,126.64	1,126.26	NHC Surveyed 2015	Crew 1	NO	on floodplain, not connected to channel flow
69	side channel (Bow River)	108,615	Canmore	Walking Trail	Canmore	BG15	no	Pedestrian bridge	timber beam bridge	11.29	2.88	0	0	1,309.80	1,309.80	1,308.78	NHC Surveyed 2015	Crew 3	NO	on floodplain, not connected to channel flow
55	side channel (Bow River)	109,929	Canmore	Spur Line Trail	Canmore	81694 (BG18)	no	Pedestrian bridge	steel truss bridge	40.65	6.76	2	0	1,311.90	1,311.90	1,310.94	NHC Surveyed 2015	Crew 3	YES	
63	side channel (Bow River)	110,852	Canmore	Walking Trail	Canmore	BG30	no	Pedestrian bridge	timber beam bridge	1.15	1.9	0	0	1,311.63	1,311.62	1,311.49	NHC Surveyed 2015	Crew 3	NO	on floodplain, not connected to channel flow

NHC ID	Stream Name	River Station (m)	Municipality	Road/Trail	Owner	Owner ID	Design Drawing /Info	Type of Bridge	Descrip.	Span (m)	Width (m)	Number of Piers	Skew (°)	Elevation (m GD)			Survey Status	Survey by	In Model	Model Comment
														Top Chord	Deck	Low Chord				
71	Bighill Creek	208	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	7.5	2.8	0	0	1,122.12	1,121.98	1,121.60	NHC Surveyed 2015	Crew 4	YES	
317	Bighill Creek	372	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	5.6	1.5	0	0	1,123.45	1,123.23	1,123.16	NHC Surveyed 2015	Crew 4	YES	
316	Bighill Creek	581	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	8	2.5	0	0	1,126.15	1,126.00	1,125.20	NHC Surveyed 2015	Crew 4	YES	
77	Bighill Creek	992	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	27.63	1.25	2	0	1,130.13	1,131.10	1,129.83	NHC Surveyed 2015	Crew 4	YES	
76	Bighill Creek	1,207	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	6.03	1.5	0	0	1,131.76	1,131.70	1,131.30	NHC Surveyed 2015	Crew 4	YES	
315	Bighill Creek	1,722	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	6	1.5	0	0	1,135.70	1,135.57	1,135.17	NHC Surveyed 2015	Crew 4	YES	
314	Bighill Creek	1,812	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	6	1.5	0	0	1,136.26	1,136.12	1,135.72	NHC Surveyed 2015	Crew 4	YES	
313	Bighill Creek	2,158	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	7.2	1.2	0	0	1,138.20	1,138.00	1,137.65	NHC Surveyed 2015	Crew 4	YES	
312	Bighill Creek	2,754	Cochrane	CP Rail	CP Rail	mile 23.6	yes	Rail bridge	concrete beam bridge	10	4.6	0	0	1,143.42	1,143.20	1,142.20	NHC Surveyed 2015	Crew 4	YES	
311	Bighill Creek	2,786	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	5.5	1	0	0	1,140.60	1,140.60	1,140.00	NHC Surveyed 2015	Crew 4	NO	small pedestrian bridge parallel to high flow direction
14	Bighill Creek	2,814	Cochrane	Bow Valley Trail/Hwy 1A	Alberta Transportation	521	yes	Highway bridge	concrete beam bridge	11	14.17	0	35	1,143.30	1,143.05	1,142.46	NHC Surveyed 2015	Crew 4	YES	
310	Bighill Creek	3,385	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	11.7	2.5	0	0	1,144.55	1,144.24	1,143.84	NHC Surveyed 2015	Crew 4	YES	
309	Bighill Creek	3,794	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	5.1	2.3	2	0	1,145.85	1,145.85	1,145.60	NHC Surveyed 2015	Crew 4	YES	
308	Bighill Creek	4,360	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	5.6	1.7	0	0	1,150.85	1,150.30	1,150.00	NHC Surveyed 2015	Crew 4	YES	
318	side channel (Bighill Creek)	164	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	4	2.7	0	0	1,122.40	1,122.25	1,121.85	NHC Surveyed 2015	Crew 4	NO	on floodplain, not connected to channel flow

NHC ID	Stream Name	River Station (m)	Municipality	Road/Trail	Owner	Owner ID	Design Drawing /Info	Type of Bridge	Descrip.	Span (m)	Width (m)	Number of Piers	Skew (°)	Elevation (m GD)			Survey Status	Survey by	In Model	Model Comment
														Top Chord	Deck	Low Chord				
72	side channel (Bighill Creek)	185	Cochrane	Walking Trail	Cochrane	-	no	Pedestrian bridge	timber beam bridge	3.7	2.95	0	0	1,121.85	1,121.75	1,121.48	NHC Surveyed 2015	Crew 4	NO	on floodplain, not connected to channel flow
16	Jumpingpound Creek	647	Cochrane	George Fox Trail	Alberta Transportation	283	yes	Paved road bridge	concrete beam bridge	50	10	1	40	1,131.96	1,130.10	1,129.20	NHC Surveyed 2015	Crew 4	YES	
24	Exshaw Creek	111	Exshaw	Diamond Drive	M.D. Bighorn	-	no	Paved road bridge	steel beam bridge	12	0	0	0	1,295.25	1,295.10	1,294.40	NHC Surveyed 2015	Crew 4	YES	
25	Exshaw Creek	155	Exshaw	CP Rail	CP Rail	mile 57.0	yes	Paved road bridge	steel beam bridge	22.8	0	0	0	1,297.26	1,296.20	1,295.17	NHC Surveyed 2015	Crew 4	YES	
304	Exshaw Creek	451	Exshaw	Walking Trail	M.D. Bighorn	-	no	Pedestrian bridge	timber beam bridge	16.8	0	0	0	1,307.85	1,307.73	1,307.38	NHC Surveyed 2015	Crew 4	YES	
43	Policeman Creek	1,552	Canmore	Wastewater Treatment Plant Road	Canmore	BG33	yes	Gravel road bridge	steel beam bridge	20.62	5.49	0	0	1,307.50	1,307.50	1,306.40	NHC Surveyed 2015	Crew 4	YES	
2	Policeman Creek	2,793	Canmore	Spring Creek Gate	Canmore	79434 (BG24)	yes	Paved road bridge	concrete beam bridge	14.51	11.2	0	0	1,309.05	1,309.05	1,307.81	NHC Surveyed 2015	Crew 4	YES	
45	Policeman Creek	3,147	Canmore	Walking Trail	Canmore	BG31	no	Pedestrian bridge	timber arch bridge	24.9	2.26	0	0	1,309.34	1,309.34	1,308.34	NHC Surveyed 2015	Crew 4	YES	
46	Policeman Creek	3,699	Canmore	8 Street	Alberta Transportation	71563 (BG06)	yes	Paved road bridge	concrete beam bridge	8.37	13.96	0	0	1,308.40	1,308.40	1,307.80	NHC Surveyed 2015	Crew 4	YES	
47	Policeman Creek	3,876	Canmore	10 Street	Alberta Transportation	80959 (BG07)	yes	Paved road bridge	concrete beam bridge	20.15	13.73	2	0	1,309.36	1,308.97	1,308.60	NHC Surveyed 2015	Crew 4	YES	
4	Policeman Creek	4,328	Canmore	Walking Trail	Canmore	81618 (BG08)	yes	Pedestrian bridge	timber beam bridge	13.99	2.03	2	0	1,309.98	1,309.98	1,309.37	NHC Surveyed 2015	Crew 4	YES	
66	Policeman Creek	4,717	Canmore	Walking Trail	Canmore	BG09	yes	Pedestrian bridge	timber beam bridge	28.07	1.27	2	0	1,310.31	1,310.31	1,309.98	NHC Surveyed 2015	Crew 4	YES	
65	Policeman Creek	4,853	Canmore	Walking Trail	Canmore	BG28	yes	Pedestrian bridge	timber beam bridge	6.85	1.26	0	0	1,310.53	1,310.53	1,310.12	NHC Surveyed 2015	Crew 4	YES	
61	Policeman Creek	5,103	Canmore	Walking Trail	Canmore	BG10	yes	Pedestrian bridge	timber beam bridge	32.07	1.68	4	0	1,131.52	1,131.52	1,311.15	NHC Surveyed 2015	Crew 4	YES	
60	Policeman Creek	5,252	Canmore	Walking Trail	Canmore	BG11	yes	Pedestrian bridge	timber beam bridge	21.97	1.42	2	0	1,311.51	1,311.51	1,311.18	NHC Surveyed 2015	Crew 4	YES	
303	Policeman Creek	5,648	Canmore	Walking Trail	Canmore	-	no	Pedestrian bridge	timber beam bridge	0	0	0	0	1,312.20	1,312.20	1,311.70	NHC Surveyed 2015	Crew 4	YES	

NHC ID	Stream Name	River Station (m)	Municipality	Road/Trail	Owner	Owner ID	Design Drawing /Info	Type of Bridge	Descrip.	Span (m)	Width (m)	Number of Piers	Skew (°)	Elevation (m GD)			Survey Status	Survey by	In Model	Model Comment
														Top Chord	Deck	Low Chord				
302	Policeman Creek	5,668	Canmore	Golf Course	Canmore Golf Course	-	no	Pedestrian bridge	timber beam bridge	5.3	3.7	0	0	1,312.30	1,312.30	1,312.15	NHC Surveyed 2015	Crew 4	YES	
301	Policeman Creek	6,022	Canmore	Unknown	Unknown	-	no	Abandoned pedestrian bridge	steel beam bridge	2.8	0	0	0	1,312.65	1,312.65	1,312.20	NHC Surveyed 2015	Crew 4	NO	abandoned pedestrian bridge
3	side channel (Policeman Creek)	3,360	Canmore	Walking Trail	Canmore	unknown (possibly BG40)	no	Pedestrian bridge	unknown	12.4	2.25	0	0	1,307.88	1,307.88	1,307.23	NHC Surveyed 2015	Crew 4	NO	on floodplain, not connected to channel flow
62	side channel (Policeman Creek)	5,331	Canmore	Walking Trail	Canmore	BG38	no	Pedestrian bridge	timber beam bridge	35.58	1.4	7	0	1,131.59	1,311.60	1,311.12	NHC Surveyed 2015	Crew 3	NO	on floodplain, not connected to channel flow

Table B-3a Culvert location details

NHC ID	Stream Name	River Station (m)	Municipality	Road or Trail	Owner	Owner ID	Design Drawing/Info	In Model	Model Comment
405	Bow River	87,721	near Exshaw	Lac Des Arcs Dike	M.D. Bighorn			no	accounted for in permeable embankment
204	Bow River	87,904	near Exshaw	Lac Des Arcs Dike	M.D. Bighorn		no	no	accounted for in permeable embankment
404	Bow River	88,087	near Exshaw	Lac Des Arcs Dike	M.D. Bighorn			no	accounted for in permeable embankment
203	Bow River	88,251	near Exshaw	Lac Des Arcs Dike	M.D. Bighorn		no	no	accounted for in permeable embankment
202	Bow River	88,420	near Exshaw	Lac Des Arcs Dike	M.D. Bighorn		no	no	accounted for in permeable embankment
201	Bow River	91,122	near Exshaw	Lac Des Arcs proposed inlet structure	M.D. Bighorn		no	no	accounted for in permeable embankment
407	side channel (Bow River)	23,505	Cochrane	Walking trail	Cochrane			no	on floodplain, not connected to main flow
33	side channel (Bow River)	96,000	Lac Des Arcs	Gravel Road	unknown (possibly M.D. Bighorn)		no	no	on floodplain, not connected to main flow
164	side channel (Bow River)	105,661	near Canmore	Trans-Canada Highway - Hwy 1	Alberta Transportation	74363	yes	yes	culvert through highway embankment
168	side channel (Bow River)	105,880	near Canmore	Trans-Canada Highway - Hwy 1	Alberta Transportation	74364	yes	yes	culvert through highway embankment
81	Bighill Creek	480	Cochrane	Griffin Road W	Alberta Transportation	76989	yes	yes	
75	Bighill Creek	1,519	Cochrane	Glenpatrick Road	Cochrane		no	yes	
83	Bighill Creek	2,498	Cochrane	Glenbow Drive	Alberta Transportation	81092	no	yes	
26	Exshaw Creek	206	Exshaw	Bow Valley Trail - Hwy 1A	Alberta Transportation	71734	yes	yes	
64	Policeman Creek	4,923	Canmore	8 Avenue	Canmore	81617 (BG27)	no	yes	
196	Policeman Creek	5,003	Canmore	17 Street	Canmore	81616 (BG26)	no	yes	
59	Policeman Creek	5,957	Canmore	Golf course	Canmore Golf Course	BG25	no	yes	
401	Policeman Creek	6,435	Canmore	Canmore Town Dike	AEP		yes	yes	Policeman Creek Diversion Structure
175	side channel (Policeman Creek)	4,159	Canmore	7 Avenue	Canmore		no	yes	
197	side channel (Policeman Creek)	4,256	Canmore	Pedestrian pathway	Canmore	BG29	yes	yes	
155	side channel (Policeman Creek)	4,877	Canmore	8 Avenue	Canmore		no	yes	

Note: Culvert barrel details are included in Table C-2c and can be related to the culvert locations in Table C-2b using the NHC ID field.

Table B-3b Culvert barrel details

NHC ID	Stream Name	River Station (m)	Culvert Shape	Material	Barrel Length (m)	Diameter, Rise or Height (m)	Span or Width (m)	Upstream Invert Elev. (m)	Downstream Invert Elev. (m)	Entrance Condition	Comment
405	Bow River	87,721			15	0.9		1,289.84	1,289.84		
204	Bow River	87,904	round	CSP	15	0.845	N/A	1,289.85	1,289.84		
404	Bow River	88,087		CSP	13	0.9	0.9	1,289.86	1,289.79		
203	Bow River	88,251	round	CSP	13.36	0.83	N/A	1,289.95	1,289.91		
202	Bow River	88,420	round	CSP	12.93	0.755	N/A	1,290.02	1,289.79	mitred to conform to slope	flapper gate d/s
201	Bow River	91,122	round	CSP	13.03	0.55	N/A	1,290.10	1,289.80		
407	side channel (Bow River)	23,505	square	concrete	4.5	1.8	1.2	1,120.10	1,119.90	no fill	"bridge" made up of 4 concrete culverts, inverts vary, photos
33	side channel (Bow River)	96,000			0	0		0	0		
164	side channel (Bow River)	105,661	round	CSP	72.3	1.19	N/A	1,301.71	1,301.69		
168	side channel (Bow River)	105,880	round	CSP	74.43	1.87	N/A	1,301.99	1,301.49		
168	side channel (Bow River)	105,880	round	CSP	74.43	0.69	N/A	1,303.66	0		
81	Bighill Creek	480	round	CSP	36.64	4.74	N/A	1,123.08	1,122.56	mitred to conform to slope	culvert with pedestrian bridge/walkway inside, area under walkway modelled as blocked
75	Bighill Creek	1,519	ellipse	CSP	33.51	6.95	6.95	1,135.84	1,135.74	mitred to conform to slope	added depth blocked = 3.6 m
83	Bighill Creek	2,498	arch	concrete	27.4	3.3	9.1	1,138.10	1,138.30	mitred to conform to slope	
26	Exshaw Creek	206	ellipse	SPCSP	14	3	12	1,295.67	1,294.93		
64	Policeman Creek	4,923	round	CSP	23.99	1.48	N/A	1,309.50	1,309.19	projecting from fill	
64	Policeman Creek	4,923	round	CSP	21.11	0.77	N/A	1,309.97	1,309.56	projecting from fill	
196	Policeman Creek	5,003	round	CSP	29	1	N/A	1,309.97	1,309.68	projecting from fill	
196	Policeman Creek	5,003	round	CSP	29	0.7	N/A	1,310.10	1,310.07	projecting from fill	
59	Policeman Creek	5,957	round	CSP	5.7	1.1	N/A	1,311.22	1,311.28	mitred to conform to slope	
401	Policeman Creek	6,435	round	CSP	28	0.5	N/A	1,312.75	1,312.05	projecting from fill	Policeman Creek Diversion Structure, inverted T with trash rack and flap gate
175	side channel (Policeman Creek)	4,159	ellipse	CSP	12.33	0.72		1,308.41	1,308.36	projecting from fill	
175	side channel (Policeman Creek)	4,159	ellipse	CSP	13.25	0.7		1,308.47	1,308.35	projecting from fill	
197	side channel (Policeman Creek)	4,256	round	CSP	6.42	0.9	N/A	1,308.22	1,308.18	mitred to conform to slope	
197	side channel (Policeman Creek)	4,256	round	CSP	6.56	0.87	N/A	1,308.29	1,308.17	projecting from fill	
155	side channel (Policeman Creek)	4,877	round	CSP	20.35	1.07	N/A	1,309.59	1,309.26	projecting from fill	
155	side channel (Policeman Creek)	4,877	round	CSP	21.1	0.855	N/A	1,309.17	1,309.18	projecting from fill	

Note: Culvert location information is included in Table C-2b and can be related to the culvert barrel details in Table C-2c using the NHC ID field.

Table B-4 Calibration results (differences between simulated water levels and surveyed highwater marks)

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
1	Bow River near Banff Park Gate	Bow River	KM 112	117,485	1986	AEP	good	1323.84	1324.68	0.84
2	Bow River at Harvie Heights, 2km downstream from Park Gates	Bow River	KM 112	114,700	1986	AEP	good	1318.94	1318.54	-0.40
3	Bow River at Harvie Heights; 0.8 km downstream of Bow-2	Bow River	KM 112	113,979	1990	AEP	approx (WL not HWM)	1317.82	1317.29	-0.53
4	Bow River at Harvie Heights; 0.8 km downstream of Bow-2	Bow River	KM 112	113,979	1986	AEP	good	1317.82	1317.39	-0.43
5	Bow River 0.2km downstream of Bow-3	Bow River	KM 112	113,842	1986	AEP	good	1317.34	1317.10	-0.24
6	Bow River at Canmore Golf Course	Bow River	KM 112	112,959	1990	AEP	approx (WL not HWM)	1315.43	1315.37	-0.06
7	Bow River at Canmore Golf Course	Bow River	KM 112	112,959	1986	AEP	good	1315.45	1315.49	0.04
8	Bow River at control structure for Policeman Creek	Bow River	KM 106	112,459	1986	AT	good	1314.70	1314.74	0.04
9	Bow River at 16th Street and 12th Avenue	Bow River	KM 087	110,823	1990	AEP	approx (WL not HWM)	1311.25	1311.85	0.60
10	Bow River at 16th Street and 12th Avenue	Bow River	KM 106	110,807	2013	AEP	good	1312.30	1312.59	0.29
11	Bow River at 16th Street and 12th Avenue	Bow River	KM 106	110,805	2012	AEP	good	1311.78	1312.02	0.24
12	Bow River at 16th Street and 12th Avenue	Bow River	KM 106	110,790	1986	AEP	good	1311.36	1311.89	0.53

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
13	Bow River near 15th Street	Bow River	KM 106	110,680	1986	AEP	good	1311.09	1311.72	0.63
14	Bow River near 14th Street	Bow River	KM 106	110,153	1986	AEP	good	1310.97	1310.87	-0.10
15	Bow River at Engine Bridge - 50m u/s	Bow River	KM 106	109,981	1986	AT	approx - location unsure	1310.16	1310.08	-0.08
16	Bow River at Engine Bridge - 20 m u/s of u/s side	Bow River	KM 106	109,957	2012	AEP	good	1310.63	1310.38	-0.26
17	Bow River at Engine Bridge - 20m u/s of u/s side	Bow River	KM 106	109,957	1986	AEP	good	1310.48	1310.15	-0.33
18	Bow River at Engine Bridge - u/s side	Bow River	KM 106	109,935	2013	AEP	good	1310.94	1311.44	0.50
19	Bow River at Engine Bridge	Bow River	KM 106	109,935	1990	AEP	approx (WL not HWM)	1310.17	1310.13	-0.04
20	Bow River at Engine Bridge - u/s side	Bow River	KM 106	109,935	1986	AEP	good	1310.17	1310.19	0.02
21	Bow River at Engine Bridge - d/s side	Bow River	KM 106	109,924	1986	AEP	good	1310.11	1310.09	-0.02
22	Bow River at Engine Bridge - d/s side	Bow River	KM 106	109,914	2013	AEP	good	1310.98	1311.26	0.27
23	Bow River at Engine Bridge - 10m d/s of d/s side	Bow River	KM 106	109,914	2012	AEP	good	1310.42	1310.25	-0.17
24	Bow River at Engine Bridge - 20m d/s of d/s side	Bow River	KM 106	109,904	1986	AEP	good	1310.19	1310.05	-0.14
25	Bow River near 8th Street	Bow River	KM 106	109,640	1986	AEP	good	1309.90	1309.80	-0.10
26	Bow River at Bridge Road - 140 m u/s from centreline	Bow River	KM 106	109,366	1990	AT	good	1309.40	1309.35	-0.05

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
27	Bow River at Bridge Road - 25m u/s of u/s side of bridge	Bow River	KM 106	109,250	1986	AEP	good	1309.14	1309.29	0.15
28	Bow River at Bridge Road - 20m u/s	Bow River	KM 106	109,247	2013	AEP	good	1309.91	1310.28	0.37
29	Bow River at Bridge Road - 12m u/s	Bow River	KM 106	109,242	2013	AEP	good	1310.00	1310.27	0.27
30	Bow River at Bridge Road - 12m u/s	Bow River	KM 106	109,242	2012	AEP	good	1309.37	1309.43	0.07
31	Bow River at Bridge Road - 10m u/s from centreline	Bow River	KM 106	109,235	1990	AT	good	1309.15	1309.14	-0.01
32	Bow River at Bridge Road - 20m d/s of d/s side of bridge	Bow River	KM 106	109,233	1986	AEP	good	1309.10	1309.26	0.16
33	Bow River at Bridge Road - d/s side of traffic bridge	Bow River	KM 106	109,233	1986	AEP	good	1309.14	1309.26	0.12
34	Bow River at Bridge Road - u/s side of traffic bridge	Bow River	KM 106	109,233	1986	AEP	good	1309.10	1309.26	0.16
35	Bow River at Bridge Rd in Canmore	Bow River	KM 106	109,230	2013	AT	good	1310.52	1310.24	-0.28
36	Bow River at Bridge Rd in Canmore	Bow River	KM 106	109,230	1986	AT	approx	1309.11	1309.25	0.14
37	Bow River at Bridge Rd in Canmore	Bow River	KM 106	109,221	2013	AT	approx	1310.30	1310.21	-0.09
38	Bow River at Bridge Rd in Canmore	Bow River	KM 106	109,219	2013	AT	approx	1310.70	1310.21	-0.49
39	Bow River at Bridge Road - d/s	Bow River	KM 106	109,219	1990	AEP	approx (WL not HWM)	1309.15	1309.11	-0.04
40	Bow River at Bridge Road - 10m d/s of walking bridge	Bow River	KM 106	109,202	2013	AEP	good	1309.79	1310.16	0.37
41	Bow River at Bridge Road - 10m d/s of walking bridge	Bow River	KM 106	109,202	2012	AEP	good	1309.19	1309.35	0.16
42	Bow River at Bridge Road - 20 m d/s from traffic bridge centreline	Bow River	KM 106	109,202	1990	AT	good	1309.01	1309.07	0.06

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
43	Bow River at Bridge Rd in Canmore	Bow River	KM 106	109,192	2013	AT	approx	1309.47	1310.13	0.66
44	Bow River at Bridge Road - 110 m u/s from centreline	Bow River	KM 106	109,114	1990	AT	good	1309.00	1308.95	-0.05
45	Bow River at Bridge Road - 110 m u/s from centreline	Bow River	KM 106	108,998	1990	AT	good	1308.80	1308.77	-0.03
46	Bow River near lift station 4	Bow River	KM 106	108,757	1986	AEP	good	1308.36	1308.45	0.09
47	Bow River 50 m u/s of XS13	Bow River	KM 106	108,508	1990	AEP	good	1307.87	1307.73	-0.14
48	Bow River 50 m u/s of XS13	Bow River	KM 106	108,508	1986	AEP	good	1308.02	1307.84	-0.18
49	Bow River 95 m u/s of XS12	Bow River	KM 106	108,150	1990	AEP	good	1307.22	1307.30	0.08
50	Bow River 95 m u/s of XS12	Bow River	KM 106	108,150	1986	AEP	good	1307.36	1307.43	0.07
51	Bow River high water channel at proposed SR 742 crossing	Bow River	KM 106	107,891	1986	AEP	good, side channel	1306.86	1307.10	0.24
52	Bow River at proposed SR 742 crossing	Bow River	KM 106	107,891	1986	AEP	good	1307.12	1307.10	-0.02
53	Bow River near WWTP	Bow River	KM 106	107,503	1990	AEP	good	1306.24	1306.26	0.02
54	Bow River near WWTP	Bow River	KM 106	107,503	1986	AEP	good	1306.15	1306.36	0.21
55	Bow River at Hwy 1	Bow River	KM 106	104,700	1990	AT	good	1301.60	1302.08	0.48
56	Bow River at Hwy 1 Bridge - 25m u/s of u/s side of eastbound bridge	Bow River	KM 087	104,590	1990	AEP	good	1301.68	1301.89	0.21
57	Bow River at Hwy 1 Bridge - 25m u/s of u/s side of eastbound bridge	Bow River	KM 087	104,590	1986	AEP	good	1301.53	1301.92	0.39
58	Bow River at Hwy 1 Bridge	Bow River	KM 087	104,572	2013	AT	approx	1302.40	1302.82	0.42
59	Bow River at Hwy 1 Bridge	Bow River	KM 087	104,570	1990	AT	good	1301.42	1301.86	0.44
60	Bow River at Hwy 1 Bridge	Bow River	KM 087	104,565	2013	AT	approx	1302.20	1302.78	0.58

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
61	Bow River at Hwy 1 Bridge - u/s side of eastbound bridge	Bow River	KM 087	104,562	1990	AEP	good	1301.63	1301.84	0.21
62	Bow River at Hwy 1 Bridge - u/s side of eastbound bridge	Bow River	KM 087	104,562	1986	AEP	good	1301.50	1301.85	0.35
63	Bow River at Hwy 1 Bridge - d/s side of eastbound bridge	Bow River	KM 087	104,540	1990	AEP	good	1301.69	1301.80	0.11
64	Bow River at Hwy 1 Bridge - d/s side of eastbound bridge	Bow River	KM 087	104,540	1986	AEP	good	1301.44	1301.80	0.36
65	Bow River at Hwy 1 Bridge	Bow River	KM 106	104,530	1990	AT	good	1301.37	1301.77	0.40
66	Bow River at Hwy 1 Bridge - u/s side of westbound bridge	Bow River	KM 087	104,525	1990	AEP	good	1301.56	1301.76	0.20
67	Bow River at Hwy 1 Bridge - u/s side of westbound bridge	Bow River	KM 087	104,525	1986	AEP	good	1301.41	1301.75	0.34
68	Bow River at Hwy 1 Bridge	Bow River	KM 087	104,515	2013	AT	approx	1302.10	1302.53	0.43
69	Bow River at Hwy 1 Bridge	Bow River	KM 087	104,513	2013	AT	approx	1301.80	1302.52	0.72
70	Bow River at Hwy 1 Bridge	Bow River	KM 087	104,510	1990	AT	good	1301.37	1301.73	0.36
71	Bow River at Hwy 1 Bridge - d/s side of west bound bridge	Bow River	KM 087	104,495	1990	AEP	good	1301.47	1301.70	0.23
72	Bow River at Hwy 1 Bridge - d/s side of west bound bridge	Bow River	KM 087	104,495	1986	AEP	good	1301.35	1301.67	0.32
73	Bow River at Hwy 1 Bridge - 20m d/s of d/s side of west bound bridge	Bow River	KM 087	104,479	1990	AEP	good	1301.38	1301.67	0.29
74	Bow River at Hwy 1 Bridge - 30m d/s of d/s side of west bound bridge	Bow River	KM 087	104,479	1986	AEP	good	1301.30	1301.64	0.34

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
75	Bow River at Hwy 1	Bow River	KM 106	104,455	1990	AT	good	1301.37	1301.64	0.27
76	Bow River at Bow River campground d/s of Trans Canada Bridge	Bow River	KM 087	104,208	1986	AT	good	1301.08	1301.06	-0.02
77	Bow River near 'Old Camp' picnic area	Bow River	KM 087	101,540	1986	AT	good	1296.37	1296.15	-0.22
78	Bow River at Deadman Flats (Three Sisters) Campground	Bow River	KM 087	98,320	1986	AT	good	1294.03	1293.37	-0.66
79	Bow River at u/s of Gap Lake	Bow River	KM 087	94,715	1990	AEP	good	1292.20	1292.31	0.11
80	Bow River at u/s of Gap Lake	Bow River	KM 087	94,715	1986	AT	good	1292.33	1292.23	-0.10
81	Bow River at u/s of Gap Lake	Bow River	KM 087	94,715	1986	AEP	good	1292.05	1292.23	0.18
82	Bow River in Exshaw	Bow River	KM 087	87,298	2013	AEP	good	1292.24	1292.46	0.22
83	Bow River at Morley Road Bridge	Bow River	KM 025	54,450	2013	AT	approx - girder El unsure	1192.00	1191.93	-0.07
84	Bow River Bridge at Morley	Bow River	KM 025	54,450	2013	AT	approx - girder El unsure	1192.10	1191.93	-0.17
85	Bow River at Morley Road Bridge - 20m d/s of bridge	Bow River	KM 025	54,433	2013	AEP	good	1191.82	1191.90	0.08
86	Bow River at Hwy 22 near Cochrane AB	Bow River	KM 023	23,410	2013	AT	good	1123.15	1122.99	-0.16
87	Bow River at Hwy 22 near Cochrane AB	Bow River	KM 023	23,393	2005	AT	good	1121.45	1121.45	0.00
88	Bow River at Hwy 22 near Cochrane AB	Bow River	KM 023	23,393	1990	AT	approx	1120.40	1120.77	0.37

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
89	Bow River at HWY 22 Bridge - 10m d/s of d/s side	Bow River	KM 023	23,390	2013	AEP	good	1122.94	1122.82	-0.12
90	Bow River at River Ave Bridge - 25m u/s	Bow River	KM 000	21,256	2013	AEP	good	1118.40	1118.42	0.02
91	Bow River at River Ave Bridge in Cochrane AB	Bow River	KM 000	21,221	2005	AT	good	1117.70	1116.96	-0.74
92	Bow River at River Ave Bridge - 10m d/s	Bow River	KM 000	21,210	2013	AEP	good	1118.16	1118.22	0.06
93	Bow River near Cochrane sewate lagoons	Bow River	KM 000	20,069	2013	AEP	good	1116.00	1116.31	0.31
94	Bighill Creek at Highway 1A	Bighill Creek	KM 000	2,820	2013	AT	approx	1140.20	1141.27	1.07
95	Jumpingpound Creek Bridge near Cochrane	Jumpingpound Creek	KM 000	654	2005	AT	good	1128.60	1128.40	-0.20
96	Policeman Creek Headgate	Policeman Creek	KM 000	6,465	1986	AEP	good	1314.60	1315.83	1.23
97	Policeman Creek Headgate	Policeman Creek	KM 000	6,465	1986	AEP	good	1314.60	1315.83	1.23
98	Policeman Creek at control structure on Bow River	Policeman Creek	KM 000	6,418	1986	AT	good	1312.57	1313.23	0.66
99	Policeman Creek at vacant lot near 400 Larch Drive	Policeman Creek	KM 000	5,550	1986	AT	good	1311.21	1311.47	0.26
100	Pond near 101 Larch Avenue at bend in road	Policeman Creek	KM 000	5,163	1986	AT	approx - side channel	1311.00	1311.45	0.45

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
101	Policeman Creek at 17th Street Culverts - Inlet	Policeman Creek	KM 000	5,023	1986	AT	good	1310.93	1311.45	0.52
102	Policeman Creek at 17th Street Culverts - Outlet	Policeman Creek	KM 000	4,985	1986	AT	good	1310.67	1310.90	0.23
103	Policeman Creek at 8 Avenue Culverts - Inlet	Policeman Creek	KM 000	4,936	1986	AT	good	1310.43	1310.84	0.41
104	Policeman Creek at 8 Avenue Culverts - Outlet	Policeman Creek	KM 000	4,907	1986	AT	good	1310.43	1310.32	-0.11
105	Side Channel at 8 Avenue Culverts - Inlet	Policeman Creek	KM 000	4,880	1986	AT	good - side channel	1309.81	1310.19	0.38
106	Side Channel at 8 Avenue Culverts - Outlet	Policeman Creek	KM 000	4,860	1986	AT	good - side channel	1309.71	1310.00	0.29
107	Policeman Creek at Birchwood Place off of Railway Avenue	Policeman Creek	KM 000	4,550	1986	AT	good	1309.27	1309.19	-0.09
108	Policeman Creek at old CPR line	Policeman Creek	KM 000	4,337	1986	AT	good	1308.43	1308.43	0.00
109	Small Channel at old CPR line - Inlet	Policeman Creek	KM 000	4,337	1986	AT	good - side channel	1308.47	1308.43	-0.04
110	Side Channel at old CPR line culverts - Inlet	Policeman Creek	KM 000	4,337	1986	AT	good - side channel	1308.98	1308.43	-0.55
111	Small Channel at old CPR line - Outlet	Policeman Creek	KM 000	4,320	1986	AT	good - side channel	1308.19	1308.34	0.15

No	Location Name	Branch	HEC-RAS Model Sub-Reach	River Station (m)	Event Year	Source	Comment on HWM Location and Elevation	Highwater Mark Elevation (m)	Simulated Water Level (m)	Diff (m)
112	Side Channel at old CPR line culverts - Outlet	Policeman Creek	KM 000	4,320	1986	AT	good - side channel	1308.97	1308.34	-0.63
113	Side Channel at 7 Avenue Culverts - Inlet	Policeman Creek	KM 000	4,184	1986	AT	good - side channel	1308.96	1308.15	-0.81
114	Side Channel at 7 Avenue Culverts - Outlet	Policeman Creek	KM 000	4,154	1986	AT	good - side channel	1308.46	1308.11	-0.35
115	Policeman Creek at proposed 10 Street Crossing	Policeman Creek	KM 000	3,862	1986	AT	good	1307.65	1307.59	-0.06
116	Policeman Creek at 8th Street Crossing - u/s of bridge	Policeman Creek	KM 000	3,715	1986	AT	good	1307.57	1307.54	-0.03
117	Policeman Creek at 8th Street Crossing - d/s of bridge	Policeman Creek	KM 000	3,679	1986	AT	good	1307.26	1307.38	0.13
118	Policeman Creek at trailer court near office	Policeman Creek	KM 000	3,389	1986	AT	good	1306.76	1306.91	0.15
119	Spring Creek at trailer court near office	Policeman Creek	KM 000	3,389	1986	AT	good - side channel	1306.53	1306.91	0.38
120	Policeman Creek at trailer court 300m downstream of office	Policeman Creek	KM 000	3,093	1986	AT	good	1306.66	1306.72	0.06
121	Spring Creek at trailer court 300m downstream of office	Policeman Creek	KM 000	3,093	1986	AT	good - side channel	1306.49	1306.72	0.23
122	Policeman Creek at proposed SR 742 Crossing	Policeman Creek	KM 000	1,885	1986	AT	good	1305.02	1305.37	0.35

Table B-5 Open water flood frequency water levels

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 112	118148	1323.34	1327.40	1327.36	1327.29	1327.22	1327.12	1326.99	1326.93	1326.85	1326.77	1326.63	1326.44	1326.24	1325.92
Bow River	KM 112	117852	1322.93	1326.55	1326.50	1326.43	1326.36	1326.26	1326.12	1326.07	1325.99	1325.92	1325.81	1325.66	1325.48	1325.18
Bow River	KM 112	117547	1322.32	1326.07	1326.02	1325.95	1325.89	1325.78	1325.65	1325.60	1325.52	1325.45	1325.34	1325.20	1325.05	1324.75
Bow River	KM 112	117241	1321.04	1325.56	1325.51	1325.45	1325.39	1325.29	1325.15	1325.10	1325.03	1324.97	1324.85	1324.71	1324.56	1324.26
Bow River	KM 112	116670	1319.30	1323.86	1323.82	1323.76	1323.71	1323.63	1323.52	1323.47	1323.41	1323.36	1323.27	1323.14	1323.00	1322.74
Bow River	KM 112	116188	1319.03	1322.84	1322.80	1322.75	1322.69	1322.61	1322.50	1322.46	1322.39	1322.34	1322.25	1322.13	1322.00	1321.78
Bow River	KM 112	115644	1318.21	1321.75	1321.71	1321.66	1321.62	1321.55	1321.47	1321.43	1321.38	1321.33	1321.25	1321.15	1321.04	1320.85
Bow River	KM 112	115415	1316.91	1320.93	1320.90	1320.86	1320.82	1320.76	1320.69	1320.66	1320.62	1320.57	1320.50	1320.41	1320.33	1320.17
Bow River	KM 112	115134	1317.94	1320.30	1320.27	1320.23	1320.19	1320.13	1320.04	1320.01	1319.96	1319.92	1319.83	1319.72	1319.60	1319.39
Bow River	KM 112	114700	1315.69	1319.52	1319.49	1319.44	1319.40	1319.33	1319.24	1319.21	1319.14	1319.09	1319.00	1318.88	1318.75	1318.52
Bow River	KM 112	114258	1314.97	1318.92	1318.89	1318.84	1318.80	1318.74	1318.66	1318.63	1318.57	1318.52	1318.44	1318.32	1318.18	1317.93
Bow River	KM 112	113821	1314.50	1318.06	1318.02	1317.97	1317.92	1317.84	1317.75	1317.71	1317.65	1317.60	1317.51	1317.40	1317.28	1317.04
Bow River	KM 112	113472	1313.89	1317.33	1317.29	1317.25	1317.20	1317.13	1317.04	1317.00	1316.94	1316.90	1316.82	1316.71	1316.60	1316.42
Bow River	KM 112	113065	1312.73	1316.59	1316.55	1316.50	1316.45	1316.39	1316.28	1316.24	1316.18	1316.13	1316.04	1315.93	1315.80	1315.55
Bow River	KM 112	112898	1312.71	1316.39	1316.35	1316.29	1316.24	1316.19	1316.09	1316.05	1315.99	1315.94	1315.86	1315.75	1315.64	1315.40
Bow River	KM 112	112726	1312.17	1316.19	1316.15	1316.10	1316.05	1315.98	1315.88	1315.84	1315.79	1315.73	1315.65	1315.55	1315.45	1315.21
Bow River	KM 112	112725	Lat Struct													
Bow River	KM 112	112580	1311.54	1315.96	1315.93	1315.87	1315.81	1315.73	1315.62	1315.57	1315.51	1315.45	1315.37	1315.25	1315.14	1314.93
Bow River	KM 106	112416	1311.86	1315.74	1315.69	1315.63	1315.57	1315.48	1315.35	1315.31	1315.24	1315.18	1315.08	1314.96	1314.84	1314.65
Bow River	KM 106	112279	1311.64	1315.60	1315.55	1315.49	1315.43	1315.33	1315.20	1315.15	1315.08	1315.02	1314.92	1314.80	1314.68	1314.49
Bow River	KM 106	112071	1310.67	1315.35	1315.31	1315.24	1315.18	1315.07	1314.94	1314.88	1314.80	1314.73	1314.62	1314.48	1314.33	1314.10
Bow River	KM 106	111915	1310.95	1315.14	1315.10	1315.03	1314.97	1314.87	1314.73	1314.67	1314.59	1314.52	1314.41	1314.26	1314.11	1313.88
Bow River	KM 106	111823	1310.66	1315.00	1314.96	1314.90	1314.84	1314.74	1314.61	1314.55	1314.47	1314.41	1314.30	1314.16	1314.02	1313.79
Bow River	KM 106	111706	1310.10	1314.90	1314.86	1314.80	1314.74	1314.64	1314.51	1314.45	1314.38	1314.31	1314.20	1314.06	1313.92	1313.70
Bow River	KM 106	111305	1310.04	1314.20	1314.16	1314.10	1314.03	1313.97	1313.83	1313.78	1313.69	1313.62	1313.51	1313.36	1313.21	1312.96
Bow River	KM 106	111132	1310.15	1313.81	1313.77	1313.71	1313.65	1313.63	1313.49	1313.43	1313.34	1313.27	1313.15	1313.00	1312.84	1312.58
Bow River	KM 106	110887	1309.12	1313.23	1313.18	1313.11	1313.04	1312.95	1312.84	1312.78	1312.70	1312.63	1312.52	1312.37	1312.22	1311.99
Bow River	KM 106	110886	Lat Struct													
Bow River	KM 106	110734	1309.32	1312.98	1312.94	1312.86	1312.79	1312.70	1312.61	1312.55	1312.48	1312.41	1312.30	1312.16	1312.01	1311.79
Bow River	KM 106	110352	1307.92	1312.65	1312.60	1312.50	1312.40	1312.30	1312.11	1312.03	1311.94	1311.85	1311.71	1311.54	1311.38	1311.16
Bow River	KM 106	110148	1307.71	1312.52	1312.47	1312.36	1312.25	1312.14	1311.93	1311.83	1311.73	1311.63	1311.48	1311.28	1311.08	1310.84
Bow River	KM 106	109981	1306.03	1312.39	1312.29	1312.17	1312.05	1311.90	1311.67	1311.54	1311.44	1311.31	1311.10	1310.83	1310.50	1310.03
Bow River	KM 106	109938	1305.83	1312.36	1312.29	1312.17	1312.05	1311.91	1311.69	1311.57	1311.46	1311.34	1311.13	1310.87	1310.58	1310.17
Bow River	KM 106	109929.1	Mult Open													
Bow River	KM 106	109921	1304.55	1312.24	1312.16	1312.03	1311.90	1311.76	1311.51	1311.41	1311.25	1311.13	1310.93	1310.67	1310.42	1310.02
Bow River	KM 106	109727	1307.03	1312.18	1312.10	1311.95	1311.82	1311.66	1311.40	1311.29	1311.14	1311.01	1310.79	1310.52	1310.24	1309.84
Bow River	KM 106	109501	1305.87	1312.02	1311.93	1311.77	1311.61	1311.34	1311.09	1310.99	1310.85	1310.72	1310.53	1310.28	1310.02	1309.64
Bow River	KM 106	109366	1305.94	1311.68	1311.58	1311.39	1311.22	1311.04	1310.81	1310.71	1310.58	1310.46	1310.28	1310.04	1309.81	1309.44
Bow River	KM 106	109235	1305.58	1311.31	1311.16	1310.91	1310.77	1310.63	1310.43	1310.35	1310.24	1310.14	1309.98	1309.77	1309.56	1309.23
Bow River	KM 106	109224.4	Bridge													
Bow River	KM 106	109202	1305.97	1310.90	1310.83	1310.75	1310.68	1310.53	1310.34	1310.26	1310.14	1310.05	1309.89	1309.69	1309.48	1309.16

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 106	109115	Lat Struct													
Bow River	KM 106	109114	1305.85	1310.54	1310.45	1310.35	1310.31	1310.18	1310.02	1309.95	1309.86	1309.78	1309.65	1309.48	1309.30	1309.02
Bow River	KM 106	108998	1306.04	1309.80	1309.78	1309.76	1309.73	1309.67	1309.58	1309.55	1309.49	1309.43	1309.34	1309.21	1309.07	1308.84
Bow River	KM 106	108757	1305.79	1309.56	1309.54	1309.50	1309.45	1309.36	1309.23	1309.18	1309.10	1309.03	1308.93	1308.79	1308.64	1308.43
Bow River	KM 106	108586	1305.56	1309.25	1309.22	1309.18	1309.14	1309.04	1308.91	1308.86	1308.77	1308.69	1308.58	1308.43	1308.23	1307.93
Bow River	KM 106	108458	1305.78	1309.07	1309.05	1309.01	1308.97	1308.87	1308.73	1308.67	1308.58	1308.50	1308.41	1308.26	1308.06	1307.73
Bow River	KM 106	108052	1304.17	1308.64	1308.63	1308.61	1308.58	1308.49	1308.36	1308.30	1308.21	1308.13	1308.06	1307.86	1307.64	1307.28
Bow River	KM 106	108051	Lat Struct													
Bow River	KM 106	107747	1303.84	1308.02	1308.02	1308.00	1307.97	1307.89	1307.78	1307.72	1307.64	1307.57	1307.52	1307.35	1307.17	1306.86
Bow River	KM 106	107333	1302.27	1307.34	1307.34	1307.33	1307.30	1307.22	1307.09	1307.02	1306.92	1306.83	1306.67	1306.48	1306.27	1305.96
Bow River	KM 106	107113	1302.41	1307.18	1307.18	1307.18	1307.15	1307.06	1306.92	1306.85	1306.73	1306.63	1306.46	1306.24	1306.00	1305.64
Bow River	KM 106	106702	1301.44	1305.98	1305.93	1305.86	1305.81	1305.73	1305.56	1305.52	1305.48	1305.44	1305.36	1305.24	1305.11	1304.87
Bow River	KM 087	106497	1301.98	1305.86	1305.80	1305.71	1305.68	1305.57	1305.42	1305.36	1305.28	1305.22	1305.11	1304.97	1304.83	1304.60
Bow River	KM 087	106143	1301.36	1305.62	1305.55	1305.45	1305.44	1305.32	1305.16	1305.09	1305.00	1304.93	1304.80	1304.63	1304.46	1304.20
Bow River	KM 087	105995	1301.19	1305.44	1305.36	1305.26	1305.28	1305.16	1304.99	1304.92	1304.83	1304.76	1304.62	1304.45	1304.28	1304.02
Bow River	KM 087	105742	1300.32	1305.27	1305.20	1305.09	1305.13	1304.97	1304.79	1304.72	1304.62	1304.55	1304.41	1304.23	1304.05	1303.77
Bow River	KM 087	105620	1297.49	1305.17	1305.10	1304.99	1304.93	1304.78	1304.61	1304.54	1304.45	1304.39	1304.26	1304.08	1303.92	1303.66
Bow River	KM 087	105224	1298.84	1304.99	1304.91	1304.79	1304.68	1304.52	1304.34	1304.27	1304.16	1304.12	1303.98	1303.80	1303.63	1303.38
Bow River	KM 087	104790	1298.71	1304.50	1304.41	1304.27	1304.15	1303.95	1303.73	1303.63	1303.50	1303.38	1303.20	1302.97	1302.74	1302.36
Bow River	KM 087	104631	1297.59	1303.88	1303.80	1303.68	1303.57	1303.41	1303.21	1303.13	1303.02	1302.92	1302.77	1302.57	1302.37	1302.05
Bow River	KM 087	104575	1297.83	1303.67	1303.59	1303.48	1303.38	1303.22	1303.04	1302.96	1302.86	1302.77	1302.62	1302.44	1302.26	1301.97
Bow River	KM 087	104500	Bridge													
Bow River	KM 087	104490	1298.14	1303.04	1302.99	1302.91	1302.84	1302.73	1302.60	1302.55	1302.47	1302.41	1302.30	1302.16	1302.02	1301.78
Bow River	KM 087	104338	1298.60	1302.70	1302.65	1302.58	1302.51	1302.41	1302.30	1302.25	1302.18	1302.12	1302.03	1301.91	1301.78	1301.57
Bow River	KM 087	104163	1298.87	1302.01	1301.97	1301.91	1301.86	1301.77	1301.67	1301.63	1301.57	1301.52	1301.44	1301.33	1301.22	1301.03
Bow River	KM 087	103697	1296.68	1300.43	1300.39	1300.33	1300.28	1300.21	1300.12	1300.08	1300.02	1299.98	1299.89	1299.79	1299.68	1299.50
Bow River	KM 087	103126	1297.33	1299.47	1299.43	1299.37	1299.32	1299.25	1299.16	1299.12	1299.06	1299.02	1298.94	1298.83	1298.72	1298.55
Bow River	KM 087	102497	1295.33	1298.43	1298.39	1298.33	1298.27	1298.19	1298.09	1298.05	1297.99	1297.94	1297.86	1297.74	1297.64	1297.46
Bow River	KM 087	101706	1293.17	1297.67	1297.62	1297.56	1297.50	1297.40	1297.29	1297.24	1297.17	1297.11	1297.01	1296.87	1296.72	1296.48
Bow River	KM 087	101260	1291.01	1296.92	1296.87	1296.80	1296.74	1296.65	1296.55	1296.50	1296.44	1296.38	1296.29	1296.17	1296.05	1295.84
Bow River	KM 087	100785	1292.35	1296.38	1296.31	1296.22	1296.15	1296.05	1295.95	1295.90	1295.85	1295.80	1295.71	1295.61	1295.50	1295.32
Bow River	KM 087	100276	1292.47	1296.06	1295.95	1295.83	1295.73	1295.60	1295.47	1295.43	1295.37	1295.31	1295.23	1295.12	1294.99	1294.76
Bow River	KM 087	99728	1291.59	1295.83	1295.70	1295.54	1295.40	1295.21	1295.01	1294.94	1294.84	1294.76	1294.64	1294.49	1294.33	1294.06
Bow River	KM 087	99027	1290.49	1295.74	1295.60	1295.42	1295.27	1295.05	1294.83	1294.74	1294.62	1294.53	1294.39	1294.22	1294.06	1293.76
Bow River	KM 087	98134	1287.90	1295.62	1295.47	1295.27	1295.10	1294.86	1294.60	1294.49	1294.36	1294.26	1294.09	1293.91	1293.74	1293.44
Bow River	KM 087	97769	1290.55	1295.56	1295.41	1295.20	1295.02	1294.77	1294.50	1294.39	1294.25	1294.14	1293.97	1293.77	1293.60	1293.27
Bow River	KM 087	97378	1289.89	1295.44	1295.28	1295.06	1294.87	1294.60	1294.30	1294.18	1294.02	1293.89	1293.70	1293.48	1293.29	1292.91
Bow River	KM 087	97076	1289.52	1295.36	1295.20	1294.97	1294.78	1294.49	1294.18	1294.06	1293.89	1293.76	1293.56	1293.32	1293.15	1292.74
Bow River	KM 087	96451	1288.84	1295.30	1295.13	1294.90	1294.70	1294.40	1294.08	1293.95	1293.78	1293.64	1293.42	1293.18	1293.01	1292.58
Bow River	KM 087	94012	1287.04	1295.24	1295.07	1294.83	1294.63	1294.33	1294.00	1293.86	1293.69	1293.55	1293.33	1293.08	1292.84	1292.39
Bow River	KM 087	93591	1286.51	1295.23	1295.06	1294.82	1294.62	1294.32	1293.98	1293.85	1293.68	1293.53	1293.32	1293.07	1292.83	1292.38
Bow River	KM 087	93261	1286.49	1295.23	1295.05	1294.82	1294.61	1294.31	1293.98	1293.85	1293.67	1293.53	1293.31	1293.06	1292.83	1292.37
Bow River	KM 087	92667	1285.47	1295.21	1295.03	1294.80	1294.59	1294.29	1293.96	1293.83	1293.65	1293.51	1293.29	1293.05	1292.81	1292.36

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 087	92367	1285.63	1295.14	1294.97	1294.74	1294.53	1294.23	1293.90	1293.77	1293.60	1293.46	1293.25	1293.01	1292.78	1292.33
Bow River	KM 087	92095	1287.55	1295.05	1294.88	1294.65	1294.44	1294.15	1293.82	1293.70	1293.53	1293.39	1293.18	1292.95	1292.73	1292.29
Bow River	KM 087	91818	1287.66	1295.01	1294.84	1294.61	1294.40	1294.10	1293.78	1293.65	1293.48	1293.34	1293.14	1292.91	1292.69	1292.26
Bow River	KM 087	91466	1287.66	1295.01	1294.83	1294.59	1294.38	1294.08	1293.75	1293.63	1293.45	1293.32	1293.11	1292.88	1292.67	1292.23
Bow River	KM 087	91102	1285.48	1294.99	1294.82	1294.58	1294.37	1294.07	1293.73	1293.60	1293.43	1293.29	1293.08	1292.85	1292.63	1292.19
Bow River	KM 087	90778	1285.58	1294.99	1294.81	1294.57	1294.36	1294.06	1293.72	1293.59	1293.41	1293.27	1293.05	1292.82	1292.59	1292.13
Bow River	KM 087	90350	1287.31	1294.98	1294.81	1294.57	1294.35	1294.05	1293.71	1293.57	1293.39	1293.25	1293.03	1292.78	1292.54	1292.06
Bow River	KM 087	89770	1285.67	1294.98	1294.80	1294.56	1294.34	1294.03	1293.69	1293.55	1293.37	1293.22	1292.99	1292.72	1292.45	1291.93
Bow River	KM 087	89451	1286.22	1294.97	1294.79	1294.55	1294.33	1294.02	1293.67	1293.53	1293.34	1293.19	1292.95	1292.67	1292.39	1291.88
Bow River	KM 087	89200	1286.52	1294.96	1294.78	1294.54	1294.32	1294.01	1293.65	1293.51	1293.32	1293.16	1292.92	1292.63	1292.34	1291.83
Bow River	KM 087	88802	1286.44	1294.95	1294.77	1294.52	1294.30	1293.99	1293.63	1293.48	1293.29	1293.12	1292.87	1292.56	1292.24	1291.75
Bow River	KM 087	88345	1287.46	1294.93	1294.75	1294.51	1294.28	1293.96	1293.60	1293.45	1293.25	1293.08	1292.81	1292.48	1292.15	1291.67
Bow River	KM 087	88021	1286.48	1294.91	1294.73	1294.48	1294.26	1293.93	1293.57	1293.42	1293.21	1293.04	1292.77	1292.43	1292.10	1291.61
Bow River	KM 087	87652	1286.62	1294.90	1294.72	1294.47	1294.24	1293.92	1293.55	1293.40	1293.19	1293.02	1292.74	1292.41	1292.07	1291.59
Bow River	KM 087	87519	1287.51	1294.89	1294.70	1294.46	1294.23	1293.91	1293.54	1293.39	1293.18	1293.01	1292.74	1292.40	1292.07	1291.58
Bow River	KM 087	87122	1286.84	1293.41	1293.26	1293.05	1292.85	1292.62	1292.38	1292.28	1292.14	1292.02	1291.83	1291.59	1291.34	1290.96
Bow River	KM 087	86899	1285.51	1292.17	1292.11	1292.02	1291.93	1291.81	1291.65	1291.58	1291.49	1291.41	1291.28	1291.10	1290.92	1290.61
Bow River	KM 025	86717	1287.28	1291.41	1291.36	1291.29	1291.23	1291.19	1291.06	1291.01	1290.95	1290.89	1290.80	1290.67	1290.52	1290.27
Bow River	KM 025	86352	1286.85	1290.41	1290.36	1290.29	1290.22	1290.10	1290.02	1289.95	1289.86	1289.78	1289.66	1289.50	1289.33	1289.09
Bow River	KM 025	86209	1284.03	1289.10	1289.02	1288.93	1288.88	1288.84	1288.68	1288.66	1288.64	1288.62	1288.58	1288.53	1288.44	1288.26
Bow River	KM 025	85929	1284.33	1288.87	1288.78	1288.65	1288.54	1288.37	1288.17	1288.09	1287.98	1287.89	1287.75	1287.58	1287.41	1287.19
Bow River	KM 025	85513	1284.39	1288.76	1288.66	1288.53	1288.41	1288.23	1288.02	1287.93	1287.81	1287.71	1287.56	1287.36	1287.16	1286.89
Bow River	KM 025	85060	1282.89	1288.60	1288.50	1288.36	1288.24	1288.05	1287.83	1287.74	1287.62	1287.51	1287.35	1287.14	1286.92	1286.60
Bow River	KM 025	84733	1282.70	1288.14	1288.05	1287.91	1287.79	1287.60	1287.39	1287.30	1287.18	1287.07	1286.91	1286.69	1286.45	1286.10
Bow River	KM 025	84602	1282.32	1287.69	1287.60	1287.48	1287.37	1287.20	1287.01	1286.93	1286.82	1286.72	1286.58	1286.38	1286.16	1285.84
Bow River	KM 025	84367	1281.74	1287.02	1286.93	1286.81	1286.69	1286.53	1286.32	1286.24	1286.14	1286.04	1285.90	1285.72	1285.54	1285.28
Bow River	KM 025	84072	1281.58	1286.52	1286.43	1286.31	1286.18	1286.01	1285.80	1285.72	1285.61	1285.52	1285.37	1285.19	1285.00	1284.70
Bow River	KM 025	83674	1279.16	1286.03	1285.93	1285.81	1285.69	1285.51	1285.26	1285.17	1285.06	1284.96	1284.80	1284.61	1284.40	1284.04
Bow River	KM 025	83328	1276.16	1285.53	1285.43	1285.28	1285.15	1284.95	1284.71	1284.62	1284.49	1284.37	1284.19	1283.96	1283.73	1283.35
Bow River	KM 025	82904	1277.75	1285.12	1285.02	1284.87	1284.75	1284.56	1284.33	1284.24	1284.12	1284.01	1283.85	1283.64	1283.44	1283.06
Bow River	KM 025	82575	1278.67	1285.01	1284.90	1284.76	1284.62	1284.42	1284.19	1284.10	1283.97	1283.86	1283.69	1283.48	1283.27	1282.88
Bow River	KM 025	82081	1279.51	1284.59	1284.48	1284.33	1284.19	1283.98	1283.73	1283.63	1283.49	1283.37	1283.19	1282.95	1282.72	1282.33
Bow River	KM 025	81556	1278.14	1284.26	1284.15	1284.00	1283.86	1283.65	1283.41	1283.31	1283.18	1283.06	1282.88	1282.65	1282.42	1282.08
Bow River	KM 025	81162	1276.92	1283.97	1283.87	1283.73	1283.61	1283.42	1283.20	1283.11	1282.99	1282.88	1282.71	1282.51	1282.30	1281.98
Bow River	KM 025	80811	1276.58	1283.82	1283.72	1283.59	1283.47	1283.29	1283.07	1282.99	1282.87	1282.77	1282.61	1282.41	1282.21	1281.91
Bow River	KM 025	80511	1277.96	1283.65	1283.56	1283.42	1283.31	1283.13	1282.92	1282.84	1282.72	1282.62	1282.47	1282.28	1282.08	1281.80
Bow River	KM 025	80146	1279.71	1283.23	1283.14	1283.00	1282.89	1282.71	1282.50	1282.42	1282.31	1282.21	1282.06	1281.88	1281.70	1281.44
Bow River	KM 025	79719	1278.88	1282.42	1282.32	1282.20	1282.08	1281.91	1281.71	1281.63	1281.52	1281.43	1281.30	1281.13	1280.97	1280.74
Bow River	KM 025	79688	1278.87	1282.29	1282.20	1282.07	1281.96	1281.79	1281.60	1281.53	1281.42	1281.33	1281.20	1281.03	1280.88	1280.67
Bow River	KM 025	79677.2	Bridge													
Bow River	KM 025	79662	1278.56	1282.13	1282.04	1281.93	1281.82	1281.66	1281.48	1281.41	1281.31	1281.23	1281.10	1280.95	1280.80	1280.61
Bow River	KM 025	79598	1278.73	1282.00	1281.91	1281.79	1281.68	1281.52	1281.34	1281.27	1281.17	1281.09	1280.97	1280.82	1280.68	1280.51
Bow River	KM 025	79245	1277.35	1281.64	1281.55	1281.44	1281.34	1281.20	1281.04	1280.97	1280.89	1280.82	1280.72	1280.61	1280.51	1280.39

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 025	78845	1276.49	1281.47	1281.39	1281.29	1281.19	1281.06	1280.91	1280.85	1280.78	1280.72	1280.63	1280.53	1280.45	1280.35
Bow River	KM 025	78451	1275.08	1281.30	1281.22	1281.12	1281.04	1280.92	1280.79	1280.74	1280.67	1280.62	1280.54	1280.46	1280.39	1280.32
Bow River	KM 025	78039	1274.49	1281.11	1281.04	1280.95	1280.87	1280.76	1280.65	1280.61	1280.55	1280.51	1280.45	1280.39	1280.34	1280.28
Bow River	KM 025	77716	1274.06	1280.63	1280.59	1280.54	1280.49	1280.44	1280.38	1280.36	1280.34	1280.32	1280.30	1280.27	1280.25	1280.23
Bow River	KM 025	77654	1272.02	1280.46	1280.43	1280.40	1280.38	1280.34	1280.31	1280.30	1280.28	1280.27	1280.26	1280.24	1280.23	1280.22
Bow River	KM 025	77638.7	Bridge													
Bow River	KM 025	77609	1274.12	1280.45	1280.42	1280.39	1280.36	1280.33	1280.30	1280.29	1280.28	1280.27	1280.25	1280.24	1280.23	1280.22
Bow River	KM 025	77494	1274.12	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20	1280.20
Bow River	KM 025	77488	1263.10	1266.75	1266.60	1266.39	1266.23	1265.97	1265.68	1265.57	1265.43	1265.29	1265.10	1264.89	1264.68	1264.41
Bow River	KM 025	76811	1251.24	1261.03	1260.78	1260.45	1260.20	1259.82	1259.41	1259.26	1259.06	1258.89	1258.64	1258.37	1258.12	1257.80
Bow River	KM 025	76468	1254.28	1260.76	1260.50	1260.16	1259.90	1259.51	1259.10	1258.94	1258.74	1258.58	1258.34	1258.09	1257.87	1257.60
Bow River	KM 025	76158	1253.29	1260.59	1260.33	1259.97	1259.71	1259.30	1258.88	1258.72	1258.52	1258.36	1258.13	1257.89	1257.69	1257.46
Bow River	KM 025	75774	1251.92	1260.45	1260.18	1259.81	1259.54	1259.13	1258.70	1258.54	1258.34	1258.19	1257.97	1257.75	1257.57	1257.37
Bow River	KM 025	75465	1249.48	1258.65	1258.53	1258.37	1258.25	1258.05	1257.85	1257.77	1257.68	1257.60	1257.50	1257.39	1257.31	1257.22
Bow River	KM 025	75281	1248.77	1259.03	1258.86	1258.62	1258.45	1258.19	1257.94	1257.85	1257.73	1257.64	1257.52	1257.41	1257.32	1257.23
Bow River	KM 025	75120	1245.44	1258.44	1258.33	1258.18	1258.07	1257.89	1257.72	1257.65	1257.57	1257.51	1257.42	1257.33	1257.27	1257.20
Bow River	KM 025	74927	1246.86	1258.45	1258.31	1258.13	1258.00	1257.81	1257.63	1257.57	1257.49	1257.43	1257.36	1257.28	1257.23	1257.17
Bow River	KM 025	74746	1247.68	1257.89	1257.82	1257.71	1257.64	1257.53	1257.43	1257.39	1257.34	1257.31	1257.26	1257.22	1257.18	1257.15
Bow River	KM 025	74376	1251.90	1257.79	1257.71	1257.61	1257.54	1257.44	1257.35	1257.32	1257.28	1257.25	1257.22	1257.18	1257.16	1257.13
Bow River	KM 025	74053	1245.27	1257.13	1257.13	1257.12	1257.12	1257.12	1257.11	1257.11	1257.11	1257.11	1257.11	1257.10	1257.10	1257.10
Bow River	KM 025	73903	1249.68	1257.09	1257.09	1257.09	1257.09	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10
Bow River	KM 025	73863	1249.68	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10	1257.10
Bow River	KM 025	73845	1237.80	1241.97	1241.79	1241.57	1241.39	1241.10	1240.77	1240.65	1240.49	1240.33	1240.11	1239.87	1239.63	1239.32
Bow River	KM 025	73571	1233.14	1239.23	1239.10	1238.94	1238.80	1238.57	1238.27	1238.15	1237.98	1237.84	1237.61	1237.34	1237.10	1236.66
Bow River	KM 025	73410	1232.61	1238.17	1237.95	1237.71	1237.53	1237.28	1237.01	1236.91	1236.77	1236.65	1236.47	1236.25	1236.03	1235.74
Bow River	KM 025	73134	1232.58	1237.88	1237.59	1237.25	1236.99	1236.64	1236.27	1236.14	1235.97	1235.82	1235.61	1235.37	1235.12	1234.77
Bow River	KM 025	72680	1230.55	1237.11	1236.76	1236.31	1235.97	1235.48	1234.93	1234.75	1234.52	1234.34	1234.09	1233.84	1233.63	1233.41
Bow River	KM 025	72441	1229.35	1236.80	1236.42	1235.92	1235.54	1234.96	1234.24	1233.99	1233.65	1233.37	1232.97	1232.50	1232.06	1231.43
Bow River	KM 025	71892	1218.32	1231.50	1231.12	1230.64	1230.17	1229.55	1229.43	1229.36	1229.24	1229.13	1228.94	1228.68	1228.39	1227.98
Bow River	KM 025	71726	1224.68	1229.35	1229.21	1229.03	1228.89	1228.67	1228.40	1228.29	1228.14	1228.01	1227.80	1227.55	1227.30	1226.95
Bow River	KM 025	71458	1222.56	1228.09	1227.91	1227.67	1227.48	1227.19	1226.85	1226.72	1226.55	1226.41	1226.20	1225.96	1225.73	1225.42
Bow River	KM 025	71322	1222.10	1227.53	1227.33	1227.07	1226.85	1226.53	1226.14	1225.99	1225.79	1225.61	1225.35	1225.05	1224.75	1224.36
Bow River	KM 025	70886	1217.99	1226.01	1225.83	1225.58	1225.38	1225.07	1224.69	1224.54	1224.33	1224.15	1223.88	1223.56	1223.25	1222.81
Bow River	KM 025	70342	1218.65	1224.95	1224.75	1224.49	1224.27	1223.95	1223.56	1223.41	1223.20	1223.02	1222.76	1222.44	1222.14	1221.72
Bow River	KM 025	69862	1218.12	1224.32	1224.11	1223.83	1223.61	1223.27	1222.87	1222.71	1222.50	1222.32	1222.05	1221.72	1221.40	1220.96
Bow River	KM 025	69341	1215.97	1222.72	1222.54	1222.31	1222.12	1221.84	1221.50	1221.38	1221.20	1221.05	1220.82	1220.52	1220.23	1219.83
Bow River	KM 025	69060	1215.25	1220.99	1220.78	1220.52	1220.30	1219.97	1219.58	1219.43	1219.22	1219.04	1218.78	1218.48	1218.18	1217.77
Bow River	KM 025	68797	1212.23	1220.21	1220.00	1219.73	1219.52	1219.18	1218.78	1218.63	1218.42	1218.24	1217.97	1217.65	1217.33	1216.88
Bow River	KM 025	68599	1205.03	1219.81	1219.64	1219.42	1219.24	1218.95	1218.61	1218.48	1218.30	1218.15	1217.91	1217.61	1217.32	1216.89
Bow River	KM 025	68516	1213.79	1219.78	1219.60	1219.36	1219.16	1218.86	1218.49	1218.35	1218.15	1217.98	1217.73	1217.43	1217.14	1216.71
Bow River	KM 025	68296	1212.08	1218.92	1218.78	1218.61	1218.46	1218.21	1217.91	1217.79	1217.62	1217.48	1217.26	1217.00	1216.73	1216.34
Bow River	KM 025	68089	1213.46	1218.63	1218.47	1218.25	1218.07	1217.81	1217.49	1217.37	1217.20	1217.06	1216.85	1216.59	1216.34	1215.97
Bow River	KM 025	67716	1212.30	1218.03	1217.86	1217.62	1217.43	1217.15	1216.81	1216.68	1216.50	1216.35	1216.13	1215.85	1215.59	1215.24

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 025	67419	1211.71	1217.45	1217.28	1217.05	1216.87	1216.60	1216.27	1216.14	1215.97	1215.82	1215.60	1215.31	1215.04	1214.67
Bow River	KM 025	67278	1211.62	1216.90	1216.76	1216.56	1216.40	1216.16	1215.87	1215.75	1215.59	1215.46	1215.25	1214.97	1214.71	1214.35
Bow River	KM 025	67115	1210.93	1216.61	1216.46	1216.27	1216.11	1215.86	1215.58	1215.47	1215.31	1215.18	1214.98	1214.68	1214.41	1214.02
Bow River	KM 025	66773	1209.94	1216.27	1216.10	1215.86	1215.67	1215.38	1215.04	1214.91	1214.73	1214.57	1214.34	1214.03	1213.76	1213.36
Bow River	KM 025	66431	1209.94	1215.74	1215.57	1215.36	1215.18	1214.91	1214.57	1214.45	1214.27	1214.12	1213.90	1213.64	1213.39	1213.02
Bow River	KM 025	66144	1209.20	1215.37	1215.20	1214.98	1214.79	1214.51	1214.16	1214.02	1213.84	1213.67	1213.43	1213.14	1212.85	1212.42
Bow River	KM 025	65921	1207.64	1214.21	1214.06	1213.86	1213.70	1213.46	1213.16	1213.05	1212.89	1212.75	1212.54	1212.28	1212.02	1211.63
Bow River	KM 025	65549	1208.02	1213.74	1213.57	1213.34	1213.16	1212.88	1212.53	1212.40	1212.21	1212.07	1211.81	1211.51	1211.23	1210.86
Bow River	KM 025	65150	1206.99	1213.13	1212.98	1212.77	1212.60	1212.33	1212.00	1211.87	1211.68	1211.55	1211.26	1210.91	1210.57	1210.07
Bow River	KM 025	64837	1205.34	1212.18	1212.06	1211.90	1211.77	1211.58	1211.32	1211.23	1211.07	1211.00	1210.75	1210.45	1210.14	1209.68
Bow River	KM 025	64628	1205.64	1211.92	1211.81	1211.67	1211.54	1211.35	1211.11	1211.02	1210.88	1210.73	1210.51	1210.23	1209.94	1209.51
Bow River	KM 025	64302	1205.72	1211.54	1211.43	1211.30	1211.18	1211.01	1210.78	1210.69	1210.56	1210.43	1210.20	1209.91	1209.60	1209.16
Bow River	KM 025	64027	1205.29	1210.92	1210.82	1210.67	1210.56	1210.38	1210.13	1210.04	1209.88	1209.74	1209.51	1209.24	1208.95	1208.48
Bow River	KM 025	63717	1204.73	1210.04	1209.92	1209.78	1209.66	1209.48	1209.26	1209.18	1209.06	1208.95	1208.79	1208.59	1208.34	1207.88
Bow River	KM 025	63212	1203.77	1209.39	1209.26	1209.09	1208.96	1208.77	1208.55	1208.47	1208.35	1208.23	1208.03	1207.75	1207.46	1207.00
Bow River	KM 025	62736	1201.68	1208.79	1208.61	1208.39	1208.21	1207.92	1207.57	1207.44	1207.27	1207.11	1206.88	1206.59	1206.30	1205.88
Bow River	KM 025	62402	1200.62	1208.02	1207.86	1207.64	1207.47	1207.21	1206.89	1206.77	1206.60	1206.46	1206.24	1205.98	1205.73	1205.35
Bow River	KM 025	61981	1200.90	1207.58	1207.40	1207.18	1206.99	1206.70	1206.35	1206.21	1206.02	1205.85	1205.61	1205.33	1205.03	1204.61
Bow River	KM 025	61281	1200.00	1206.30	1206.14	1205.95	1205.78	1205.54	1205.20	1205.07	1204.88	1204.73	1204.48	1204.19	1203.90	1203.50
Bow River	KM 025	60832	1200.17	1205.37	1205.24	1205.08	1204.95	1204.77	1204.45	1204.33	1204.15	1204.00	1203.77	1203.49	1203.21	1202.83
Bow River	KM 025	60261	1199.00	1204.22	1204.14	1204.05	1203.92	1203.77	1203.49	1203.38	1203.22	1203.08	1202.86	1202.59	1202.32	1201.95
Bow River	KM 025	59664	1198.20	1203.32	1203.15	1202.93	1202.75	1202.48	1202.16	1202.04	1201.88	1201.74	1201.52	1201.26	1201.01	1200.67
Bow River	KM 025	59198	1195.99	1202.27	1202.10	1201.87	1201.69	1201.40	1201.07	1200.94	1200.77	1200.62	1200.41	1200.15	1199.90	1199.56
Bow River	KM 025	58730	1195.94	1201.28	1201.08	1200.82	1200.61	1200.30	1199.92	1199.78	1199.59	1199.42	1199.18	1198.88	1198.59	1198.19
Bow River	KM 025	58375	1192.24	1200.34	1200.17	1199.94	1199.76	1199.48	1199.15	1199.02	1198.84	1198.68	1198.45	1198.17	1197.89	1197.50
Bow River	KM 025	57997	1194.29	1199.33	1199.17	1198.96	1198.80	1198.54	1198.22	1198.10	1197.94	1197.79	1197.58	1197.33	1197.08	1196.73
Bow River	KM 025	57624	1192.83	1197.90	1197.75	1197.56	1197.40	1197.16	1196.87	1196.76	1196.61	1196.48	1196.29	1196.07	1195.84	1195.53
Bow River	KM 025	57271	1192.13	1197.24	1197.07	1196.84	1196.66	1196.39	1196.06	1195.94	1195.77	1195.63	1195.42	1195.17	1194.94	1194.62
Bow River	KM 025	56775	1190.54	1196.29	1196.11	1195.88	1195.70	1195.41	1195.07	1194.94	1194.76	1194.61	1194.38	1194.10	1193.84	1193.47
Bow River	KM 025	56284	1189.54	1195.09	1194.91	1194.69	1194.51	1194.25	1193.94	1193.82	1193.66	1193.52	1193.32	1193.08	1192.85	1192.55
Bow River	KM 025	55904	1189.61	1194.66	1194.47	1194.23	1194.04	1193.76	1193.44	1193.31	1193.15	1193.02	1192.82	1192.60	1192.41	1192.19
Bow River	KM 025	55458	1188.00	1194.11	1193.92	1193.69	1193.51	1193.25	1192.96	1192.85	1192.71	1192.60	1192.45	1192.28	1192.15	1192.01
Bow River	KM 025	55088	1187.41	1193.43	1193.28	1193.09	1192.95	1192.76	1192.54	1192.47	1192.37	1192.29	1192.19	1192.09	1192.01	1191.92
Bow River	KM 025	54806	1186.24	1193.56	1193.39	1193.17	1193.01	1192.77	1192.54	1192.46	1192.36	1192.28	1192.18	1192.08	1191.99	1191.91
Bow River	KM 025	54585	1186.38	1193.50	1193.33	1193.11	1192.95	1192.73	1192.50	1192.43	1192.33	1192.25	1192.15	1192.05	1191.98	1191.90
Bow River	KM 025	54487	1185.78	1193.07	1192.93	1192.76	1192.63	1192.46	1192.29	1192.23	1192.16	1192.11	1192.04	1191.97	1191.92	1191.87
Bow River	KM 025	54458.2	Bridge													
Bow River	KM 025	54433	1184.57	1192.49	1192.42	1192.35	1192.28	1192.20	1192.11	1192.07	1192.03	1192.00	1191.96	1191.91	1191.88	1191.85
Bow River	KM 025	54283	1186.26	1192.55	1192.48	1192.39	1192.32	1192.23	1192.13	1192.09	1192.05	1192.01	1191.97	1191.92	1191.88	1191.85
Bow River	KM 025	54078	1185.21	1192.51	1192.44	1192.36	1192.29	1192.20	1192.10	1192.07	1192.03	1191.99	1191.95	1191.91	1191.88	1191.84
Bow River	KM 025	53802	1184.91	1192.42	1192.36	1192.28	1192.22	1192.14	1192.06	1192.03	1191.99	1191.96	1191.93	1191.89	1191.86	1191.84
Bow River	KM 025	53388	1184.23	1192.26	1192.21	1192.15	1192.11	1192.05	1191.98	1191.96	1191.94	1191.92	1191.89	1191.87	1191.85	1191.83
Bow River	KM 025	52796	1183.07	1192.13	1192.09	1192.05	1192.01	1191.97	1191.93	1191.91	1191.89	1191.88	1191.86	1191.84	1191.83	1191.82

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 025	52139	1182.64	1192.02	1192.00	1191.97	1191.94	1191.91	1191.88	1191.87	1191.86	1191.85	1191.84	1191.83	1191.82	1191.81
Bow River	KM 025	51427	1180.30	1191.90	1191.89	1191.88	1191.87	1191.85	1191.84	1191.83	1191.83	1191.82	1191.82	1191.81	1191.81	1191.81
Bow River	KM 025	50452	1181.18	1191.79	1191.79	1191.79	1191.79	1191.79	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	49366	1179.02	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	48977	1175.55	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	47540	1171.71	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	45971	1168.16	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	44631	1165.58	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	42928	1163.59	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	42170	1163.59	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80	1191.80
Bow River	KM 025	42132	1158.00	1164.25	1164.06	1163.82	1163.61	1163.30	1162.92	1162.78	1162.53	1162.32	1162.00	1161.59	1161.18	1160.58
Bow River	KM 025	41824	1154.33	1163.47	1163.26	1162.99	1162.73	1162.36	1161.92	1161.76	1161.53	1161.34	1161.03	1160.67	1160.32	1159.84
Bow River	KM 025	41537	1156.09	1162.82	1162.65	1162.40	1162.17	1161.83	1161.44	1161.29	1161.07	1160.89	1160.60	1160.25	1159.91	1159.45
Bow River	KM 025	41361	1155.94	1162.34	1162.14	1161.89	1161.65	1161.32	1160.93	1160.79	1160.57	1160.39	1160.11	1159.77	1159.44	1158.99
Bow River	KM 025	40989	1155.19	1161.01	1160.81	1160.55	1160.31	1159.98	1159.61	1159.48	1159.28	1159.12	1158.87	1158.58	1158.30	1157.90
Bow River	KM 025	40712	1153.74	1160.83	1160.58	1160.25	1159.96	1159.57	1159.15	1159.01	1158.80	1158.63	1158.38	1158.10	1157.84	1157.49
Bow River	KM 025	40439	1154.47	1160.58	1160.32	1159.98	1159.67	1159.24	1158.77	1158.60	1158.35	1158.16	1157.87	1157.55	1157.27	1156.92
Bow River	KM 025	40129	1153.14	1159.91	1159.66	1159.32	1159.01	1158.58	1158.09	1157.91	1157.65	1157.44	1157.11	1156.74	1156.38	1155.92
Bow River	KM 025	39836	1152.38	1159.44	1159.17	1158.82	1158.48	1158.01	1157.47	1157.27	1156.97	1156.74	1156.36	1155.93	1155.52	1154.97
Bow River	KM 025	39478	1150.20	1158.11	1157.89	1157.60	1157.32	1156.93	1156.46	1156.29	1156.03	1155.82	1155.48	1155.09	1154.70	1154.18
Bow River	KM 025	39161	1149.88	1157.32	1157.13	1156.87	1156.61	1156.25	1155.83	1155.67	1155.43	1155.24	1154.93	1154.58	1154.24	1153.78
Bow River	KM 025	38875	1150.09	1156.83	1156.63	1156.35	1156.08	1155.71	1155.27	1155.10	1154.85	1154.66	1154.34	1153.99	1153.66	1153.25
Bow River	KM 025	38529	1149.55	1156.39	1156.16	1155.86	1155.57	1155.16	1154.67	1154.49	1154.21	1153.98	1153.61	1153.19	1152.80	1152.28
Bow River	KM 025	38248	1147.77	1155.51	1155.28	1155.00	1154.74	1154.36	1153.91	1153.75	1153.49	1153.28	1152.93	1152.54	1152.14	1151.60
Bow River	KM 025	38018	1146.99	1154.87	1154.66	1154.38	1154.11	1153.74	1153.29	1153.13	1152.89	1152.69	1152.36	1151.98	1151.61	1151.12
Bow River	KM 025	37774	1147.19	1154.64	1154.42	1154.13	1153.86	1153.48	1153.02	1152.85	1152.60	1152.39	1152.05	1151.65	1151.26	1150.73
Bow River	KM 025	37502	1145.24	1153.74	1153.53	1153.26	1153.01	1152.66	1152.26	1152.11	1151.89	1151.72	1151.43	1151.10	1150.77	1150.32
Bow River	KM 025	37086	1146.40	1152.89	1152.67	1152.39	1152.13	1151.78	1151.37	1151.22	1151.00	1150.83	1150.55	1150.24	1149.94	1149.55
Bow River	KM 025	36785	1145.87	1152.17	1151.95	1151.66	1151.40	1151.03	1150.61	1150.47	1150.24	1150.07	1149.79	1149.47	1149.17	1148.75
Bow River	KM 025	36450	1144.88	1151.41	1151.17	1150.86	1150.57	1150.16	1149.69	1149.52	1149.26	1149.05	1148.73	1148.37	1148.02	1147.56
Bow River	KM 025	36158	1143.81	1150.39	1150.18	1149.90	1149.64	1149.27	1148.85	1148.69	1148.45	1148.26	1147.95	1147.59	1147.24	1146.76
Bow River	KM 025	35863	1142.37	1149.37	1149.19	1148.96	1148.73	1148.42	1148.05	1147.91	1147.71	1147.54	1147.26	1146.94	1146.62	1146.16
Bow River	KM 025	35381	1142.19	1148.45	1148.22	1147.92	1147.66	1147.31	1146.91	1146.77	1146.56	1146.39	1146.13	1145.83	1145.54	1145.16
Bow River	KM 025	35009	1141.67	1147.47	1147.25	1146.97	1146.70	1146.33	1145.92	1145.77	1145.54	1145.36	1145.09	1144.78	1144.49	1144.12
Bow River	KM 025	34562	1140.94	1146.83	1146.60	1146.30	1146.02	1145.62	1145.16	1145.00	1144.75	1144.55	1144.23	1143.87	1143.53	1143.09
Bow River	KM 025	34140	1139.49	1146.02	1145.80	1145.51	1145.23	1144.84	1144.38	1144.22	1143.97	1143.77	1143.44	1143.08	1142.73	1142.24
Bow River	KM 025	33877	1138.96	1145.33	1145.10	1144.81	1144.55	1144.18	1143.74	1143.58	1143.35	1143.15	1142.85	1142.50	1142.16	1141.67
Bow River	KM 025	33609	1137.40	1144.66	1144.46	1144.20	1143.96	1143.60	1143.19	1143.04	1142.81	1142.63	1142.34	1142.01	1141.70	1141.22
Bow River	KM 025	33289	1137.84	1144.17	1143.96	1143.68	1143.42	1143.04	1142.60	1142.43	1142.19	1141.99	1141.67	1141.31	1140.96	1140.43
Bow River	KM 025	32977	1136.09	1143.22	1143.04	1142.80	1142.58	1142.24	1141.84	1141.69	1141.46	1141.28	1140.98	1140.64	1140.30	1139.82
Bow River	KM 025	32605	1136.77	1142.55	1142.36	1142.12	1141.89	1141.56	1141.15	1141.00	1140.78	1140.61	1140.32	1140.00	1139.67	1139.18
Bow River	KM 025	32220	1134.71	1141.87	1141.69	1141.43	1141.21	1140.83	1140.38	1140.21	1139.96	1139.75	1139.42	1139.03	1138.67	1138.18
Bow River	KM 025	31935	1134.82	1141.39	1141.21	1140.96	1140.75	1140.41	1139.99	1139.83	1139.59	1139.39	1139.08	1138.71	1138.36	1137.88

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 025	31588	1134.51	1140.80	1140.58	1140.30	1140.04	1139.69	1139.27	1139.12	1138.89	1138.70	1138.40	1138.05	1137.71	1137.27
Bow River	KM 025	31260	1133.78	1140.14	1139.94	1139.68	1139.44	1139.10	1138.66	1138.49	1138.24	1138.04	1137.72	1137.35	1137.01	1136.54
Bow River	KM 025	30935	1132.78	1139.60	1139.39	1139.10	1138.82	1138.44	1137.99	1137.84	1137.60	1137.41	1137.10	1136.74	1136.39	1135.92
Bow River	KM 025	30566	1132.33	1138.58	1138.38	1138.13	1137.88	1137.54	1137.14	1137.00	1136.77	1136.59	1136.28	1135.91	1135.54	1135.03
Bow River	KM 025	30214	1130.92	1138.10	1137.88	1137.59	1137.32	1136.94	1136.49	1136.33	1136.08	1135.89	1135.57	1135.19	1134.82	1134.32
Bow River	KM 025	29937	1130.72	1137.22	1137.06	1136.86	1136.67	1136.38	1136.02	1135.89	1135.66	1135.49	1135.20	1134.84	1134.48	1134.00
Bow River	KM 025	29563	1130.34	1136.75	1136.57	1136.34	1136.13	1135.81	1135.40	1135.26	1135.03	1134.85	1134.56	1134.19	1133.81	1133.32
Bow River	KM 025	29172	1129.51	1136.26	1136.06	1135.81	1135.57	1135.22	1134.77	1134.63	1134.35	1134.13	1133.76	1133.37	1133.00	1132.50
Bow River	KM 025	28925	1128.19	1135.69	1135.47	1135.18	1134.91	1134.51	1134.07	1133.98	1133.74	1133.55	1133.24	1132.88	1132.54	1132.07
Bow River	KM 025	28798	1128.25	1135.60	1135.39	1135.11	1134.85	1134.45	1133.97	1133.74	1133.49	1133.28	1132.96	1132.58	1132.23	1131.75
Bow River	KM 025	28448	1127.89	1134.87	1134.62	1134.31	1134.02	1133.62	1133.16	1132.99	1132.74	1132.54	1132.21	1131.84	1131.48	1130.99
Bow River	KM 025	27998	1126.66	1133.97	1133.73	1133.43	1133.15	1132.75	1132.29	1132.12	1131.87	1131.67	1131.34	1130.98	1130.63	1130.16
Bow River	KM 025	27701	1126.73	1133.64	1133.38	1133.04	1132.74	1132.31	1131.84	1131.67	1131.41	1131.20	1130.86	1130.49	1130.13	1129.66
Bow River	KM 025	27469	1125.55	1133.17	1132.90	1132.55	1132.23	1131.80	1131.32	1131.14	1130.88	1130.67	1130.33	1129.95	1129.59	1129.14
Bow River	KM 025	27386	1125.57	1132.50	1132.29	1132.01	1131.76	1131.40	1130.98	1130.83	1130.60	1130.41	1130.11	1129.76	1129.42	1128.99
Bow River	KM 025	27372.4	Bridge													
Bow River	KM 025	27359	1125.83	1132.12	1131.94	1131.70	1131.47	1131.15	1130.77	1130.63	1130.42	1130.25	1129.97	1129.63	1129.32	1128.91
Bow River	KM 025	27295	1126.05	1132.17	1131.97	1131.71	1131.46	1131.12	1130.72	1130.57	1130.35	1130.17	1129.88	1129.53	1129.20	1128.78
Bow River	KM 025	27116	1125.38	1131.76	1131.55	1131.28	1131.04	1130.69	1130.29	1130.14	1129.91	1129.73	1129.44	1129.04	1128.68	1128.19
Bow River	KM 025	26844	1124.09	1131.26	1131.04	1130.76	1130.50	1130.14	1129.73	1129.58	1129.37	1129.20	1128.94	1128.54	1128.19	1127.74
Bow River	KM 025	26671	1125.09	1131.22	1131.00	1130.71	1130.44	1130.07	1129.64	1129.49	1129.26	1129.09	1128.82	1128.39	1128.02	1127.56
Bow River	KM 025	26466	1123.93	1131.03	1130.79	1130.48	1130.20	1129.80	1129.34	1129.17	1128.92	1128.73	1128.43	1127.95	1127.57	1127.10
Bow River	KM 025	26203	1122.86	1130.16	1129.94	1129.65	1129.38	1128.99	1128.54	1128.38	1128.13	1127.93	1127.61	1127.26	1126.92	1126.47
Bow River	KM 025	25944	1122.94	1129.81	1129.56	1129.25	1128.97	1128.57	1128.10	1127.92	1127.66	1127.45	1127.12	1126.74	1126.38	1125.89
Bow River	KM 025	25748	1122.27	1129.48	1129.23	1128.90	1128.61	1128.20	1127.72	1127.54	1127.28	1127.07	1126.74	1126.36	1126.00	1125.51
Bow River	KM 025	25534	1122.50	1129.18	1128.92	1128.58	1128.28	1127.86	1127.35	1127.16	1126.88	1126.66	1126.30	1125.90	1125.54	1125.07
Bow River	KM 025	25343	1122.22	1129.03	1128.76	1128.43	1128.13	1127.70	1127.18	1126.98	1126.70	1126.46	1126.09	1125.66	1125.27	1124.76
Bow River	KM 025	25205	1121.93	1128.90	1128.62	1128.27	1127.96	1127.53	1127.01	1126.80	1126.51	1126.27	1125.88	1125.45	1125.04	1124.51
Bow River	KM 025	24999	1121.02	1128.53	1128.24	1127.86	1127.53	1127.07	1126.50	1126.27	1125.97	1125.73	1125.35	1124.93	1124.53	1124.00
Bow River	KM 025	24879	1120.60	1128.30	1128.01	1127.61	1127.28	1126.80	1126.25	1126.02	1125.72	1125.48	1125.08	1124.64	1124.22	1123.66
Bow River	KM 023	24684	1120.58	1127.99	1127.72	1127.34	1127.02	1126.57	1126.01	1125.77	1125.46	1125.20	1124.77	1124.31	1123.86	1123.27
Bow River	KM 023	24482	1118.84	1127.03	1126.76	1126.39	1126.07	1125.62	1125.11	1124.90	1124.63	1124.40	1124.05	1123.66	1123.27	1122.76
Bow River	KM 023	24338	1119.10	1126.65	1126.37	1125.99	1125.68	1125.24	1124.73	1124.54	1124.27	1124.06	1123.73	1123.36	1123.00	1122.52
Bow River	KM 023	24132	1119.53	1126.45	1126.16	1125.75	1125.41	1124.93	1124.38	1124.16	1123.88	1123.66	1123.31	1122.92	1122.55	1122.07
Bow River	KM 023	24010	1119.38	1126.31	1126.00	1125.58	1125.22	1124.71	1124.13	1123.90	1123.61	1123.38	1123.02	1122.62	1122.22	1121.69
Bow River	KM 023	23713	1118.09	1126.13	1125.81	1125.37	1124.99	1124.45	1123.81	1123.55	1123.21	1122.94	1122.53	1122.05	1121.56	1120.94
Bow River	KM 023	23562	1117.16	1125.90	1125.59	1125.14	1124.76	1124.20	1123.52	1123.24	1122.87	1122.57	1122.13	1121.65	1121.20	1120.59
Bow River	KM 023	23415	1116.59	1125.10	1124.85	1124.48	1124.17	1123.70	1123.13	1122.88	1122.56	1122.31	1121.90	1121.43	1120.97	1120.35
Bow River	KM 023	23401.3	Bridge													
Bow River	KM 023	23391	1116.61	1124.63	1124.43	1124.12	1123.85	1123.44	1122.90	1122.67	1122.36	1122.12	1121.72	1121.28	1120.83	1120.23
Bow River	KM 023	23317	1117.14	1124.55	1124.33	1123.99	1123.70	1123.31	1122.77	1122.52	1122.21	1121.95	1121.53	1121.05	1120.61	1120.03
Bow River	KM 023	23130	1116.68	1124.35	1124.13	1123.77	1123.48	1123.01	1122.43	1122.19	1121.87	1121.61	1121.19	1120.72	1120.27	1119.69
Bow River	KM 023	22973	1116.75	1124.17	1123.93	1123.55	1123.24	1122.77	1122.14	1121.87	1121.51	1121.22	1120.75	1120.26	1119.81	1119.23

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 000	22894	1116.77	1124.17	1123.94	1123.56	1123.25	1122.77	1122.16	1121.89	1121.51	1121.20	1120.72	1120.18	1119.69	1119.06
Bow River	KM 000	22726	1115.96	1123.76	1123.52	1123.08	1122.75	1122.27	1121.69	1121.44	1121.09	1120.81	1120.35	1119.83	1119.33	1118.68
Bow River	KM 000	22599	1115.22	1123.47	1123.19	1122.58	1122.22	1121.73	1121.18	1120.95	1120.64	1120.39	1119.97	1119.50	1119.05	1118.44
Bow River	KM 000	22340	1114.30	1123.24	1122.96	1122.27	1121.87	1121.32	1120.69	1120.46	1120.14	1119.89	1119.48	1119.02	1118.59	1118.00
Bow River	KM 000	22028	1114.08	1122.88	1122.62	1121.91	1121.52	1120.99	1120.38	1120.14	1119.82	1119.55	1119.12	1118.65	1118.19	1117.58
Bow River	KM 000	21803	1113.22	1121.82	1121.66	1120.70	1120.38	1119.95	1119.45	1119.26	1119.00	1118.78	1118.43	1118.04	1117.65	1117.13
Bow River	KM 000	21608	1113.34	1121.74	1121.58	1120.46	1120.11	1119.64	1119.12	1118.91	1118.64	1118.42	1118.07	1117.68	1117.30	1116.81
Bow River	KM 000	21421	1114.08	1121.58	1121.44	1120.17	1119.80	1119.31	1118.76	1118.55	1118.26	1118.04	1117.68	1117.29	1116.92	1116.46
Bow River	KM 000	21274	1114.14	1121.50	1121.36	1120.00	1119.62	1119.11	1118.53	1118.30	1118.01	1117.77	1117.40	1116.99	1116.61	1116.13
Bow River	KM 000	21235	1113.94	1121.41	1121.28	1119.82	1119.46	1118.97	1118.41	1118.18	1117.89	1117.66	1117.29	1116.88	1116.50	1116.03
Bow River	KM 000	21224.5	Bridge													
Bow River	KM 000	21217	1113.78	1120.34	1120.04	1119.64	1119.29	1118.82	1118.28	1118.06	1117.78	1117.55	1117.19	1116.79	1116.41	1115.95
Bow River	KM 000	21170	1113.43	1120.32	1120.02	1119.60	1119.25	1118.77	1118.22	1118.00	1117.71	1117.47	1117.10	1116.69	1116.30	1115.79
Bow River	KM 000	21030	1112.90	1120.19	1119.89	1119.47	1119.11	1118.61	1118.04	1117.81	1117.51	1117.26	1116.87	1116.42	1115.98	1115.39
Bow River	KM 000	20876	1111.95	1119.76	1119.45	1119.03	1118.68	1118.19	1117.59	1117.35	1117.03	1116.76	1116.34	1115.89	1115.47	1114.93
Bow River	KM 000	20666	1111.81	1119.37	1119.08	1118.68	1118.34	1117.85	1117.28	1117.04	1116.73	1116.47	1116.06	1115.62	1115.19	1114.64
Bow River	KM 000	20496	1111.64	1119.08	1118.79	1118.38	1118.03	1117.53	1116.95	1116.73	1116.42	1116.17	1115.77	1115.33	1114.91	1114.37
Bow River	KM 000	20329	1111.20	1118.82	1118.52	1118.11	1117.76	1117.26	1116.69	1116.46	1116.16	1115.91	1115.52	1115.09	1114.68	1114.16
Bow River	KM 000	20174	1111.53	1118.67	1118.37	1117.95	1117.60	1117.10	1116.51	1116.28	1115.97	1115.72	1115.31	1114.87	1114.46	1113.94
Bow River	KM 000	19933	1110.38	1118.46	1118.13	1117.67	1117.29	1116.77	1116.17	1115.93	1115.61	1115.34	1114.90	1114.42	1113.95	1113.36
Bow River	KM 000	19798	1110.05	1118.12	1117.81	1117.37	1117.00	1116.48	1115.88	1115.65	1115.32	1115.05	1114.60	1114.11	1113.64	1113.01
Bow River	KM 000	19603	1107.94	1116.66	1116.42	1116.08	1115.78	1115.37	1114.88	1114.69	1114.42	1114.20	1113.86	1113.48	1113.11	1112.57
Bow River	KM 000	19507	1107.64	1116.53	1116.20	1115.83	1115.52	1115.08	1114.59	1114.40	1114.17	1113.97	1113.66	1113.30	1112.95	1112.44
Bow River	KM 000	19342	1108.98	1116.14	1115.92	1115.55	1115.24	1114.80	1114.30	1114.11	1113.86	1113.67	1113.35	1113.01	1112.69	1112.21
Bow River	KM 000	19150	1109.59	1116.35	1116.05	1115.62	1115.25	1114.72	1114.16	1113.95	1113.67	1113.45	1113.12	1112.77	1112.46	1111.98
Bow River	KM 000	18984	1108.48	1116.26	1115.95	1115.52	1115.14	1114.61	1114.02	1113.79	1113.49	1113.25	1112.89	1112.52	1112.18	1111.63
Bow River	KM 000	18840	1108.47	1116.02	1115.72	1115.30	1114.92	1114.38	1113.76	1113.52	1113.21	1112.95	1112.56	1112.14	1111.77	1111.25
Bow River	KM 000	18709	1108.13	1115.86	1115.56	1115.13	1114.75	1114.20	1113.57	1113.33	1113.01	1112.74	1112.33	1111.89	1111.49	1110.98
Bow River	KM 000	18500	1107.46	1115.56	1115.25	1114.83	1114.46	1113.91	1113.28	1113.03	1112.70	1112.42	1111.98	1111.50	1111.05	1110.46
Bow River	KM 000	18270	1106.42	1114.00	1113.79	1113.46	1113.17	1112.76	1112.28	1112.08	1111.82	1111.60	1111.24	1110.83	1110.44	1109.90
Bow River	KM 000	17960	1106.36	1113.47	1113.20	1112.85	1112.55	1112.14	1111.66	1111.48	1111.23	1111.02	1110.69	1110.31	1109.95	1109.45
Bow River	KM 000	17680	1106.16	1113.48	1113.20	1112.81	1112.47	1112.00	1111.46	1111.25	1110.98	1110.74	1110.36	1109.93	1109.53	1108.99
Bow River	KM 000	17298	1105.17	1112.93	1112.64	1112.23	1111.87	1111.36	1110.74	1110.50	1110.17	1109.90	1109.47	1109.02	1108.59	1108.05
Bow River	KM 000	16969	1104.90	1112.45	1112.19	1111.81	1111.48	1110.98	1110.38	1110.14	1109.81	1109.54	1109.10	1108.60	1108.13	1107.50
Bow River	KM 000	16703	1103.38	1111.40	1111.19	1110.90	1110.64	1110.22	1109.68	1109.46	1109.16	1108.90	1108.50	1108.06	1107.64	1107.07
Bow River	KM 000	16437	1103.54	1111.11	1110.89	1110.58	1110.31	1109.89	1109.36	1109.15	1108.84	1108.59	1108.19	1107.76	1107.34	1106.80
Bow River	KM 000	16269	1104.13	1110.95	1110.71	1110.37	1110.06	1109.65	1109.12	1108.90	1108.59	1108.34	1107.94	1107.50	1107.09	1106.56
Bow River	KM 000	16024	1103.27	1110.53	1110.27	1109.92	1109.62	1109.21	1108.70	1108.49	1108.18	1107.93	1107.52	1107.09	1106.67	1106.14
Bow River	KM 000	15830	1102.65	1110.16	1109.92	1109.58	1109.30	1108.89	1108.39	1108.18	1107.87	1107.60	1107.18	1106.72	1106.29	1105.76
Bow River	KM 000	15648	1102.88	1110.10	1109.86	1109.53	1109.25	1108.82	1108.29	1108.07	1107.74	1107.46	1107.00	1106.50	1106.02	1105.41
Bow River	KM 000	15440	1101.72	1109.47	1109.22	1108.87	1108.57	1108.15	1107.62	1107.43	1107.12	1106.86	1106.45	1105.99	1105.55	1104.96
Bow River	KM 000	15224	1101.71	1109.23	1108.96	1108.60	1108.28	1107.83	1107.32	1107.12	1106.81	1106.56	1106.14	1105.68	1105.23	1104.64
Bow River	KM 000	14981	1101.06	1108.91	1108.62	1108.23	1107.89	1107.39	1106.84	1106.60	1106.31	1106.06	1105.67	1105.23	1104.80	1104.23

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bow River	KM 000	14763	1100.47	1108.41	1108.12	1107.72	1107.37	1106.87	1106.30	1106.09	1105.80	1105.57	1105.19	1104.76	1104.35	1103.80
Bow River	KM 000	14383	1099.61	1107.18	1106.95	1106.63	1106.34	1105.93	1105.44	1105.25	1104.99	1104.77	1104.42	1104.04	1103.68	1103.17
Bow River	KM 000	14213	1100.24	1106.92	1106.69	1106.35	1106.06	1105.63	1105.12	1104.93	1104.66	1104.44	1104.09	1103.71	1103.34	1102.82
Bow River	KM 000	13874	1098.60	1106.41	1106.15	1105.80	1105.48	1105.01	1104.46	1104.24	1103.95	1103.71	1103.31	1102.87	1102.44	1101.88
Bow River	KM 000	13626	1098.65	1105.78	1105.55	1105.22	1104.93	1104.49	1103.93	1103.72	1103.43	1103.19	1102.80	1102.38	1101.99	1101.46
Bow River	KM 000	13399	1098.17	1105.63	1105.39	1105.05	1104.76	1104.31	1103.75	1103.53	1103.23	1102.99	1102.58	1102.12	1101.70	1101.14
Bow River	KM 000	13018	1097.12	1104.67	1104.41	1104.06	1103.75	1103.32	1102.81	1102.61	1102.34	1102.13	1101.77	1101.37	1101.00	1100.51
Bow River	KM 000	12701	1096.70	1104.23	1103.94	1103.55	1103.22	1102.74	1102.19	1101.99	1101.72	1101.50	1101.12	1100.70	1100.29	1099.78
Bow River	KM 000	12451	1096.56	1103.89	1103.59	1103.18	1102.82	1102.32	1101.71	1101.47	1101.16	1100.90	1100.51	1100.07	1099.64	1099.13
Bow River	KM 000	12234	1095.15	1103.46	1103.16	1102.76	1102.41	1101.90	1101.31	1101.08	1100.78	1100.53	1100.15	1099.73	1099.33	1098.82
Bow River	KM 000	11894	1096.38	1103.15	1102.86	1102.46	1102.11	1101.59	1100.98	1100.74	1100.43	1100.15	1099.75	1099.29	1098.86	1098.31
Bow River	KM 000	11503	1094.24	1102.07	1101.81	1101.47	1101.16	1100.69	1100.14	1099.92	1099.65	1099.41	1099.04	1098.61	1098.19	1097.63
Bow River	KM 000	11230	1094.31	1101.43	1101.16	1100.80	1100.50	1100.08	1099.57	1099.37	1099.12	1098.89	1098.55	1098.15	1097.76	1097.23
Bow River	KM 000	10967	1093.98	1101.20	1100.92	1100.54	1100.22	1099.76	1099.21	1098.99	1098.73	1098.49	1098.14	1097.73	1097.34	1096.86
Bow River	KM 000	10591	1093.90	1100.82	1100.52	1100.12	1099.77	1099.28	1098.70	1098.48	1098.20	1097.94	1097.56	1097.13	1096.69	1096.15
Bow River	KM 000	10200	1092.02	1100.12	1099.82	1099.42	1099.07	1098.53	1097.87	1097.60	1097.28	1097.00	1096.60	1096.13	1095.68	1095.13
Bow River	KM 000	10063	1092.24	1100.09	1099.79	1099.38	1099.02	1098.47	1097.79	1097.51	1097.16	1096.86	1096.41	1095.91	1095.45	1094.90
Bow River	KM 000	9667	1090.48	1099.29	1099.00	1098.64	1098.33	1097.85	1097.21	1096.94	1096.61	1096.30	1095.82	1095.26	1094.72	1094.03
Bow River	KM 000	9467	1090.23	1099.01	1098.69	1098.28	1097.92	1097.38	1096.76	1096.51	1096.20	1095.91	1095.47	1094.94	1094.43	1093.74
Bow River	KM 000	9283	1089.22	1098.59	1098.23	1097.76	1097.37	1096.86	1096.29	1096.06	1095.78	1095.51	1095.12	1094.64	1094.17	1093.53
Bow River	KM 000	9041	1090.28	1098.57	1098.22	1097.75	1097.35	1096.78	1096.12	1095.86	1095.53	1095.25	1094.84	1094.35	1093.89	1093.26
Bow River	KM 000	8729	1089.02	1097.16	1096.91	1096.57	1096.28	1095.86	1095.35	1095.15	1094.89	1094.65	1094.28	1093.83	1093.40	1092.80
Bow River	KM 000	8459	1088.82	1096.64	1096.40	1096.08	1095.81	1095.42	1094.95	1094.75	1094.51	1094.29	1093.94	1093.51	1093.10	1092.51
Bow River	KM 000	8192	1088.20	1096.55	1096.28	1095.93	1095.63	1095.20	1094.69	1094.49	1094.23	1093.99	1093.61	1093.16	1092.73	1092.12
Bow River	KM 000	7916	1087.98	1095.95	1095.68	1095.32	1095.01	1094.57	1094.06	1093.85	1093.60	1093.37	1093.03	1092.63	1092.24	1091.74
Bow River	KM 000	7653	1088.09	1095.62	1095.35	1094.98	1094.66	1094.22	1093.70	1093.49	1093.24	1093.02	1092.70	1092.33	1091.96	1091.52
Bow River	KM 000	7469	1087.46	1095.17	1094.91	1094.57	1094.28	1093.87	1093.39	1093.19	1092.96	1092.76	1092.46	1092.12	1091.80	1091.41
Bow River	KM 000	7251	1087.35	1094.40	1094.21	1093.95	1093.73	1093.41	1093.03	1092.87	1092.68	1092.51	1092.25	1091.96	1091.67	1091.33
Bow River	KM 000	7027	1087.83	1094.26	1094.05	1093.76	1093.53	1093.19	1092.80	1092.65	1092.45	1092.29	1092.04	1091.77	1091.52	1091.24
Bow River	KM 000	6740	1085.52	1093.83	1093.62	1093.33	1093.10	1092.76	1092.39	1092.24	1092.06	1091.91	1091.69	1091.46	1091.27	1091.08
Bow River	KM 000	6416	1086.53	1093.37	1093.16	1092.88	1092.64	1092.32	1091.97	1091.83	1091.68	1091.55	1091.38	1091.21	1091.09	1090.99
Bow River	KM 000	6005	1086.14	1093.04	1092.83	1092.57	1092.35	1092.05	1091.74	1091.63	1091.50	1091.39	1091.25	1091.13	1091.04	1090.96
Bow River	KM 000	5633	1084.80	1092.82	1092.62	1092.37	1092.17	1091.90	1091.61	1091.51	1091.40	1091.31	1091.19	1091.08	1091.01	1090.95
Bow River	KM 000	5196	1084.61	1092.63	1092.45	1092.21	1092.02	1091.77	1091.51	1091.42	1091.32	1091.24	1091.14	1091.05	1090.99	1090.94
Bow River	KM 000	4675	1082.64	1092.31	1092.15	1091.94	1091.78	1091.57	1091.36	1091.29	1091.21	1091.15	1091.08	1091.01	1090.97	1090.93
Bow River	KM 000	4201	1082.20	1091.97	1091.84	1091.67	1091.54	1091.38	1091.23	1091.17	1091.12	1091.07	1091.02	1090.98	1090.94	1090.92
Bow River	KM 000	3744	1083.83	1091.76	1091.65	1091.50	1091.40	1091.27	1091.15	1091.11	1091.06	1091.03	1090.99	1090.96	1090.93	1090.91
Bow River	KM 000	3204	1080.68	1091.51	1091.42	1091.32	1091.24	1091.15	1091.06	1091.03	1091.01	1090.98	1090.96	1090.94	1090.92	1090.91
Bow River	KM 000	2677	1081.85	1091.47	1091.38	1091.28	1091.21	1091.13	1091.05	1091.02	1091.00	1090.98	1090.95	1090.93	1090.92	1090.91
Bow River	KM 000	2148	1079.94	1091.43	1091.35	1091.26	1091.19	1091.11	1091.04	1091.01	1090.99	1090.97	1090.95	1090.93	1090.92	1090.91
Bow River	KM 000	1302	1076.84	1091.37	1091.30	1091.21	1091.15	1091.08	1091.02	1091.00	1090.98	1090.96	1090.94	1090.93	1090.92	1090.91
Bow River	KM 000	329	1075.65	1091.33	1091.26	1091.19	1091.13	1091.07	1091.01	1090.99	1090.97	1090.96	1090.94	1090.92	1090.91	1090.91
Bow River	KM 000	12	1075.00	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90	1090.90

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bighill Creek	KM 000	5030	1153.45	1155.35	1155.32	1155.28	1155.25	1155.23	1155.14	1155.11	1155.06	1154.99	1154.85	1154.66	1154.39	1153.90
Bighill Creek	KM 000	4966	1152.59	1154.64	1154.63	1154.60	1154.56	1154.44	1154.34	1154.29	1154.23	1154.17	1154.08	1153.90	1153.67	1153.40
Bighill Creek	KM 000	4883	1152.05	1153.98	1153.95	1153.91	1153.87	1153.80	1153.71	1153.67	1153.61	1153.55	1153.45	1153.27	1152.99	1152.47
Bighill Creek	KM 000	4810	1151.07	1153.60	1153.58	1153.55	1153.52	1153.46	1153.39	1153.35	1153.30	1153.24	1153.13	1152.96	1152.72	1152.20
Bighill Creek	KM 000	4715	1151.17	1153.03	1153.01	1152.97	1152.94	1152.88	1152.78	1152.74	1152.69	1152.64	1152.55	1152.42	1152.28	1151.90
Bighill Creek	KM 000	4639	1150.58	1152.47	1152.45	1152.42	1152.39	1152.35	1152.30	1152.28	1152.22	1152.18	1152.11	1151.98	1151.81	1151.49
Bighill Creek	KM 000	4527	1149.80	1151.83	1151.79	1151.74	1151.69	1151.61	1151.52	1151.48	1151.42	1151.37	1151.31	1151.24	1151.12	1150.81
Bighill Creek	KM 000	4461	1149.32	1151.61	1151.56	1151.48	1151.42	1151.32	1151.19	1151.13	1151.05	1150.98	1150.86	1150.70	1150.48	1149.96
Bighill Creek	KM 000	4363	1148.32	1151.03	1150.98	1150.90	1150.84	1150.73	1150.59	1150.53	1150.46	1150.37	1150.19	1149.93	1149.69	1149.33
Bighill Creek	KM 000	4359.6	Bridge													
Bighill Creek	KM 000	4357	1148.58	1150.95	1150.89	1150.80	1150.72	1150.60	1150.43	1150.36	1150.26	1150.17	1150.03	1149.84	1149.64	1149.30
Bighill Creek	KM 000	4295	1148.12	1150.61	1150.56	1150.48	1150.41	1150.28	1150.09	1150.01	1149.90	1149.80	1149.63	1149.42	1149.18	1148.87
Bighill Creek	KM 000	4203	1147.45	1149.74	1149.70	1149.64	1149.57	1149.47	1149.33	1149.27	1149.18	1149.09	1148.95	1148.74	1148.52	1148.11
Bighill Creek	KM 000	4129	1147.01	1148.72	1148.67	1148.61	1148.55	1148.47	1148.37	1148.32	1148.27	1148.21	1148.12	1148.01	1147.88	1147.61
Bighill Creek	KM 000	4055	1146.16	1148.31	1148.24	1148.16	1148.10	1147.99	1147.86	1147.81	1147.73	1147.66	1147.55	1147.41	1147.27	1147.03
Bighill Creek	KM 000	3915	1145.10	1147.49	1147.43	1147.36	1147.31	1147.21	1147.07	1147.01	1146.93	1146.85	1146.72	1146.54	1146.34	1145.95
Bighill Creek	KM 000	3851	1144.59	1146.56	1146.53	1146.49	1146.45	1146.39	1146.30	1146.26	1146.21	1146.16	1146.06	1145.93	1145.78	1145.47
Bighill Creek	KM 000	3797	1144.44	1146.14	1146.11	1146.07	1146.04	1145.98	1145.91	1145.88	1145.83	1145.78	1145.73	1145.62	1145.46	1145.08
Bighill Creek	KM 000	3793.4	Bridge													
Bighill Creek	KM 000	3790	1144.38	1146.05	1146.02	1145.97	1145.93	1145.87	1145.78	1145.74	1145.69	1145.63	1145.55	1145.45	1145.34	1145.03
Bighill Creek	KM 000	3675	1143.66	1145.46	1145.44	1145.40	1145.36	1145.29	1145.22	1145.18	1145.12	1145.07	1144.97	1144.82	1144.66	1144.33
Bighill Creek	KM 000	3563	1142.89	1144.68	1144.65	1144.63	1144.60	1144.57	1144.47	1144.45	1144.42	1144.37	1144.32	1144.22	1144.05	1143.70
Bighill Creek	KM 000	3388	1142.07	1144.02	1144.02	1143.98	1143.96	1143.92	1143.90	1143.87	1143.83	1143.80	1143.73	1143.58	1143.29	1142.76
Bighill Creek	KM 000	3384.6	Bridge													
Bighill Creek	KM 000	3382	1141.96	1143.98	1143.98	1143.94	1143.92	1143.88	1143.87	1143.84	1143.80	1143.75	1143.66	1143.51	1143.24	1142.73
Bighill Creek	KM 000	3263	1141.21	1143.55	1143.51	1143.51	1143.49	1143.47	1143.46	1143.44	1143.37	1143.28	1143.10	1142.85	1142.57	1142.15
Bighill Creek	KM 000	3094	1140.34	1143.33	1143.24	1143.13	1143.06	1142.98	1142.88	1142.79	1142.66	1142.53	1142.31	1142.00	1141.66	1141.08
Bighill Creek	KM 000	2960	1139.30	1143.27	1143.13	1142.94	1142.72	1142.57	1142.41	1142.32	1142.20	1142.08	1141.88	1141.61	1141.32	1140.83
Bighill Creek	KM 000	2905	1139.38	1143.26	1143.13	1142.94	1142.72	1142.56	1142.34	1142.25	1142.11	1141.97	1141.76	1141.49	1141.19	1140.71
Bighill Creek	KM 000	2848	1139.49	1143.24	1143.10	1142.90	1142.63	1142.39	1142.12	1142.01	1141.85	1141.72	1141.51	1141.24	1140.95	1140.45
Bighill Creek	KM 000	2826	1139.28	1143.19	1143.03	1142.84	1142.58	1142.36	1142.09	1141.98	1141.83	1141.69	1141.48	1141.21	1140.92	1140.41
Bighill Creek	KM 000	2814	Bridge													
Bighill Creek	KM 000	2804	1139.26	1142.12	1142.06	1141.97	1141.88	1141.75	1141.58	1141.51	1141.40	1141.31	1141.16	1140.95	1140.69	1140.22
Bighill Creek	KM 000	2792	1138.94	1142.11	1142.05	1141.95	1141.86	1141.73	1141.55	1141.47	1141.35	1141.25	1141.09	1140.87	1140.61	1140.13
Bighill Creek	KM 000	2780	1138.95	1141.95	1141.89	1141.79	1141.70	1141.57	1141.40	1141.32	1141.21	1141.10	1140.94	1140.70	1140.45	1140.02
Bighill Creek	KM 000	2761	1139.22	1141.82	1141.77	1141.68	1141.60	1141.48	1141.32	1141.24	1141.13	1141.03	1140.87	1140.63	1140.37	1139.89
Bighill Creek	KM 000	2754.5	Bridge													
Bighill Creek	KM 000	2748	1139.01	1141.66	1141.61	1141.54	1141.47	1141.37	1141.22	1141.14	1141.04	1140.95	1140.79	1140.56	1140.30	1139.79
Bighill Creek	KM 000	2729	1138.60	1141.18	1141.14	1141.12	1141.16	1141.03	1140.87	1140.81	1140.72	1140.63	1140.48	1140.30	1140.09	1139.67
Bighill Creek	KM 000	2676	1138.46	1141.19	1141.16	1141.08	1141.00	1140.88	1140.73	1140.67	1140.58	1140.49	1140.33	1140.11	1139.87	1139.38
Bighill Creek	KM 000	2631	1138.10	1141.13	1141.04	1140.92	1140.82	1140.66	1140.48	1140.40	1140.29	1140.20	1140.05	1139.86	1139.65	1139.22
Bighill Creek	KM 000	2573	1137.80	1141.05	1140.96	1140.85	1140.74	1140.58	1140.39	1140.31	1140.19	1140.09	1139.92	1139.71	1139.48	1139.06
Bighill Creek	KM 000	2543	1137.77	1140.83	1140.73	1140.60	1140.49	1140.31	1140.10	1140.01	1139.90	1139.80	1139.66	1139.51	1139.33	1138.96

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bighill Creek	KM 000	2517	1137.76	1140.80	1140.70	1140.56	1140.42	1140.22	1139.97	1139.86	1139.71	1139.58	1139.36	1139.04	1138.80	1138.43
Bighill Creek	KM 000	2497.6	Culvert													
Bighill Creek	KM 000	2482	1137.76	1139.42	1139.37	1139.30	1139.24	1139.12	1139.00	1139.01	1139.00	1138.97	1138.89	1138.73	1138.54	1138.27
Bighill Creek	KM 000	2387	1136.89	1139.15	1139.11	1139.06	1139.01	1138.93	1138.82	1138.77	1138.70	1138.63	1138.50	1138.29	1138.03	1137.57
Bighill Creek	KM 000	2267	1136.10	1138.45	1138.41	1138.37	1138.32	1138.22	1138.15	1138.13	1138.07	1138.03	1137.91	1137.67	1137.39	1136.90
Bighill Creek	KM 000	2161	1135.38	1137.87	1137.85	1137.82	1137.79	1137.77	1137.67	1137.61	1137.55	1137.44	1137.23	1136.98	1136.70	1136.23
Bighill Creek	KM 000	2157.6	Bridge													
Bighill Creek	KM 000	2154	1135.41	1137.69	1137.67	1137.63	1137.60	1137.54	1137.40	1137.39	1137.41	1137.33	1137.15	1136.92	1136.64	1136.18
Bighill Creek	KM 000	2106	1135.15	1137.24	1137.20	1137.18	1137.13	1137.11	1137.04	1136.98	1136.85	1136.81	1136.72	1136.54	1136.29	1135.87
Bighill Creek	KM 000	1937	1134.11	1136.88	1136.85	1136.81	1136.76	1136.69	1136.60	1136.55	1136.48	1136.40	1136.23	1135.99	1135.74	1135.35
Bighill Creek	KM 000	1769	1133.95	1136.35	1136.32	1136.28	1136.24	1136.19	1136.09	1136.04	1135.98	1135.92	1135.77	1135.45	1135.12	1134.57
Bighill Creek	KM 000	1723	1133.44	1136.11	1136.08	1136.04	1136.01	1135.89	1135.86	1135.82	1135.78	1135.74	1135.57	1135.27	1134.95	1134.40
Bighill Creek	KM 000	1721.9	Bridge													
Bighill Creek	KM 000	1720	1133.50	1135.94	1135.92	1135.87	1135.83	1135.74	1135.78	1135.74	1135.68	1135.61	1135.46	1135.22	1134.92	1134.38
Bighill Creek	KM 000	1606	1132.88	1135.85	1135.75	1135.63	1135.50	1135.33	1135.11	1135.01	1134.88	1134.76	1134.57	1134.34	1134.17	1133.85
Bighill Creek	KM 000	1536	1132.22	1135.64	1135.53	1135.39	1135.25	1135.05	1134.82	1134.71	1134.55	1134.41	1134.16	1133.82	1133.40	1132.84
Bighill Creek	KM 000	1518.8	Culvert													
Bighill Creek	KM 000	1501	1132.29	1134.88	1134.86	1134.83	1134.78	1134.70	1134.58	1134.51	1134.40	1134.29	1134.07	1133.77	1133.41	1132.92
Bighill Creek	KM 000	1484	1132.07	1134.57	1134.52	1134.43	1134.39	1134.29	1134.01	1133.92	1133.77	1133.64	1133.45	1133.17	1133.01	1132.69
Bighill Creek	KM 000	1395	1131.17	1132.70	1132.67	1132.63	1132.60	1132.54	1132.47	1132.45	1132.41	1132.38	1132.30	1132.20	1132.06	1131.71
Bighill Creek	KM 000	1212	1130.05	1132.09	1132.06	1132.01	1131.97	1131.90	1131.77	1131.68	1131.55	1131.38	1131.23	1131.05	1130.87	1130.60
Bighill Creek	KM 000	1206.9	Bridge													
Bighill Creek	KM 000	1202	1130.06	1131.83	1131.77	1131.70	1131.63	1131.50	1131.36	1131.29	1131.20	1131.13	1131.01	1130.85	1130.70	1130.47
Bighill Creek	KM 000	1168	1129.23	1131.48	1131.43	1131.34	1131.27	1131.15	1130.99	1130.93	1130.83	1130.75	1130.62	1130.44	1130.24	1129.94
Bighill Creek	KM 000	1095	1128.64	1130.72	1130.67	1130.60	1130.53	1130.43	1130.29	1130.22	1130.13	1130.05	1129.92	1129.74	1129.54	1129.22
Bighill Creek	KM 000	995	1127.88	1129.74	1129.69	1129.63	1129.57	1129.47	1129.37	1129.31	1129.23	1129.16	1129.03	1128.86	1128.67	1128.40
Bighill Creek	KM 000	991.8	Bridge													
Bighill Creek	KM 000	989	1127.77	1129.59	1129.57	1129.51	1129.45	1129.37	1129.28	1129.22	1129.14	1129.07	1128.95	1128.78	1128.60	1128.34
Bighill Creek	KM 000	915	1126.98	1128.77	1128.72	1128.69	1128.66	1128.60	1128.47	1128.38	1128.28	1128.20	1128.11	1127.98	1127.85	1127.60
Bighill Creek	KM 000	822	1126.02	1128.07	1127.93	1127.75	1127.62	1127.49	1127.44	1127.42	1127.41	1127.36	1127.20	1127.01	1126.82	1126.56
Bighill Creek	KM 000	740	1125.32	1127.96	1127.80	1127.57	1127.37	1127.06	1126.72	1126.59	1126.44	1126.37	1126.36	1126.31	1126.22	1125.87
Bighill Creek	KM 000	617	1124.19	1127.94	1127.77	1127.54	1127.33	1127.00	1126.62	1126.46	1126.23	1126.04	1125.76	1125.49	1125.24	1124.97
Bighill Creek	KM 000	586	1124.03	1127.94	1127.77	1127.53	1127.32	1127.00	1126.61	1126.45	1126.23	1126.03	1125.73	1125.41	1125.11	1124.75
Bighill Creek	KM 000	580.7	Bridge													
Bighill Creek	KM 000	576	1123.78	1127.94	1127.77	1127.53	1127.32	1127.00	1126.61	1126.45	1126.22	1126.03	1125.72	1125.35	1125.00	1124.61
Bighill Creek	KM 000	505	1123.35	1127.91	1127.74	1127.51	1127.30	1126.97	1126.58	1126.42	1126.19	1125.99	1125.67	1125.25	1124.84	1124.25
Bighill Creek	KM 000	481.6	Culvert													
Bighill Creek	KM 000	454	1122.41	1124.76	1124.58	1124.45	1124.45	1124.40	1124.27	1124.21	1124.13	1124.05	1123.91	1123.73	1123.49	1123.05
Bighill Creek	KM 000	376	1121.78	1124.80	1124.57	1124.21	1123.95	1123.80	1123.74	1123.70	1123.66	1123.62	1123.58	1123.32	1123.01	1122.57
Bighill Creek	KM 000	372.7	Bridge													
Bighill Creek	KM 000	369	1121.88	1124.79	1124.56	1124.19	1123.89	1123.57	1123.49	1123.47	1123.42	1123.38	1123.21	1122.91	1122.78	1122.45
Bighill Creek	KM 000	335	1121.20	1124.78	1124.54	1124.17	1123.86	1123.39	1122.79	1122.63	1122.59	1122.60	1122.60	1122.44	1122.27	1121.97
Bighill Creek	KM 000	262	1120.39	1124.77	1124.53	1124.15	1123.83	1123.34	1122.71	1122.45	1122.12	1121.89	1121.64	1121.45	1121.23	1120.86

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Bighill Creek	KM 000	211	1119.40	1124.77	1124.53	1124.15	1123.83	1123.34	1122.70	1122.43	1122.07	1121.79	1121.37	1121.05	1120.81	1120.44
Bighill Creek	KM 000	208.2	Bridge													
Bighill Creek	KM 000	206	1119.65	**1124.77**	1124.53	1124.15	1123.83	1123.34	1122.70	1122.43	1122.06	1121.77	1121.26	1120.74	1120.65	1120.36
Bighill Creek	KM 000	185	1119.30	1124.77	1124.53	1124.15	1123.83	1123.34	1122.70	1122.43	1122.06	1121.77	1121.29	1120.73	1120.18	1119.78
Exshaw Creek	KM 000	1319	1341.28	1343.37	1343.29	1343.18	1343.07	1342.93	1342.75	1342.67	1342.57	1342.49	1342.36	1342.21	1342.06	1341.87
Exshaw Creek	KM 000	1182	1337.57	1339.45	1339.39	1339.30	1339.23	1339.11	1338.97	1338.89	1338.81	1338.73	1338.61	1338.48	1338.34	1338.15
Exshaw Creek	KM 000	1105	1334.72	1336.04	1335.99	1335.94	1335.88	1335.80	1335.69	1335.65	1335.60	1335.56	1335.49	1335.41	1335.33	1335.18
Exshaw Creek	KM 000	1014	1329.70	1332.16	1332.07	1331.96	1331.86	1331.71	1331.54	1331.46	1331.36	1331.26	1331.12	1330.94	1330.77	1330.54
Exshaw Creek	KM 000	922	1326.72	1328.70	1328.63	1328.55	1328.46	1328.34	1328.19	1328.13	1328.06	1328.00	1327.90	1327.78	1327.64	1327.39
Exshaw Creek	KM 000	838	1321.44	1323.78	1323.69	1323.58	1323.50	1323.33	1323.16	1323.09	1323.00	1322.92	1322.79	1322.64	1322.49	1322.25
Exshaw Creek	KM 000	708	1316.65	1318.38	1318.32	1318.23	1318.13	1318.03	1317.90	1317.85	1317.78	1317.71	1317.62	1317.49	1317.36	1317.20
Exshaw Creek	KM 000	593	1311.77	1313.60	1313.55	1313.47	1313.41	1313.29	1313.16	1313.11	1313.05	1312.99	1312.91	1312.82	1312.72	1312.57
Exshaw Creek	KM 000	475	1306.54	1308.20	1308.15	1308.08	1308.00	1307.93	1307.83	1307.79	1307.73	1307.68	1307.60	1307.49	1307.38	1307.20
Exshaw Creek	KM 000	454	1304.52	1307.14	1307.05	1306.90	1306.79	1306.56	1306.31	1306.23	1306.13	1306.04	1305.93	1305.77	1305.60	1305.32
Exshaw Creek	KM 000	451.7	Bridge													
Exshaw Creek	KM 000	449	1304.10	1306.56	1306.43	1306.38	1306.33	1306.26	1306.14	1306.09	1306.02	1305.96	1305.86	1305.73	1305.57	1305.30
Exshaw Creek	KM 000	434	1304.51	1306.32	1306.25	1306.15	1306.03	1305.88	1305.72	1305.67	1305.60	1305.54	1305.46	1305.35	1305.24	1305.05
Exshaw Creek	KM 000	352	1300.98	1302.87	1302.81	1302.74	1302.74	1302.69	1302.59	1302.54	1302.47	1302.41	1302.31	1302.17	1302.04	1301.84
Exshaw Creek	KM 000	233	1295.90	1298.73	1298.36	1298.05	1297.83	1297.55	1297.29	1297.20	1297.09	1296.99	1296.86	1296.71	1296.56	1296.35
Exshaw Creek	KM 000	219	1295.21	1298.66	1298.28	1297.96	1297.73	1297.43	1297.13	1297.02	1296.89	1296.77	1296.61	1296.43	1296.26	1296.04
Exshaw Creek	KM 000	208	Bridge													
Exshaw Creek	KM 000	198	1294.75	1296.80	1296.73	1296.63	1296.53	1296.38	1296.21	1296.14	1296.04	1295.95	1295.82	1295.66	1295.51	1295.30
Exshaw Creek	KM 000	190	1294.43	1296.23	1296.14	1296.03	1295.94	1295.80	1295.64	1295.57	1295.51	1295.44	1295.36	1295.25	1295.14	1294.97
Exshaw Creek	KM 000	171	1293.04	1294.84	1294.74	1294.63	1294.54	1294.39	1294.23	1294.17	1294.08	1294.01	1293.90	1293.76	1293.64	1293.48
Exshaw Creek	KM 000	161	1291.92	1295.10	1294.92	1294.73	1294.57	1294.35	1294.08	1293.98	1293.83	1293.71	1293.52	1293.29	1293.06	1292.73
Exshaw Creek	KM 000	151.4	Bridge													
Exshaw Creek	KM 000	147	1291.91	1295.00	1294.86	1294.68	1294.53	1294.30	1294.03	1293.93	1293.79	1293.67	1293.48	1293.25	1293.02	1292.69
Exshaw Creek	KM 000	133	1291.95	1294.84	1294.70	1294.53	1294.38	1294.15	1293.90	1293.80	1293.66	1293.55	1293.37	1293.15	1292.93	1292.62
Exshaw Creek	KM 000	118	1291.69	1294.56	1294.43	1294.27	1294.13	1293.93	1293.69	1293.59	1293.47	1293.35	1293.19	1292.98	1292.78	1292.47
Exshaw Creek	KM 000	110.5	Bridge													
Exshaw Creek	KM 000	104	1291.67	1293.84	1293.77	1293.66	1293.58	1293.45	1293.27	1293.20	1293.10	1293.02	1292.88	1292.72	1292.55	1292.29
Exshaw Creek	KM 000	89	1291.20	1293.07	1292.99	1292.89	1292.79	1292.62	1292.47	1292.40	1292.31	1292.23	1292.12	1291.98	1291.83	1291.66
Jumpingpound Ck	KM 000	5294	1151.11	1156.92	1156.98	1156.56	1156.12	1155.55	1154.88	1154.62	1154.30	1154.07	1153.69	1153.23	1152.80	1152.21
Jumpingpound Ck	KM 000	5202	1150.51	1156.42	1155.61	1155.14	1154.88	1154.47	1154.07	1153.92	1153.76	1153.63	1153.28	1152.87	1152.47	1151.91
Jumpingpound Ck	KM 000	5101	1150.40	1155.89	1155.55	1155.07	1154.68	1154.07	1153.46	1153.22	1152.87	1152.57	1152.28	1151.94	1151.60	1151.22
Jumpingpound Ck	KM 000	4984	1147.73	1154.47	1154.32	1154.09	1153.78	1153.35	1152.85	1152.65	1152.35	1152.09	1151.65	1151.10	1150.57	1149.88
Jumpingpound Ck	KM 000	4882	1147.92	1153.78	1153.54	1153.26	1153.04	1152.69	1152.25	1152.06	1151.79	1151.56	1151.18	1150.70	1150.22	1149.59
Jumpingpound Ck	KM 000	4791	1147.78	1153.24	1153.14	1152.93	1152.70	1152.33	1151.91	1151.69	1151.42	1151.18	1150.86	1150.41	1149.95	1149.33
Jumpingpound Ck	KM 000	4648	1147.33	1152.47	1152.13	1151.84	1151.59	1151.22	1150.63	1150.47	1150.23	1150.04	1149.64	1149.21	1148.81	1148.32
Jumpingpound Ck	KM 000	4550	1146.37	1151.75	1151.53	1151.21	1150.91	1150.47	1150.09	1149.95	1149.72	1149.51	1149.22	1148.84	1148.44	1147.91
Jumpingpound Ck	KM 000	4463	1146.48	1151.70	1151.47	1151.16	1150.86	1150.39	1149.85	1149.63	1149.33	1149.07	1148.70	1148.29	1147.94	1147.51
Jumpingpound Ck	KM 000	4369	1145.51	1150.96	1150.80	1150.56	1150.33	1149.92	1149.49	1149.27	1148.96	1148.69	1148.30	1147.85	1147.44	1146.94
Jumpingpound Ck	KM 000	4277	1145.13	1150.17	1149.94	1149.65	1149.43	1149.07	1148.43	1148.22	1147.96	1147.77	1147.45	1147.11	1146.78	1146.35

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Jumpingpound Ck	KM 000	4168	1144.43	1150.18	1149.96	1149.65	1149.37	1148.99	1148.29	1148.02	1147.67	1147.39	1146.95	1146.47	1146.06	1145.56
Jumpingpound Ck	KM 000	4040	1143.71	1148.84	1148.65	1148.39	1148.13	1147.39	1147.04	1146.92	1146.72	1146.64	1146.19	1145.69	1145.26	1144.76
Jumpingpound Ck	KM 000	3915	1143.18	1148.13	1147.98	1147.78	1147.59	1147.29	1146.85	1146.64	1146.39	1146.28	1145.75	1145.19	1144.67	1144.05
Jumpingpound Ck	KM 000	3824	1141.95	1147.36	1147.24	1147.06	1146.91	1146.48	1145.98	1145.84	1145.56	1145.16	1144.88	1144.51	1144.13	1143.57
Jumpingpound Ck	KM 000	3672	1141.44	1147.02	1146.79	1146.46	1146.15	1145.71	1145.27	1145.10	1144.88	1144.69	1144.41	1144.05	1143.71	1143.25
Jumpingpound Ck	KM 000	3591	1142.11	1145.73	1145.53	1145.31	1145.12	1144.84	1144.53	1144.40	1144.23	1144.06	1143.78	1143.47	1143.16	1142.80
Jumpingpound Ck	KM 000	3503	1141.07	1145.33	1145.15	1144.90	1144.67	1144.32	1143.90	1143.75	1143.56	1143.42	1143.19	1142.94	1142.61	1142.16
Jumpingpound Ck	KM 000	3363	1140.02	1145.19	1144.99	1144.72	1144.47	1144.09	1143.57	1143.37	1143.10	1142.89	1142.57	1142.18	1141.81	1141.26
Jumpingpound Ck	KM 000	3202	1137.90	1143.92	1143.72	1143.44	1143.18	1142.82	1142.30	1142.10	1141.83	1141.60	1141.26	1140.86	1140.46	1139.90
Jumpingpound Ck	KM 000	3095	1138.21	1143.16	1142.96	1142.68	1142.43	1141.96	1141.43	1141.25	1141.01	1140.80	1140.48	1140.12	1139.77	1139.28
Jumpingpound Ck	KM 000	3006	1137.17	1142.55	1142.33	1142.02	1141.73	1141.30	1140.83	1140.65	1140.42	1140.19	1139.84	1139.46	1139.14	1138.84
Jumpingpound Ck	KM 000	2867	1136.77	1142.30	1142.07	1141.74	1141.43	1140.89	1140.28	1140.06	1139.76	1139.51	1139.15	1138.66	1138.17	1137.56
Jumpingpound Ck	KM 000	2745	1134.99	1141.45	1141.29	1140.97	1140.70	1140.39	1139.86	1139.64	1139.35	1139.11	1138.79	1138.33	1137.85	1137.20
Jumpingpound Ck	KM 000	2650	1135.15	1140.65	1140.43	1140.10	1139.87	1139.46	1139.11	1138.98	1138.80	1138.64	1138.48	1138.08	1137.65	1137.06
Jumpingpound Ck	KM 000	2557	1135.53	1139.64	1139.52	1139.35	1139.20	1138.95	1138.57	1138.48	1138.39	1138.28	1138.22	1137.87	1137.47	1136.93
Jumpingpound Ck	KM 000	2410	1135.35	1138.96	1138.80	1138.62	1138.46	1138.24	1137.99	1137.87	1137.69	1137.55	1137.26	1136.87	1136.59	1136.24
Jumpingpound Ck	KM 000	2301	1133.75	1138.46	1138.33	1138.19	1138.00	1137.73	1137.42	1137.31	1137.15	1136.88	1136.50	1136.07	1135.62	1135.04
Jumpingpound Ck	KM 000	2181	1133.18	1137.92	1137.75	1137.51	1137.29	1137.02	1136.72	1136.53	1136.20	1136.04	1135.73	1135.34	1134.97	1134.48
Jumpingpound Ck	KM 000	2081	1132.64	1137.80	1137.63	1137.39	1137.15	1136.78	1136.33	1136.17	1135.88	1135.66	1135.30	1134.87	1134.49	1134.02
Jumpingpound Ck	KM 000	1861	1130.75	1136.33	1136.14	1135.85	1135.60	1135.16	1134.61	1134.30	1134.03	1133.74	1133.37	1132.95	1132.56	1132.01
Jumpingpound Ck	KM 000	1733	1130.22	1136.07	1135.82	1135.49	1135.20	1134.77	1134.29	1134.10	1133.80	1133.54	1133.16	1132.76	1132.38	1131.87
Jumpingpound Ck	KM 000	1592	1130.60	1135.74	1135.50	1135.18	1134.89	1134.48	1134.02	1133.83	1133.51	1133.22	1132.77	1132.29	1131.87	1131.41
Jumpingpound Ck	KM 000	1455	1129.02	1134.89	1134.62	1134.25	1133.91	1133.43	1132.92	1132.71	1132.42	1132.20	1131.82	1131.35	1130.89	1130.28
Jumpingpound Ck	KM 000	1327	1128.41	1133.66	1133.52	1133.31	1133.13	1132.85	1132.33	1132.13	1131.85	1131.59	1131.22	1130.72	1130.27	1129.71
Jumpingpound Ck	KM 000	1224	1128.16	1133.12	1132.97	1132.72	1132.49	1131.94	1131.93	1131.74	1131.47	1131.22	1130.81	1130.28	1129.80	1129.18
Jumpingpound Ck	KM 000	1056	1127.01	1132.71	1132.51	1132.23	1131.96	1131.57	1131.01	1130.81	1130.55	1130.34	1130.07	1129.61	1129.17	1128.59
Jumpingpound Ck	KM 000	901	1126.67	1132.57	1132.36	1132.08	1131.81	1131.41	1130.65	1130.41	1129.97	1129.68	1129.22	1128.70	1128.23	1127.68
Jumpingpound Ck	KM 000	791	1125.66	1132.45	1132.24	1131.96	1131.67	1131.26	1130.52	1130.24	1129.17	1128.85	1128.39	1127.92	1127.45	1126.82
Jumpingpound Ck	KM 000	722	1125.47	1132.41	1132.21	1131.93	1131.65	1131.25	1130.51	1130.25	1129.28	1128.92	1128.39	1127.83	1127.30	1126.61
Jumpingpound Ck	KM 000	665	1125.01	1132.15	1131.94	1131.63	1131.31	1130.91	1130.29	1130.06	1129.07	1128.74	1128.25	1127.70	1127.17	1126.48
Jumpingpound Ck	KM 000	646.7	Bridge													
Jumpingpound Ck	KM 000	625	1124.93	1130.47	1130.31	1130.07	1129.84	1129.28	1128.93	1128.73	1128.47	1128.25	1127.84	1127.39	1126.93	1126.32
Jumpingpound Ck	KM 000	562	1124.81	1130.22	1130.03	1129.76	1129.49	1129.09	1128.76	1128.46	1128.20	1128.00	1127.56	1127.12	1126.71	1126.15
Jumpingpound Ck	KM 000	501	1124.78	1129.53	1129.38	1129.18	1129.01	1128.64	1127.91	1127.74	1127.50	1127.24	1127.05	1126.77	1126.49	1126.02
Jumpingpound Ck	KM 000	386	1124.13	1128.98	1128.72	1128.38	1128.10	1127.72	1127.34	1127.20	1127.02	1126.86	1126.64	1126.35	1126.01	1125.50
Jumpingpound Ck	KM 000	232	1123.21	1128.76	1128.47	1128.07	1127.74	1127.26	1126.76	1126.61	1126.46	1126.29	1125.99	1125.67	1125.26	1124.67
Jumpingpound Ck	KM 000	116	1122.94	1128.55	1128.24	1127.82	1127.46	1126.95	1126.27	1125.96	1125.58	1125.36	1125.09	1124.58	1124.17	1123.68
Policeman Ck	KM 000	6465	1312.84	1316.02	1316.00	1315.99	1315.97	1315.95	1315.92	1315.91	1315.90	1315.89	1315.86	1315.84	1315.80	1315.74
Policeman Ck	KM 000	6435	Inl Struct													
Policeman Ck	KM 000	6418	1312.25	1314.41	1314.27	1314.08	1313.96	1313.90	1313.76	1313.70	1313.61	1313.53	1313.42	1313.27	1313.11	1312.87
Policeman Ck	KM 000	6410	1312.21	1314.42	1314.28	1314.07	1313.94	1313.88	1313.73	1313.67	1313.59	1313.51	1313.40	1313.25	1313.10	1312.86
Policeman Ck	KM 000	6344	1312.17	1314.22	1314.11	1313.93	1313.81	1313.78	1313.64	1313.58	1313.50	1313.42	1313.31	1313.17	1313.02	1312.80
Policeman Ck	KM 000	6312	1312.18	1314.16	1314.05	1313.87	1313.76	1313.71	1313.57	1313.51	1313.43	1313.37	1313.26	1313.12	1312.97	1312.76

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Policeman Ck	KM 000	6227	1312.07	1313.91	1313.79	1313.62	1313.51	1313.49	1313.37	1313.31	1313.24	1313.18	1313.07	1312.94	1312.80	1312.58
Policeman Ck	KM 000	6126	1311.77	1313.64	1313.52	1313.36	1313.26	1313.22	1313.11	1313.07	1313.01	1312.95	1312.86	1312.73	1312.58	1312.29
Policeman Ck	KM 000	6075	1311.59	1313.37	1313.28	1313.15	1313.08	1313.05	1312.98	1312.94	1312.90	1312.86	1312.78	1312.67	1312.52	1312.20
Policeman Ck	KM 000	6023	1311.46	1313.21	1313.13	1313.02	1312.98	1312.93	1312.88	1312.86	1312.83	1312.79	1312.72	1312.62	1312.47	1312.13
Policeman Ck	KM 000	5960	1311.50	1313.01	1312.94	1312.87	1312.78	1312.82	1312.81	1312.79	1312.78	1312.74	1312.68	1312.58	1312.44	1312.08
Policeman Ck	KM 000	5954.5	Culvert													
Policeman Ck	KM 000	5946	1311.34	1313.04	1312.97	1312.84	1312.78	1312.70	1312.66	1312.64	1312.64	1312.54	1312.40	1312.24	1312.08	1311.92
Policeman Ck	KM 000	5877	1311.46	1312.96	1312.90	1312.79	1312.74	1312.69	1312.65	1312.63	1312.63	1312.54	1312.40	1312.22	1312.04	1311.76
Policeman Ck	KM 000	5782	1311.20	1312.93	1312.88	1312.77	1312.73	1312.68	1312.64	1312.63	1312.63	1312.54	1312.39	1312.22	1312.03	1311.75
Policeman Ck	KM 000	5719	1311.15	1312.88	1312.84	1312.75	1312.72	1312.67	1312.64	1312.62	1312.62	1312.53	1312.39	1312.21	1312.03	1311.75
Policeman Ck	KM 000	5673	1311.02	1312.80	1312.77	1312.71	1312.69	1312.64	1312.60	1312.57	1312.38	1312.29	1312.17	1312.03	1311.88	1311.65
Policeman Ck	KM 000	5668.8	Bridge													
Policeman Ck	KM 000	5666	1310.84	1312.79	1312.75	1312.69	1312.67	1312.60	1312.30	1312.23	1312.15	1312.08	1311.97	1311.85	1311.72	1311.52
Policeman Ck	KM 000	5651	1310.87	1312.75	1312.71	1312.66	1312.65	1312.50	1312.15	1312.05	1311.97	1311.90	1311.80	1311.68	1311.57	1311.42
Policeman Ck	KM 000	5648.3	Bridge													
Policeman Ck	KM 000	5646	1310.89	1312.66	1312.64	1312.61	1312.11	1312.02	1311.93	1311.89	1311.84	1311.80	1311.73	1311.64	1311.55	1311.41
Policeman Ck	KM 000	5599	1310.79	1312.20	1312.07	1311.91	1311.83	1311.74	1311.68	1311.66	1311.63	1311.60	1311.54	1311.50	1311.43	1311.11
Policeman Ck	KM 000	5531	1310.48	1312.14	1312.04	1311.90	1311.81	1311.72	1311.67	1311.64	1311.62	1311.59	1311.53	1311.50	1311.43	1311.10
Policeman Ck	KM 000	5468	1310.41	1312.07	1311.97	1311.85	1311.77	1311.69	1311.64	1311.62	1311.60	1311.58	1311.52	1311.49	1311.43	1311.09
Policeman Ck	KM 000	5364	1310.36	1311.95	1311.87	1311.77	1311.71	1311.65	1311.61	1311.59	1311.57	1311.56	1311.51	1311.48	1311.42	1311.08
Policeman Ck	KM 000	5257	1310.08	1311.86	1311.80	1311.72	1311.67	1311.62	1311.59	1311.58	1311.56	1311.55	1311.50	1311.48	1311.42	1311.08
Policeman Ck	KM 000	5252.1	Bridge													
Policeman Ck	KM 000	5248	1310.14	1311.83	1311.78	1311.70	1311.66	1311.61	1311.58	1311.57	1311.56	1311.54	1311.49	1311.47	1311.42	1311.08
Policeman Ck	KM 000	5163	1310.00	1311.80	1311.75	1311.69	1311.65	1311.60	1311.58	1311.57	1311.55	1311.54	1311.49	1311.47	1311.42	1311.08
Policeman Ck	KM 000	5110	1310.06	1311.78	1311.74	1311.68	1311.64	1311.60	1311.58	1311.57	1311.55	1311.54	1311.49	1311.47	1311.42	1311.08
Policeman Ck	KM 000	5103.4	Bridge													
Policeman Ck	KM 000	5101	1309.97	1311.77	1311.73	1311.67	1311.64	1311.59	1311.57	1311.56	1311.55	1311.54	1311.49	1311.47	1311.42	1311.08
Policeman Ck	KM 000	5023	1309.75	1311.71	1311.68	1311.64	1311.62	1311.58	1311.56	1311.55	1311.54	1311.53	1311.49	1311.47	1311.41	1311.08
Policeman Ck	KM 000	5002.6	Culvert													
Policeman Ck	KM 000	4985	1309.73	1311.46	1311.39	1311.26	1311.22	1311.15	1311.10	1311.09	1311.06	1311.04	1311.00	1310.99	1310.85	1310.48
Policeman Ck	KM 000	4936	1309.60	1311.22	1311.16	1311.14	1311.04	1311.00	1311.00	1310.97	1310.97	1310.94	1310.94	1310.96	1310.81	1310.42
Policeman Ck	KM 000	4923.7	Culvert													
Policeman Ck	KM 000	4907	1309.28	1311.14	1311.09	1310.92	1310.87	1310.82	1310.77	1310.73	1310.66	1310.61	1310.50	1310.35	1310.19	1309.93
Policeman Ck	KM 000	4880	1309.24	1310.97	1310.89	1310.81	1310.76	1310.64	1310.51	1310.48	1310.45	1310.43	1310.34	1310.22	1310.08	1309.86
Policeman Ck	KM 000	4855	1309.19	1310.68	1310.63	1310.55	1310.49	1310.45	1310.42	1310.41	1310.36	1310.37	1310.16	1309.96	1309.90	1309.74
Policeman Ck	KM 000	4854	Bridge													
Policeman Ck	KM 000	4852	1309.16	1310.59	1310.51	1310.48	1310.34	1310.25	1310.20	1310.18	1310.13	1310.06	1309.99	1309.88	1309.86	1309.72
Policeman Ck	KM 000	4796	1308.87	1310.58	1310.52	1310.41	1310.34	1310.18	1310.08	1310.04	1309.99	1309.95	1309.88	1309.80	1309.72	1309.59
Policeman Ck	KM 000	4726	1308.86	1310.55	1310.48	1310.38	1310.31	1310.15	1310.05	1310.01	1309.95	1309.91	1309.83	1309.75	1309.66	1309.52
Policeman Ck	KM 000	4720	1308.96	1310.53	1310.47	1310.37	1310.29	1310.12	1310.01	1309.98	1309.93	1309.88	1309.81	1309.73	1309.64	1309.51
Policeman Ck	KM 000	4716.9	Bridge													
Policeman Ck	KM 000	4714	1308.96	1310.51	1310.44	1310.33	1310.24	1310.09	1310.00	1309.96	1309.91	1309.86	1309.79	1309.71	1309.63	1309.50
Policeman Ck	KM 000	4675	1308.93	1310.42	1310.36	1310.27	1310.19	1310.04	1309.95	1309.91	1309.86	1309.81	1309.74	1309.66	1309.57	1309.44

River	HEC-RAS Model Sub-Reach	River Station (m)	Channel Thalweg Elevation (m)	Computed Water Surface Elevation (m)												
				1000-Year	750-Year	500-Year	350-Year	200-Year	100-Year	75-Year	50-Year	35-Year	20-Year	10-Year	5-Year	2-Year
Policeman Ck	KM 000	4603	1308.97	1310.18	1310.11	1310.02	1309.94	1309.81	1309.72	1309.68	1309.63	1309.59	1309.53	1309.45	1309.37	1309.24
Policeman Ck	KM 000	4544	1308.55	1310.09	1309.87	1309.77	1309.68	1309.56	1309.47	1309.44	1309.38	1309.34	1309.27	1309.18	1309.10	1308.95
Policeman Ck	KM 000	4463	1308.21	1310.08	1309.84	1309.39	1309.31	1309.17	1309.08	1309.04	1308.99	1308.95	1308.89	1308.82	1308.75	1308.64
Policeman Ck	KM 000	4380	1307.92	1310.07	1309.83	1309.28	1309.10	1308.93	1308.81	1308.77	1308.71	1308.66	1308.59	1308.50	1308.41	1308.29
Policeman Ck	KM 000	4337	1307.91	1310.07	1309.83	1309.25	1309.07	1308.89	1308.78	1308.73	1308.67	1308.62	1308.54	1308.45	1308.36	1308.22
Policeman Ck	KM 000	4328.9	Mult Open													
Policeman Ck	KM 000	4320	1307.77	1309.37	1309.23	1309.06	1308.87	1308.72	1308.62	1308.59	1308.54	1308.50	1308.44	1308.36	1308.28	1308.16
Policeman Ck	KM 000	4220	1307.72	1309.34	1309.20	1309.01	1308.79	1308.61	1308.50	1308.46	1308.40	1308.36	1308.29	1308.21	1308.14	1308.02
Policeman Ck	KM 000	4184	1307.69	1309.33	1309.19	1309.00	1308.77	1308.58	1308.47	1308.42	1308.37	1308.32	1308.25	1308.17	1308.10	1307.97
Policeman Ck	KM 000	4030	1307.28	1309.29	1309.14	1308.94	1308.68	1308.46	1308.32	1308.27	1308.20	1308.15	1308.07	1307.99	1307.91	1307.79
Policeman Ck	KM 000	3921	1307.29	1309.26	1309.11	1308.91	1308.63	1308.39	1308.24	1308.19	1308.11	1308.05	1307.96	1307.85	1307.75	1307.62
Policeman Ck	KM 000	3888	1307.13	1309.21	1309.06	1308.87	1308.56	1308.33	1308.18	1308.12	1308.05	1307.99	1307.89	1307.79	1307.68	1307.54
Policeman Ck	KM 000	3875.5	Bridge													
Policeman Ck	KM 000	3862	1307.09	1308.82	1308.77	1308.66	1308.37	1308.15	1308.00	1307.94	1307.87	1307.81	1307.72	1307.61	1307.51	1307.36
Policeman Ck	KM 000	3835	1306.73	1308.87	1308.80	1308.68	1308.40	1308.16	1308.01	1307.96	1307.88	1307.82	1307.73	1307.62	1307.51	1307.36
Policeman Ck	KM 000	3784	1307	1308.85	1308.78	1308.67	1308.39	1308.15	1308.00	1307.95	1307.87	1307.81	1307.72	1307.61	1307.50	1307.34
Policeman Ck	KM 000	3713	1306.94	1308.80	1308.74	1308.64	1308.33	1308.10	1307.95	1307.90	1307.82	1307.76	1307.67	1307.57	1307.46	1307.30
Policeman Ck	KM 000	3698.7	Bridge													
Policeman Ck	KM 000	3685	1306.66	1308.32	1308.21	1308.03	1307.86	1307.65	1307.53	1307.51	1307.49	1307.48	1307.45	1307.41	1307.35	1307.21
Policeman Ck	KM 000	3527	1306.59	1308.30	1308.20	1308.02	1307.84	1307.61	1307.40	1307.31	1307.24	1307.18	1307.10	1307.00	1306.90	1306.79
Policeman Ck	KM 000	3354	1306.18	1308.25	1308.15	1307.98	1307.82	1307.58	1307.36	1307.27	1307.19	1307.12	1307.03	1306.92	1306.82	1306.68
Policeman Ck	KM 000	3191	1306.01	1308.22	1308.12	1307.95	1307.79	1307.56	1307.34	1307.24	1307.16	1307.10	1307.00	1306.89	1306.79	1306.66
Policeman Ck	KM 000	3154	1306.29	1308.20	1308.10	1307.94	1307.78	1307.54	1307.31	1307.22	1307.14	1307.07	1306.97	1306.86	1306.76	1306.64
Policeman Ck	KM 000	3147.6	Bridge													
Policeman Ck	KM 000	3141	1306.32	1308.18	1308.08	1307.91	1307.75	1307.51	1307.29	1307.20	1307.12	1307.05	1306.95	1306.83	1306.72	1306.60
Policeman Ck	KM 000	3002	1305.82	1308.09	1307.97	1307.78	1307.61	1307.37	1307.14	1307.05	1306.96	1306.88	1306.75	1306.60	1306.45	1306.23
Policeman Ck	KM 000	2822	1305.06	1307.92	1307.79	1307.58	1307.44	1307.21	1306.99	1306.91	1306.84	1306.76	1306.63	1306.50	1306.37	1306.19
Policeman Ck	KM 000	2804	1305.24	1307.85	1307.72	1307.54	1307.41	1307.19	1306.96	1306.88	1306.81	1306.73	1306.61	1306.48	1306.36	1306.18
Policeman Ck	KM 000	2791.3	Bridge													
Policeman Ck	KM 000	2782	1305.70	1307.74	1307.63	1307.47	1307.38	1307.17	1306.95	1306.87	1306.80	1306.72	1306.60	1306.46	1306.34	1306.17
Policeman Ck	KM 000	2666	1305.58	1307.67	1307.53	1307.31	1307.14	1306.84	1306.67	1306.64	1306.59	1306.50	1306.36	1306.21	1306.07	1305.91
Policeman Ck	KM 000	2518	1305.08	1307.62	1307.47	1307.24	1307.05	1306.79	1306.54	1306.56	1306.50	1306.36	1306.15	1305.99	1305.81	1305.54
Policeman Ck	KM 000	2394	1304.63	1307.60	1307.45	1307.22	1307.03	1306.77	1306.50	1306.34	1306.37	1306.24	1306.05	1305.89	1305.72	1305.42
Policeman Ck	KM 000	2306	1304.71	1307.59	1307.44	1307.21	1307.02	1306.76	1306.49	1306.39	1306.37	1306.24	1306.05	1305.88	1305.70	1305.38
Policeman Ck	KM 000	2128	1304.07	1307.06	1306.95	1306.78	1306.63	1306.43	1306.25	1306.18	1306.10	1306.02	1305.90	1305.76	1305.59	1305.30
Policeman Ck	KM 000	1771	1303.82	1306.84	1306.74	1306.60	1306.49	1306.34	1306.19	1306.13	1306.06	1305.99	1305.88	1305.74	1305.57	1305.29
Policeman Ck	KM 000	1560	1303.17	1306.72	1306.65	1306.54	1306.44	1306.32	1306.18	1306.13	1306.05	1305.99	1305.88	1305.73	1305.57	1305.28
Policeman Ck	KM 000	1552.3	Bridge													
Policeman Ck	KM 000	1544	1303.07	1306.70	1306.63	1306.53	1306.43	1306.31	1306.18	1306.12	1306.05	1305.99	1305.88	1305.73	1305.57	1305.28
Policeman Ck	KM 000	1373	1303.99	1306.64	1306.58	1306.49	1306.41	1306.30	1306.18	1306.12	1306.05	1305.99	1305.88	1305.73	1305.57	1305.28

Table B-6 Sensitivity analysis flood levels

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 112	118148	1326.99	1326.99	1326.99	0	0	1326.82	1327.13	-0.17	0.14	1326.93	1327.04	-0.06	0.05
Bow River	KM 112	117852	1326.12	1326.12	1326.12	0	0	1325.96	1326.25	-0.16	0.13	1326.03	1326.22	-0.09	0.10
Bow River	KM 112	117547	1325.65	1325.65	1325.65	0	0	1325.58	1325.71	-0.07	0.06	1325.52	1325.77	-0.13	0.12
Bow River	KM 112	117241	1325.15	1325.15	1325.15	0	0	1325.13	1325.19	-0.02	0.04	1325.03	1325.27	-0.12	0.12
Bow River	KM 112	116670	1323.52	1323.52	1323.52	0	0	1323.39	1323.62	-0.13	0.10	1323.44	1323.59	-0.08	0.07
Bow River	KM 112	116188	1322.50	1322.50	1322.50	0	0	1322.40	1322.58	-0.10	0.08	1322.44	1322.55	-0.06	0.05
Bow River	KM 112	115644	1321.47	1321.47	1321.47	0	0	1321.38	1321.53	-0.09	0.06	1321.41	1321.51	-0.06	0.04
Bow River	KM 112	115415	1320.69	1320.69	1320.69	0	0	1320.61	1320.75	-0.08	0.06	1320.63	1320.74	-0.06	0.05
Bow River	KM 112	115134	1320.04	1320.04	1320.04	0	0	1319.98	1320.09	-0.06	0.05	1319.99	1320.09	-0.05	0.05
Bow River	KM 112	114700	1319.24	1319.24	1319.24	0	0	1319.17	1319.31	-0.07	0.07	1319.15	1319.31	-0.09	0.07
Bow River	KM 112	114258	1318.66	1318.66	1318.66	0	0	1318.66	1318.68	0	0.02	1318.57	1318.74	-0.09	0.08
Bow River	KM 112	113821	1317.75	1317.75	1317.75	0	0	1317.64	1317.82	-0.11	0.07	1317.67	1317.82	-0.08	0.07
Bow River	KM 112	113472	1317.04	1317.04	1317.04	0	0	1316.97	1317.09	-0.07	0.05	1316.96	1317.10	-0.08	0.06
Bow River	KM 112	113065	1316.28	1316.28	1316.28	0	0	1316.21	1316.34	-0.07	0.06	1316.17	1316.39	-0.11	0.11
Bow River	KM 112	112898	1316.09	1316.09	1316.09	0	0	1316.05	1316.12	-0.04	0.03	1315.96	1316.20	-0.13	0.11
Bow River	KM 112	112726	1315.88	1315.88	1315.88	0	0	1315.84	1315.91	-0.04	0.03	1315.76	1315.99	-0.12	0.11
Bow River	KM 112	112580	1315.62	1315.62	1315.62	0	0	1315.56	1315.66	-0.06	0.04	1315.50	1315.73	-0.12	0.11
Bow River	KM 106	112416	1315.35	1315.35	1315.35	0	0	1315.29	1315.41	-0.06	0.06	1315.22	1315.48	-0.13	0.13
Bow River	KM 106	112279	1315.20	1315.20	1315.20	0	0	1315.15	1315.25	-0.05	0.05	1315.07	1315.33	-0.13	0.13
Bow River	KM 106	112071	1314.94	1314.94	1314.94	0	0	1314.87	1315.00	-0.07	0.06	1314.81	1315.05	-0.13	0.11
Bow River	KM 106	111915	1314.73	1314.73	1314.73	0	0	1314.67	1314.79	-0.06	0.06	1314.59	1314.85	-0.14	0.12
Bow River	KM 106	111823	1314.61	1314.61	1314.61	0	0	1314.56	1314.66	-0.05	0.05	1314.46	1314.75	-0.15	0.14
Bow River	KM 106	111706	1314.51	1314.51	1314.51	0	0	1314.48	1314.54	-0.03	0.03	1314.35	1314.66	-0.16	0.15
Bow River	KM 106	111305	1313.83	1313.83	1313.83	0	0	1313.77	1313.90	-0.06	0.07	1313.70	1313.95	-0.13	0.12
Bow River	KM 106	111132	1313.49	1313.49	1313.49	0	0	1313.43	1313.56	-0.06	0.07	1313.38	1313.58	-0.11	0.09
Bow River	KM 106	110887	1312.84	1312.84	1312.84	0	0	1312.67	1312.98	-0.17	0.14	1312.76	1312.91	-0.08	0.07
Bow River	KM 106	110734	1312.61	1312.61	1312.61	0	0	1312.51	1312.71	-0.10	0.10	1312.51	1312.70	-0.10	0.09
Bow River	KM 106	110352	1312.11	1312.11	1312.11	0	0	1312.00	1312.24	-0.11	0.13	1312.06	1312.17	-0.05	0.06
Bow River	KM 106	110148	1311.93	1311.93	1311.93	0	0	1311.80	1312.06	-0.13	0.13	1311.90	1311.95	-0.03	0.02
Bow River	KM 106	109981	1311.67	1311.67	1311.67	0	0	1311.49	1311.83	-0.18	0.16	1311.67	1311.67	0	0
Bow River	KM 106	109938	1311.69	1311.69	1311.69	0	0	1311.53	1311.84	-0.16	0.15	1311.68	1311.69	-0.01	0
Bow River	KM 106	109921	1311.51	1311.51	1311.51	0	0	1311.33	1311.72	-0.18	0.21	1311.49	1311.52	-0.02	0.01
Bow River	KM 106	109727	1311.40	1311.40	1311.40	0	0	1311.22	1311.60	-0.18	0.20	1311.38	1311.41	-0.02	0.01
Bow River	KM 106	109501	1311.09	1311.09	1311.09	0	0	1310.93	1311.30	-0.16	0.21	1311.09	1311.10	0	0.01

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 106	109366	1310.81	1310.81	1310.81	0	0	1310.63	1311.01	-0.18	0.20	1310.79	1310.81	-0.02	0
Bow River	KM 106	109235	1310.43	1310.43	1310.43	0	0	1310.27	1310.64	-0.16	0.21	1310.43	1310.44	0	0.01
Bow River	KM 106	109202	1310.34	1310.34	1310.34	0	0	1310.17	1310.54	-0.17	0.20	1310.33	1310.34	-0.01	0
Bow River	KM 106	109114	1310.02	1310.02	1310.02	0	0	1309.84	1310.23	-0.18	0.21	1310.02	1310.02	0	0
Bow River	KM 106	108998	1309.58	1309.58	1309.58	0	0	1309.40	1309.80	-0.18	0.22	1309.57	1309.60	-0.01	0.02
Bow River	KM 106	108757	1309.23	1309.23	1309.23	0	0	1309.08	1309.39	-0.15	0.16	1309.19	1309.27	-0.04	0.04
Bow River	KM 106	108586	1308.91	1308.91	1308.91	0	0	1308.78	1309.04	-0.13	0.13	1308.85	1308.96	-0.06	0.05
Bow River	KM 106	108458	1308.73	1308.73	1308.73	0	0	1308.62	1308.85	-0.11	0.12	1308.65	1308.80	-0.08	0.07
Bow River	KM 106	108052	1308.36	1308.36	1308.36	0	0	1308.26	1308.47	-0.10	0.11	1308.29	1308.42	-0.07	0.06
Bow River	KM 106	107747	1307.78	1307.78	1307.78	0	0	1307.63	1307.93	-0.15	0.15	1307.73	1307.82	-0.05	0.04
Bow River	KM 106	107333	1307.09	1307.09	1307.09	0	0	1306.97	1307.21	-0.12	0.12	1307.05	1307.12	-0.04	0.03
Bow River	KM 106	107113	1306.92	1306.92	1306.92	0	0	1306.86	1306.98	-0.06	0.06	1306.89	1306.95	-0.03	0.03
Bow River	KM 106	106702	1305.56	1305.56	1305.56	0	0	1305.42	1305.80	-0.14	0.24	1305.54	1305.60	-0.02	0.04
Bow River	KM 087	106497	1305.42	1305.42	1305.42	0	0	1305.27	1305.56	-0.15	0.14	1305.31	1305.52	-0.11	0.10
Bow River	KM 087	106143	1305.16	1305.16	1305.16	0	0	1305.06	1305.26	-0.10	0.10	1305.03	1305.28	-0.13	0.12
Bow River	KM 087	105995	1304.99	1304.99	1304.99	0	0	1304.89	1305.09	-0.10	0.10	1304.86	1305.12	-0.13	0.13
Bow River	KM 087	105742	1304.79	1304.79	1304.79	0	0	1304.71	1304.88	-0.08	0.09	1304.65	1304.93	-0.14	0.14
Bow River	KM 087	105620	1304.61	1304.61	1304.61	0	0	1304.52	1304.70	-0.09	0.09	1304.45	1304.76	-0.16	0.15
Bow River	KM 087	105224	1304.34	1304.34	1304.34	0	0	1304.27	1304.41	-0.07	0.07	1304.18	1304.49	-0.16	0.15
Bow River	KM 087	104790	1303.73	1303.73	1303.73	0	0	1303.61	1303.86	-0.12	0.13	1303.63	1303.82	-0.10	0.09
Bow River	KM 087	104631	1303.21	1303.21	1303.21	0	0	1303.09	1303.36	-0.12	0.15	1303.12	1303.30	-0.09	0.09
Bow River	KM 087	104575	1303.04	1303.04	1303.04	0	0	1302.94	1303.15	-0.10	0.11	1302.96	1303.12	-0.08	0.08
Bow River	KM 087	104490	1302.60	1302.60	1302.60	0	0	1302.51	1302.70	-0.09	0.10	1302.48	1302.72	-0.12	0.12
Bow River	KM 087	104338	1302.30	1302.30	1302.30	0	0	1302.24	1302.36	-0.06	0.06	1302.17	1302.41	-0.13	0.11
Bow River	KM 087	104163	1301.67	1301.67	1301.67	0	0	1301.63	1301.71	-0.04	0.04	1301.58	1301.75	-0.09	0.08
Bow River	KM 087	103697	1300.12	1300.12	1300.12	0	0	1300.02	1300.19	-0.10	0.07	1300.07	1300.15	-0.05	0.03
Bow River	KM 087	103126	1299.16	1299.16	1299.16	0	0	1299.08	1299.22	-0.08	0.06	1299.11	1299.19	-0.05	0.03
Bow River	KM 087	102497	1298.09	1298.09	1298.09	0	0	1297.99	1298.17	-0.10	0.08	1298.05	1298.13	-0.04	0.04
Bow River	KM 087	101706	1297.29	1297.29	1297.29	0	0	1297.20	1297.36	-0.09	0.07	1297.24	1297.33	-0.05	0.04
Bow River	KM 087	101260	1296.55	1296.55	1296.55	0	0	1296.44	1296.62	-0.11	0.07	1296.48	1296.60	-0.07	0.05
Bow River	KM 087	100785	1295.95	1295.95	1295.95	0	0	1295.89	1295.99	-0.06	0.04	1295.86	1296.02	-0.09	0.07
Bow River	KM 087	100276	1295.47	1295.47	1295.47	0	0	1295.41	1295.53	-0.06	0.06	1295.38	1295.56	-0.09	0.09
Bow River	KM 087	99728	1295.01	1295.01	1295.01	0	0	1294.90	1295.10	-0.11	0.09	1294.90	1295.11	-0.11	0.10
Bow River	KM 087	99027	1294.83	1294.83	1294.83	0	0	1294.73	1294.92	-0.10	0.09	1294.70	1294.93	-0.13	0.10
Bow River	KM 087	98134	1294.60	1294.60	1294.60	0	0	1294.48	1294.70	-0.12	0.10	1294.48	1294.70	-0.12	0.10
Bow River	KM 087	97769	1294.50	1294.50	1294.50	0	0	1294.39	1294.61	-0.11	0.11	1294.38	1294.60	-0.12	0.10

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 087	97378	1294.30	1294.30	1294.30	0	0	1294.17	1294.42	-0.13	0.12	1294.20	1294.38	-0.10	0.08
Bow River	KM 087	97076	1294.18	1294.18	1294.18	0	0	1294.06	1294.30	-0.12	0.12	1294.08	1294.27	-0.10	0.09
Bow River	KM 087	96451	1294.08	1294.08	1294.08	0	0	1293.98	1294.19	-0.10	0.11	1293.99	1294.16	-0.09	0.08
Bow River	KM 087	94012	1294.00	1294.00	1294.00	0	0	1293.89	1294.11	-0.11	0.11	1293.92	1294.07	-0.08	0.07
Bow River	KM 087	93591	1293.98	1293.98	1293.98	0	0	1293.88	1294.10	-0.10	0.12	1293.91	1294.05	-0.07	0.07
Bow River	KM 087	93261	1293.98	1293.98	1293.98	0	0	1293.88	1294.10	-0.10	0.12	1293.91	1294.05	-0.07	0.07
Bow River	KM 087	92667	1293.96	1293.96	1293.96	0	0	1293.86	1294.08	-0.10	0.12	1293.89	1294.02	-0.07	0.06
Bow River	KM 087	92367	1293.90	1293.90	1293.90	0	0	1293.80	1294.02	-0.10	0.12	1293.84	1293.96	-0.06	0.06
Bow River	KM 087	92095	1293.82	1293.82	1293.82	0	0	1293.73	1293.94	-0.09	0.12	1293.77	1293.88	-0.05	0.06
Bow River	KM 087	91818	1293.78	1293.78	1293.78	0	0	1293.69	1293.89	-0.09	0.11	1293.73	1293.83	-0.05	0.05
Bow River	KM 087	91466	1293.75	1293.75	1293.75	0	0	1293.67	1293.86	-0.08	0.11	1293.71	1293.80	-0.04	0.05
Bow River	KM 087	91102	1293.73	1293.73	1293.73	0	0	1293.65	1293.84	-0.08	0.11	1293.69	1293.78	-0.04	0.05
Bow River	KM 087	90778	1293.72	1293.72	1293.72	0	0	1293.64	1293.82	-0.08	0.10	1293.68	1293.76	-0.04	0.04
Bow River	KM 087	90350	1293.71	1293.71	1293.71	0	0	1293.63	1293.81	-0.08	0.10	1293.67	1293.74	-0.04	0.03
Bow River	KM 087	89770	1293.69	1293.69	1293.69	0	0	1293.61	1293.80	-0.08	0.11	1293.66	1293.72	-0.03	0.03
Bow River	KM 087	89451	1293.67	1293.67	1293.67	0	0	1293.59	1293.78	-0.08	0.11	1293.64	1293.70	-0.03	0.03
Bow River	KM 087	89200	1293.65	1293.65	1293.65	0	0	1293.57	1293.76	-0.08	0.11	1293.63	1293.68	-0.02	0.03
Bow River	KM 087	88802	1293.63	1293.63	1293.63	0	0	1293.54	1293.74	-0.09	0.11	1293.61	1293.65	-0.02	0.02
Bow River	KM 087	88345	1293.60	1293.60	1293.60	0	0	1293.51	1293.71	-0.09	0.11	1293.58	1293.61	-0.02	0.01
Bow River	KM 087	88021	1293.57	1293.57	1293.57	0	0	1293.48	1293.68	-0.09	0.11	1293.56	1293.58	-0.01	0.01
Bow River	KM 087	87652	1293.55	1293.55	1293.55	0	0	1293.47	1293.66	-0.08	0.11	1293.54	1293.56	-0.01	0.01
Bow River	KM 087	87519	1293.54	1293.54	1293.54	0	0	1293.46	1293.65	-0.08	0.11	1293.53	1293.55	-0.01	0.01
Bow River	KM 087	87122	1292.38	1292.38	1292.38	0	0	1292.09	1292.63	-0.29	0.25	1292.36	1292.40	-0.02	0.02
Bow River	KM 087	86899	1291.65	1291.65	1291.65	0	0	1291.49	1291.79	-0.16	0.14	1291.60	1291.69	-0.05	0.04
Bow River	KM 025	86717	1291.06	1291.06	1291.06	0	0	1290.94	1291.16	-0.12	0.10	1290.98	1291.14	-0.08	0.08
Bow River	KM 025	86352	1290.02	1290.02	1290.02	0	0	1289.99	1290.02	-0.03	0	1289.88	1290.14	-0.14	0.12
Bow River	KM 025	86209	1288.68	1288.68	1288.68	0	0	1288.69	1288.80	0.01	0.12	1288.66	1288.74	-0.02	0.06
Bow River	KM 025	85929	1288.17	1288.17	1288.17	0	0	1288.07	1288.25	-0.10	0.08	1288.00	1288.34	-0.17	0.17
Bow River	KM 025	85513	1288.02	1288.02	1288.02	0	0	1287.95	1288.08	-0.07	0.06	1287.80	1288.22	-0.22	0.20
Bow River	KM 025	85060	1287.83	1287.83	1287.83	0	0	1287.78	1287.88	-0.05	0.05	1287.59	1288.06	-0.24	0.23
Bow River	KM 025	84733	1287.39	1287.39	1287.39	0	0	1287.34	1287.44	-0.05	0.05	1287.15	1287.62	-0.24	0.23
Bow River	KM 025	84602	1287.01	1287.01	1287.01	0	0	1286.96	1287.06	-0.05	0.05	1286.76	1287.24	-0.25	0.23
Bow River	KM 025	84367	1286.32	1286.32	1286.32	0	0	1286.28	1286.38	-0.04	0.06	1286.09	1286.54	-0.23	0.22
Bow River	KM 025	84072	1285.80	1285.80	1285.80	0	0	1285.74	1285.88	-0.06	0.08	1285.60	1285.98	-0.20	0.18
Bow River	KM 025	83674	1285.26	1285.26	1285.26	0	0	1285.17	1285.40	-0.09	0.14	1285.10	1285.39	-0.16	0.13
Bow River	KM 025	83328	1284.71	1284.71	1284.72	0	0.01	1284.49	1284.90	-0.22	0.19	1284.62	1284.79	-0.09	0.08

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 025	82904	1284.33	1284.33	1284.34	0	0.01	1284.13	1284.51	-0.20	0.18	1284.25	1284.41	-0.08	0.08
Bow River	KM 025	82575	1284.19	1284.19	1284.21	0	0.02	1284.01	1284.36	-0.18	0.17	1284.11	1284.27	-0.08	0.08
Bow River	KM 025	82081	1283.73	1283.73	1283.76	0	0.03	1283.50	1283.94	-0.23	0.21	1283.69	1283.78	-0.04	0.05
Bow River	KM 025	81556	1283.41	1283.40	1283.45	-0.01	0.04	1283.19	1283.62	-0.22	0.21	1283.39	1283.43	-0.02	0.02
Bow River	KM 025	81162	1283.20	1283.19	1283.24	-0.01	0.04	1283.00	1283.40	-0.20	0.20	1283.18	1283.23	-0.02	0.03
Bow River	KM 025	80811	1283.07	1283.07	1283.12	0	0.05	1282.89	1283.25	-0.18	0.18	1283.05	1283.10	-0.02	0.03
Bow River	KM 025	80511	1282.92	1282.91	1282.98	-0.01	0.06	1282.75	1283.09	-0.17	0.17	1282.90	1282.94	-0.02	0.02
Bow River	KM 025	80146	1282.50	1282.48	1282.60	-0.02	0.10	1282.31	1282.68	-0.19	0.18	1282.49	1282.51	-0.01	0.01
Bow River	KM 025	79719	1281.71	1281.64	1282.00	-0.07	0.29	1281.53	1281.90	-0.18	0.19	1281.71	1281.72	0	0.01
Bow River	KM 025	79688	1281.60	1281.51	1281.93	-0.09	0.33	1281.41	1281.80	-0.19	0.20	1281.60	1281.61	0	0.01
Bow River	KM 025	79662	1281.48	1281.36	1281.85	-0.12	0.37	1281.26	1281.69	-0.22	0.21	1281.48	1281.48	0	0
Bow River	KM 025	79598	1281.34	1281.18	1281.78	-0.16	0.44	1281.12	1281.55	-0.22	0.21	1281.34	1281.34	0	0
Bow River	KM 025	79245	1281.04	1280.75	1281.62	-0.29	0.58	1280.88	1281.19	-0.16	0.15	1281.03	1281.04	-0.01	0
Bow River	KM 025	78845	1280.91	1280.56	1281.55	-0.35	0.64	1280.78	1281.04	-0.13	0.13	1280.91	1280.91	0	0
Bow River	KM 025	78451	1280.79	1280.38	1281.48	-0.41	0.69	1280.68	1280.89	-0.11	0.10	1280.79	1280.79	0	0
Bow River	KM 025	78039	1280.65	1280.13	1281.42	-0.52	0.77	1280.57	1280.73	-0.08	0.08	1280.65	1280.65	0	0
Bow River	KM 025	77716	1280.38	1279.65	1281.29	-0.73	0.91	1280.34	1280.43	-0.04	0.05	1280.38	1280.38	0	0
Bow River	KM 025	77654	1280.31	1279.51	1281.24	-0.80	0.93	1280.28	1280.34	-0.03	0.03	1280.31	1280.31	0	0
Bow River	KM 025	77609	1280.30	1279.48	1281.24	-0.82	0.94	1280.28	1280.32	-0.02	0.02	1280.30	1280.30	0	0
Bow River	KM 025	77494	1280.20	1279.20	1281.20	-1.00	1.00	1280.20	1280.20	0	0	1280.20	1280.20	0	0
Bow River	KM 025	77488	1265.68	1265.68	1265.68	0	0	1265.68	1265.68	0	0	1265.68	1265.68	0	0
Bow River	KM 025	76811	1259.41	1259.27	1259.70	-0.14	0.29	1259.10	1259.71	-0.31	0.30	1259.41	1259.42	0	0.01
Bow River	KM 025	76468	1259.10	1258.90	1259.46	-0.20	0.36	1258.79	1259.38	-0.31	0.28	1259.10	1259.10	0	0
Bow River	KM 025	76158	1258.88	1258.62	1259.31	-0.26	0.43	1258.60	1259.15	-0.28	0.27	1258.88	1258.88	0	0
Bow River	KM 025	75774	1258.70	1258.39	1259.19	-0.31	0.49	1258.45	1258.95	-0.25	0.25	1258.70	1258.70	0	0
Bow River	KM 025	75465	1257.85	1257.39	1258.50	-0.46	0.65	1257.59	1258.11	-0.26	0.26	1257.85	1257.85	0	0
Bow River	KM 025	75281	1257.94	1257.44	1258.61	-0.50	0.67	1257.73	1258.14	-0.21	0.20	1257.94	1257.94	0	0
Bow River	KM 025	75120	1257.72	1257.19	1258.42	-0.53	0.70	1257.54	1257.90	-0.18	0.18	1257.72	1257.72	0	0
Bow River	KM 025	74927	1257.63	1256.96	1258.42	-0.67	0.79	1257.48	1257.79	-0.15	0.16	1257.63	1257.63	0	0
Bow River	KM 025	74746	1257.43	1256.70	1258.26	-0.73	0.83	1257.32	1257.54	-0.11	0.11	1257.43	1257.43	0	0
Bow River	KM 025	74376	1257.35	1256.49	1258.26	-0.86	0.91	1257.29	1257.41	-0.06	0.06	1257.35	1257.35	0	0
Bow River	KM 025	74053	1257.11	1256.16	1258.09	-0.95	0.98	1257.09	1257.13	-0.02	0.02	1257.11	1257.11	0	0
Bow River	KM 025	73903	1257.10	1256.10	1258.10	-1.00	1.00	1257.09	1257.10	-0.01	0	1257.10	1257.10	0	0
Bow River	KM 025	73863	1257.10	1256.10	1258.10	-1.00	1.00	1257.10	1257.10	0	0	1257.10	1257.10	0	0
Bow River	KM 025	73845	1240.77	1240.77	1240.77	0	0	1240.77	1240.77	0	0	1240.77	1240.77	0	0
Bow River	KM 025	73571	1238.27	1238.27	1238.27	0	0	1238.08	1238.44	-0.19	0.17	1238.22	1238.31	-0.05	0.04

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 025	73410	1237.01	1237.01	1237.01	0	0	1236.79	1237.38	-0.22	0.37	1237.02	1237.01	0.01	0
Bow River	KM 025	73134	1236.27	1236.27	1236.27	0	0	1236.00	1236.52	-0.27	0.25	1236.21	1236.32	-0.06	0.05
Bow River	KM 025	72680	1234.93	1234.93	1234.93	0	0	1234.65	1235.19	-0.28	0.26	1234.87	1234.98	-0.06	0.05
Bow River	KM 025	72441	1234.24	1234.24	1234.24	0	0	1233.93	1234.53	-0.31	0.29	1234.22	1234.25	-0.02	0.01
Bow River	KM 025	71892	1229.43	1229.43	1229.43	0	0	1228.90	1229.83	-0.53	0.40	1229.43	1229.43	0	0
Bow River	KM 025	71726	1228.40	1228.40	1228.40	0	0	1228.19	1228.73	-0.21	0.33	1228.39	1228.40	-0.01	0
Bow River	KM 025	71458	1226.85	1226.85	1226.85	0	0	1226.54	1227.16	-0.31	0.31	1226.84	1226.85	-0.01	0
Bow River	KM 025	71322	1226.14	1226.14	1226.14	0	0	1225.74	1226.50	-0.40	0.36	1226.13	1226.15	-0.01	0.01
Bow River	KM 025	70886	1224.69	1224.69	1224.69	0	0	1224.30	1225.04	-0.39	0.35	1224.67	1224.70	-0.02	0.01
Bow River	KM 025	70342	1223.56	1223.56	1223.56	0	0	1223.23	1223.87	-0.33	0.31	1223.52	1223.59	-0.04	0.03
Bow River	KM 025	69862	1222.87	1222.87	1222.87	0	0	1222.63	1223.12	-0.24	0.25	1222.81	1222.93	-0.06	0.06
Bow River	KM 025	69341	1221.50	1221.50	1221.50	0	0	1221.41	1221.69	-0.09	0.19	1221.45	1221.57	-0.05	0.07
Bow River	KM 025	69060	1219.58	1219.58	1219.58	0	0	1219.13	1219.95	-0.45	0.37	1219.57	1219.58	-0.01	0
Bow River	KM 025	68797	1218.78	1218.78	1218.78	0	0	1218.42	1219.12	-0.36	0.34	1218.77	1218.79	-0.01	0.01
Bow River	KM 025	68599	1218.61	1218.61	1218.61	0	0	1218.36	1218.88	-0.25	0.27	1218.60	1218.62	-0.01	0.01
Bow River	KM 025	68516	1218.49	1218.49	1218.49	0	0	1218.19	1218.77	-0.30	0.28	1218.47	1218.51	-0.02	0.02
Bow River	KM 025	68296	1217.91	1217.91	1217.91	0	0	1217.62	1218.17	-0.29	0.26	1217.87	1217.94	-0.04	0.03
Bow River	KM 025	68089	1217.49	1217.49	1217.49	0	0	1217.21	1217.74	-0.28	0.25	1217.44	1217.52	-0.05	0.03
Bow River	KM 025	67716	1216.81	1216.81	1216.81	0	0	1216.52	1217.07	-0.29	0.26	1216.81	1216.82	0	0.01
Bow River	KM 025	67419	1216.27	1216.27	1216.27	0	0	1216.02	1216.50	-0.25	0.23	1216.24	1216.30	-0.03	0.03
Bow River	KM 025	67278	1215.87	1215.87	1215.87	0	0	1215.60	1216.10	-0.27	0.23	1215.81	1215.91	-0.06	0.04
Bow River	KM 025	67115	1215.58	1215.58	1215.58	0	0	1215.35	1215.78	-0.23	0.20	1215.50	1215.64	-0.08	0.06
Bow River	KM 025	66773	1215.04	1215.04	1215.04	0	0	1214.82	1215.23	-0.22	0.19	1214.94	1215.12	-0.10	0.08
Bow River	KM 025	66431	1214.57	1214.57	1214.57	0	0	1214.40	1214.74	-0.17	0.17	1214.47	1214.67	-0.10	0.10
Bow River	KM 025	66144	1214.16	1214.16	1214.16	0	0	1214.01	1214.31	-0.15	0.15	1214.07	1214.23	-0.09	0.07
Bow River	KM 025	65921	1213.16	1213.16	1213.16	0	0	1212.86	1213.43	-0.30	0.27	1213.14	1213.18	-0.02	0.02
Bow River	KM 025	65549	1212.53	1212.53	1212.53	0	0	1212.25	1212.78	-0.28	0.25	1212.49	1212.57	-0.04	0.04
Bow River	KM 025	65150	1212.00	1212.00	1212.00	0	0	1211.79	1212.19	-0.21	0.19	1211.94	1212.06	-0.06	0.06
Bow River	KM 025	64837	1211.32	1211.32	1211.32	0	0	1211.13	1211.50	-0.19	0.18	1211.22	1211.43	-0.10	0.11
Bow River	KM 025	64628	1211.11	1211.11	1211.11	0	0	1210.97	1211.24	-0.14	0.13	1210.99	1211.23	-0.12	0.12
Bow River	KM 025	64302	1210.78	1210.78	1210.78	0	0	1210.72	1210.85	-0.06	0.07	1210.67	1210.90	-0.11	0.12
Bow River	KM 025	64027	1210.13	1210.13	1210.13	0	0	1210.01	1210.23	-0.12	0.10	1210.04	1210.24	-0.09	0.11
Bow River	KM 025	63717	1209.26	1209.26	1209.26	0	0	1209.10	1209.40	-0.16	0.14	1209.14	1209.37	-0.12	0.11
Bow River	KM 025	63212	1208.55	1208.55	1208.55	0	0	1208.48	1208.63	-0.07	0.08	1208.47	1208.62	-0.08	0.07
Bow River	KM 025	62736	1207.57	1207.57	1207.57	0	0	1207.30	1207.81	-0.27	0.24	1207.53	1207.61	-0.04	0.04
Bow River	KM 025	62402	1206.89	1206.89	1206.89	0	0	1206.61	1207.14	-0.28	0.25	1206.84	1206.93	-0.05	0.04

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 025	61981	1206.35	1206.35	1206.35	0	0	1206.08	1206.58	-0.27	0.23	1206.30	1206.40	-0.05	0.05
Bow River	KM 025	61281	1205.20	1205.20	1205.20	0	0	1204.95	1205.43	-0.25	0.23	1205.11	1205.29	-0.09	0.09
Bow River	KM 025	60832	1204.45	1204.45	1204.45	0	0	1204.23	1204.65	-0.22	0.20	1204.35	1204.54	-0.10	0.09
Bow River	KM 025	60261	1203.49	1203.49	1203.49	0	0	1203.30	1203.66	-0.19	0.17	1203.43	1203.53	-0.06	0.04
Bow River	KM 025	59664	1202.16	1202.16	1202.16	0	0	1201.90	1202.41	-0.26	0.25	1202.16	1202.17	0	0.01
Bow River	KM 025	59198	1201.07	1201.07	1201.07	0	0	1200.81	1201.33	-0.26	0.26	1201.06	1201.07	-0.01	0
Bow River	KM 025	58730	1199.92	1199.92	1199.92	0	0	1199.60	1200.22	-0.32	0.30	1199.92	1199.93	0	0.01
Bow River	KM 025	58375	1199.15	1199.15	1199.15	0	0	1198.88	1199.41	-0.27	0.26	1199.14	1199.16	-0.01	0.01
Bow River	KM 025	57997	1198.22	1198.22	1198.22	0	0	1198.00	1198.45	-0.22	0.23	1198.21	1198.23	-0.01	0.01
Bow River	KM 025	57624	1196.87	1196.87	1196.87	0	0	1196.57	1197.16	-0.30	0.29	1196.87	1196.88	0	0.01
Bow River	KM 025	57271	1196.06	1196.06	1196.07	0	0.01	1195.80	1196.34	-0.26	0.28	1196.06	1196.07	0	0.01
Bow River	KM 025	56775	1195.07	1195.07	1195.10	0	0.03	1194.85	1195.35	-0.22	0.28	1195.06	1195.08	-0.01	0.01
Bow River	KM 025	56284	1193.94	1193.87	1194.12	-0.07	0.18	1193.62	1194.28	-0.32	0.34	1193.94	1193.93	0	-0.01
Bow River	KM 025	55904	1193.44	1193.29	1193.78	-0.15	0.34	1193.17	1193.74	-0.27	0.30	1193.43	1193.44	-0.01	0
Bow River	KM 025	55458	1192.96	1192.69	1193.46	-0.27	0.50	1192.75	1193.21	-0.21	0.25	1192.95	1192.96	-0.01	0
Bow River	KM 025	55088	1192.54	1192.11	1193.20	-0.43	0.66	1192.39	1192.74	-0.15	0.20	1192.54	1192.55	0	0.01
Bow River	KM 025	54806	1192.54	1192.07	1193.23	-0.47	0.69	1192.43	1192.69	-0.11	0.15	1192.54	1192.55	0	0.01
Bow River	KM 025	54585	1192.50	1192.00	1193.21	-0.50	0.71	1192.41	1192.63	-0.09	0.13	1192.50	1192.51	0	0.01
Bow River	KM 025	54487	1192.29	1191.70	1193.06	-0.59	0.77	1192.19	1192.42	-0.10	0.13	1192.28	1192.30	-0.01	0.01
Bow River	KM 025	54433	1192.11	1191.41	1192.94	-0.70	0.83	1192.01	1192.23	-0.10	0.12	1192.10	1192.11	-0.01	0
Bow River	KM 025	54283	1192.13	1191.42	1192.96	-0.71	0.83	1192.04	1192.23	-0.09	0.10	1192.12	1192.13	-0.01	0
Bow River	KM 025	54078	1192.10	1191.37	1192.95	-0.73	0.85	1192.03	1192.20	-0.07	0.10	1192.09	1192.11	-0.01	0.01
Bow River	KM 025	53802	1192.06	1191.27	1192.93	-0.79	0.87	1191.99	1192.14	-0.07	0.08	1192.05	1192.07	-0.01	0.01
Bow River	KM 025	53388	1191.98	1191.18	1192.89	-0.80	0.91	1191.94	1192.05	-0.04	0.07	1191.98	1191.99	0	0.01
Bow River	KM 025	52796	1191.93	1191.08	1192.86	-0.85	0.93	1191.89	1191.98	-0.04	0.05	1191.93	1191.93	0	0
Bow River	KM 025	52139	1191.88	1190.97	1192.84	-0.91	0.96	1191.86	1191.92	-0.02	0.04	1191.88	1191.88	0	0
Bow River	KM 025	51427	1191.84	1190.87	1192.82	-0.97	0.98	1191.82	1191.86	-0.02	0.02	1191.84	1191.84	0	0
Bow River	KM 025	50452	1191.80	1190.79	1192.80	-1.01	1.00	1191.79	1191.80	-0.01	0	1191.80	1191.80	0	0
Bow River	KM 025	49366	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	48977	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	47540	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	45971	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	44631	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	42928	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	42170	1191.80	1190.80	1192.80	-1.00	1.00	1191.80	1191.80	0	0	1191.80	1191.80	0	0
Bow River	KM 025	42132	1162.92	1162.92	1162.92	0	0	1162.73	1163.17	-0.19	0.25	1162.92	1162.92	0	0

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 025	41824	1161.92	1161.92	1161.92	0	0	1161.52	1162.26	-0.40	0.34	1161.87	1161.97	-0.05	0.05
Bow River	KM 025	41537	1161.44	1161.44	1161.44	0	0	1161.21	1161.68	-0.23	0.24	1161.41	1161.46	-0.03	0.02
Bow River	KM 025	41361	1160.93	1160.93	1160.93	0	0	1160.70	1161.18	-0.23	0.25	1160.91	1160.94	-0.02	0.01
Bow River	KM 025	40989	1159.61	1159.61	1159.61	0	0	1159.23	1159.94	-0.38	0.33	1159.61	1159.62	0	0.01
Bow River	KM 025	40712	1159.15	1159.15	1159.15	0	0	1158.86	1159.43	-0.29	0.28	1159.13	1159.17	-0.02	0.02
Bow River	KM 025	40439	1158.77	1158.77	1158.77	0	0	1158.48	1159.04	-0.29	0.27	1158.74	1158.79	-0.03	0.02
Bow River	KM 025	40129	1158.09	1158.09	1158.09	0	0	1157.79	1158.37	-0.30	0.28	1158.04	1158.13	-0.05	0.04
Bow River	KM 025	39836	1157.47	1157.47	1157.47	0	0	1157.14	1157.78	-0.33	0.31	1157.40	1157.53	-0.07	0.06
Bow River	KM 025	39478	1156.46	1156.46	1156.46	0	0	1156.09	1156.80	-0.37	0.34	1156.42	1156.51	-0.04	0.05
Bow River	KM 025	39161	1155.83	1155.83	1155.83	0	0	1155.50	1156.13	-0.33	0.30	1155.81	1155.85	-0.02	0.02
Bow River	KM 025	38875	1155.27	1155.27	1155.27	0	0	1154.94	1155.56	-0.33	0.29	1155.24	1155.29	-0.03	0.02
Bow River	KM 025	38529	1154.67	1154.67	1154.67	0	0	1154.37	1154.95	-0.30	0.28	1154.66	1154.69	-0.01	0.02
Bow River	KM 025	38248	1153.91	1153.91	1153.91	0	0	1153.61	1154.20	-0.30	0.29	1153.88	1153.95	-0.03	0.04
Bow River	KM 025	38018	1153.29	1153.29	1153.29	0	0	1152.96	1153.60	-0.33	0.31	1153.24	1153.34	-0.05	0.05
Bow River	KM 025	37774	1153.02	1153.02	1153.02	0	0	1152.76	1153.27	-0.26	0.25	1152.97	1153.07	-0.05	0.05
Bow River	KM 025	37502	1152.26	1152.26	1152.26	0	0	1151.94	1152.56	-0.32	0.30	1152.23	1152.29	-0.03	0.03
Bow River	KM 025	37086	1151.37	1151.37	1151.37	0	0	1151.08	1151.64	-0.29	0.27	1151.34	1151.40	-0.03	0.03
Bow River	KM 025	36785	1150.61	1150.61	1150.61	0	0	1150.35	1150.87	-0.26	0.26	1150.55	1150.68	-0.06	0.07
Bow River	KM 025	36450	1149.69	1149.69	1149.69	0	0	1149.37	1149.99	-0.32	0.30	1149.66	1149.73	-0.03	0.04
Bow River	KM 025	36158	1148.85	1148.85	1148.85	0	0	1148.52	1149.15	-0.33	0.30	1148.84	1148.85	-0.01	0
Bow River	KM 025	35863	1148.05	1148.05	1148.05	0	0	1147.72	1148.35	-0.33	0.30	1148.05	1148.05	0	0
Bow River	KM 025	35381	1146.91	1146.91	1146.91	0	0	1146.62	1147.20	-0.29	0.29	1146.90	1146.92	-0.01	0.01
Bow River	KM 025	35009	1145.92	1145.92	1145.92	0	0	1145.57	1146.23	-0.35	0.31	1145.91	1145.92	-0.01	0
Bow River	KM 025	34562	1145.16	1145.16	1145.16	0	0	1144.85	1145.46	-0.31	0.30	1145.15	1145.17	-0.01	0.01
Bow River	KM 025	34140	1144.38	1144.38	1144.38	0	0	1144.07	1144.68	-0.31	0.30	1144.36	1144.40	-0.02	0.02
Bow River	KM 025	33877	1143.74	1143.74	1143.74	0	0	1143.40	1144.06	-0.34	0.32	1143.73	1143.75	-0.01	0.01
Bow River	KM 025	33609	1143.19	1143.19	1143.19	0	0	1142.86	1143.50	-0.33	0.31	1143.18	1143.19	-0.01	0
Bow River	KM 025	33289	1142.60	1142.60	1142.60	0	0	1142.28	1142.89	-0.32	0.29	1142.58	1142.61	-0.02	0.01
Bow River	KM 025	32977	1141.84	1141.84	1141.84	0	0	1141.50	1142.15	-0.34	0.31	1141.82	1141.85	-0.02	0.01
Bow River	KM 025	32605	1141.15	1141.15	1141.15	0	0	1140.85	1141.44	-0.30	0.29	1141.13	1141.17	-0.02	0.02
Bow River	KM 025	32220	1140.38	1140.38	1140.38	0	0	1140.03	1140.69	-0.35	0.31	1140.35	1140.41	-0.03	0.03
Bow River	KM 025	31935	1139.99	1139.99	1139.99	0	0	1139.71	1140.26	-0.28	0.27	1139.96	1140.02	-0.03	0.03
Bow River	KM 025	31588	1139.27	1139.27	1139.27	0	0	1138.95	1139.57	-0.32	0.30	1139.25	1139.29	-0.02	0.02
Bow River	KM 025	31260	1138.66	1138.66	1138.66	0	0	1138.32	1138.95	-0.34	0.29	1138.64	1138.67	-0.02	0.01
Bow River	KM 025	30935	1137.99	1137.99	1137.99	0	0	1137.68	1138.29	-0.31	0.30	1137.97	1138.01	-0.02	0.02
Bow River	KM 025	30566	1137.14	1137.14	1137.14	0	0	1136.82	1137.44	-0.32	0.30	1137.11	1137.17	-0.03	0.03

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 025	30214	1136.49	1136.49	1136.49	0	0	1136.14	1136.80	-0.35	0.31	1136.46	1136.51	-0.03	0.02
Bow River	KM 025	29937	1136.02	1136.02	1136.02	0	0	1135.74	1136.27	-0.28	0.25	1135.98	1136.05	-0.04	0.03
Bow River	KM 025	29563	1135.40	1135.40	1135.40	0	0	1135.12	1135.65	-0.28	0.25	1135.35	1135.44	-0.05	0.04
Bow River	KM 025	29172	1134.77	1134.77	1134.77	0	0	1134.48	1135.05	-0.29	0.28	1134.75	1134.78	-0.02	0.01
Bow River	KM 025	28925	1134.07	1134.07	1134.07	0	0	1133.79	1134.36	-0.28	0.29	1134.03	1134.10	-0.04	0.03
Bow River	KM 025	28798	1133.97	1133.97	1133.97	0	0	1133.56	1134.26	-0.41	0.29	1133.95	1133.99	-0.02	0.02
Bow River	KM 025	28448	1133.16	1133.16	1133.16	0	0	1132.82	1133.47	-0.34	0.31	1133.14	1133.18	-0.02	0.02
Bow River	KM 025	27998	1132.29	1132.29	1132.29	0	0	1131.97	1132.59	-0.32	0.30	1132.28	1132.30	-0.01	0.01
Bow River	KM 025	27701	1131.84	1131.84	1131.84	0	0	1131.57	1132.10	-0.27	0.26	1131.82	1131.85	-0.02	0.01
Bow River	KM 025	27469	1131.32	1131.32	1131.32	0	0	1131.06	1131.56	-0.26	0.24	1131.30	1131.33	-0.02	0.01
Bow River	KM 025	27386	1130.98	1130.98	1130.98	0	0	1130.74	1131.22	-0.24	0.24	1130.95	1131.00	-0.03	0.02
Bow River	KM 025	27359	1130.77	1130.77	1130.77	0	0	1130.46	1131.05	-0.31	0.28	1130.74	1130.80	-0.03	0.03
Bow River	KM 025	27295	1130.72	1130.72	1130.72	0	0	1130.44	1130.98	-0.28	0.26	1130.69	1130.75	-0.03	0.03
Bow River	KM 025	27116	1130.29	1130.29	1130.29	0	0	1129.98	1130.56	-0.31	0.27	1130.25	1130.32	-0.04	0.03
Bow River	KM 025	26844	1129.73	1129.73	1129.73	0	0	1129.42	1130.01	-0.31	0.28	1129.69	1129.77	-0.04	0.04
Bow River	KM 025	26671	1129.64	1129.64	1129.64	0	0	1129.39	1129.88	-0.25	0.24	1129.59	1129.69	-0.05	0.05
Bow River	KM 025	26466	1129.34	1129.34	1129.34	0	0	1129.09	1129.58	-0.25	0.24	1129.29	1129.39	-0.05	0.05
Bow River	KM 025	26203	1128.54	1128.54	1128.54	0	0	1128.22	1128.84	-0.32	0.30	1128.50	1128.58	-0.04	0.04
Bow River	KM 025	25944	1128.10	1128.10	1128.10	0	0	1127.80	1128.38	-0.30	0.28	1128.04	1128.15	-0.06	0.05
Bow River	KM 025	25748	1127.72	1127.72	1127.72	0	0	1127.43	1127.99	-0.29	0.27	1127.64	1127.78	-0.08	0.06
Bow River	KM 025	25534	1127.35	1127.35	1127.35	0	0	1127.06	1127.62	-0.29	0.27	1127.29	1127.41	-0.06	0.06
Bow River	KM 025	25343	1127.18	1127.18	1127.18	0	0	1126.95	1127.41	-0.23	0.23	1127.11	1127.25	-0.07	0.07
Bow River	KM 025	25205	1127.01	1127.01	1127.01	0	0	1126.78	1127.23	-0.23	0.22	1126.93	1127.08	-0.08	0.07
Bow River	KM 025	24999	1126.50	1126.50	1126.50	0	0	1126.25	1126.75	-0.25	0.25	1126.40	1126.57	-0.10	0.07
Bow River	KM 025	24879	1126.25	1126.25	1126.25	0	0	1126.03	1126.48	-0.22	0.23	1126.17	1126.31	-0.08	0.06
Bow River	KM 023	24684	1126.01	1126.01	1126.01	0	0	1125.82	1126.21	-0.19	0.20	1125.94	1126.06	-0.07	0.05
Bow River	KM 023	24482	1125.11	1125.11	1125.11	0	0	1124.69	1125.45	-0.42	0.34	1125.09	1125.13	-0.02	0.02
Bow River	KM 023	24338	1124.73	1124.73	1124.73	0	0	1124.38	1125.05	-0.35	0.32	1124.68	1124.78	-0.05	0.05
Bow River	KM 023	24132	1124.38	1124.38	1124.38	0	0	1124.09	1124.64	-0.29	0.26	1124.30	1124.44	-0.08	0.06
Bow River	KM 023	24010	1124.13	1124.13	1124.13	0	0	1123.86	1124.37	-0.27	0.24	1124.03	1124.21	-0.10	0.08
Bow River	KM 023	23713	1123.81	1123.81	1123.81	0	0	1123.55	1124.04	-0.26	0.23	1123.75	1123.84	-0.06	0.03
Bow River	KM 023	23562	1123.52	1123.52	1123.52	0	0	1123.20	1123.80	-0.32	0.28	1123.51	1123.52	-0.01	0
Bow River	KM 023	23415	1123.13	1123.13	1123.13	0	0	1122.90	1123.37	-0.23	0.24	1123.07	1123.18	-0.06	0.05
Bow River	KM 023	23391	1122.90	1122.90	1122.90	0	0	1122.61	1123.18	-0.29	0.28	1122.83	1122.97	-0.07	0.07
Bow River	KM 023	23317	1122.77	1122.77	1122.77	0	0	1122.42	1123.04	-0.35	0.27	1122.71	1122.82	-0.06	0.05
Bow River	KM 023	23130	1122.43	1122.43	1122.43	0	0	1122.12	1122.70	-0.31	0.27	1122.36	1122.50	-0.07	0.07

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 023	22973	1122.14	1122.14	1122.14	0	0	1121.80	1122.43	-0.34	0.29	1122.08	1122.19	-0.06	0.05
Bow River	KM 000	22894	1122.16	1122.16	1122.16	0	0	1121.86	1122.41	-0.30	0.25	1122.11	1122.19	-0.05	0.03
Bow River	KM 000	22726	1121.69	1121.69	1121.69	0	0	1121.38	1121.95	-0.31	0.26	1121.64	1121.73	-0.05	0.04
Bow River	KM 000	22599	1121.18	1121.18	1121.18	0	0	1120.81	1121.50	-0.37	0.32	1121.13	1121.22	-0.05	0.04
Bow River	KM 000	22340	1120.69	1120.69	1120.69	0	0	1120.37	1121.01	-0.32	0.32	1120.63	1120.76	-0.06	0.07
Bow River	KM 000	22028	1120.38	1120.38	1120.38	0	0	1120.15	1120.62	-0.23	0.24	1120.33	1120.42	-0.05	0.04
Bow River	KM 000	21803	1119.45	1119.45	1119.45	0	0	1119.11	1119.76	-0.34	0.31	1119.39	1119.50	-0.06	0.05
Bow River	KM 000	21608	1119.12	1119.12	1119.12	0	0	1118.81	1119.41	-0.31	0.29	1119.07	1119.16	-0.05	0.04
Bow River	KM 000	21421	1118.76	1118.76	1118.76	0	0	1118.48	1119.04	-0.28	0.28	1118.71	1118.81	-0.05	0.05
Bow River	KM 000	21274	1118.53	1118.53	1118.53	0	0	1118.28	1118.78	-0.25	0.25	1118.47	1118.58	-0.06	0.05
Bow River	KM 000	21235	1118.41	1118.41	1118.41	0	0	1118.16	1118.66	-0.25	0.25	1118.34	1118.46	-0.07	0.05
Bow River	KM 000	21217	1118.28	1118.28	1118.28	0	0	1118.01	1118.55	-0.27	0.27	1118.20	1118.34	-0.08	0.06
Bow River	KM 000	21170	1118.22	1118.22	1118.22	0	0	1117.95	1118.48	-0.27	0.26	1118.13	1118.28	-0.09	0.06
Bow River	KM 000	21030	1118.04	1118.04	1118.04	0	0	1117.79	1118.29	-0.25	0.25	1117.97	1118.10	-0.07	0.06
Bow River	KM 000	20876	1117.59	1117.59	1117.59	0	0	1117.19	1117.93	-0.40	0.34	1117.58	1117.60	-0.01	0.01
Bow River	KM 000	20666	1117.28	1117.28	1117.28	0	0	1116.95	1117.57	-0.33	0.29	1117.24	1117.31	-0.04	0.03
Bow River	KM 000	20496	1116.95	1116.95	1116.95	0	0	1116.65	1117.24	-0.30	0.29	1116.91	1116.99	-0.04	0.04
Bow River	KM 000	20329	1116.69	1116.69	1116.69	0	0	1116.42	1116.95	-0.27	0.26	1116.63	1116.74	-0.06	0.05
Bow River	KM 000	20174	1116.51	1116.51	1116.51	0	0	1116.28	1116.75	-0.23	0.24	1116.45	1116.56	-0.06	0.05
Bow River	KM 000	19933	1116.17	1116.17	1116.17	0	0	1115.97	1116.39	-0.20	0.22	1116.12	1116.21	-0.05	0.04
Bow River	KM 000	19798	1115.88	1115.88	1115.88	0	0	1115.69	1116.09	-0.19	0.21	1115.85	1115.91	-0.03	0.03
Bow River	KM 000	19603	1114.88	1114.88	1114.88	0	0	1114.48	1115.21	-0.40	0.33	1114.85	1114.90	-0.03	0.02
Bow River	KM 000	19507	1114.59	1114.59	1114.59	0	0	1114.22	1114.92	-0.37	0.33	1114.55	1114.62	-0.04	0.03
Bow River	KM 000	19342	1114.30	1114.30	1114.30	0	0	1113.96	1114.61	-0.34	0.31	1114.28	1114.32	-0.02	0.02
Bow River	KM 000	19150	1114.16	1114.16	1114.16	0	0	1113.88	1114.43	-0.28	0.27	1114.12	1114.19	-0.04	0.03
Bow River	KM 000	18984	1114.02	1114.02	1114.02	0	0	1113.76	1114.27	-0.26	0.25	1113.98	1114.05	-0.04	0.03
Bow River	KM 000	18840	1113.76	1113.76	1113.76	0	0	1113.49	1114.03	-0.27	0.27	1113.74	1113.78	-0.02	0.02
Bow River	KM 000	18709	1113.57	1113.57	1113.57	0	0	1113.30	1113.84	-0.27	0.27	1113.56	1113.59	-0.01	0.02
Bow River	KM 000	18500	1113.28	1113.28	1113.28	0	0	1113.02	1113.53	-0.26	0.25	1113.26	1113.29	-0.02	0.01
Bow River	KM 000	18270	1112.28	1112.28	1112.28	0	0	1111.91	1112.61	-0.37	0.33	1112.25	1112.30	-0.03	0.02
Bow River	KM 000	17960	1111.66	1111.66	1111.66	0	0	1111.35	1111.96	-0.31	0.30	1111.62	1111.69	-0.04	0.03
Bow River	KM 000	17680	1111.46	1111.46	1111.46	0	0	1111.20	1111.72	-0.26	0.26	1111.42	1111.49	-0.04	0.03
Bow River	KM 000	17298	1110.74	1110.74	1110.74	0	0	1110.37	1111.07	-0.37	0.33	1110.71	1110.77	-0.03	0.03
Bow River	KM 000	16969	1110.38	1110.38	1110.38	0	0	1110.08	1110.66	-0.30	0.28	1110.34	1110.41	-0.04	0.03
Bow River	KM 000	16703	1109.68	1109.68	1109.68	0	0	1109.28	1110.03	-0.40	0.35	1109.67	1109.69	-0.01	0.01
Bow River	KM 000	16437	1109.36	1109.36	1109.36	0	0	1109.02	1109.67	-0.34	0.31	1109.35	1109.38	-0.01	0.02

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 000	16269	1109.12	1109.12	1109.12	0	0	1108.79	1109.41	-0.33	0.29	1109.09	1109.13	-0.03	0.01
Bow River	KM 000	16024	1108.70	1108.70	1108.70	0	0	1108.39	1108.97	-0.31	0.27	1108.67	1108.72	-0.03	0.02
Bow River	KM 000	15830	1108.39	1108.39	1108.39	0	0	1108.11	1108.64	-0.28	0.25	1108.35	1108.42	-0.04	0.03
Bow River	KM 000	15648	1108.29	1108.29	1108.29	0	0	1108.05	1108.51	-0.24	0.22	1108.26	1108.32	-0.03	0.03
Bow River	KM 000	15440	1107.62	1107.62	1107.62	0	0	1107.29	1107.93	-0.33	0.31	1107.59	1107.65	-0.03	0.03
Bow River	KM 000	15224	1107.32	1107.32	1107.32	0	0	1107.03	1107.60	-0.29	0.28	1107.29	1107.35	-0.03	0.03
Bow River	KM 000	14981	1106.84	1106.84	1106.84	0	0	1106.49	1107.15	-0.35	0.31	1106.83	1106.86	-0.01	0.02
Bow River	KM 000	14763	1106.30	1106.30	1106.30	0	0	1105.96	1106.62	-0.34	0.32	1106.27	1106.33	-0.03	0.03
Bow River	KM 000	14383	1105.44	1105.44	1105.44	0	0	1105.12	1105.75	-0.32	0.31	1105.42	1105.46	-0.02	0.02
Bow River	KM 000	14213	1105.12	1105.12	1105.12	0	0	1104.80	1105.43	-0.32	0.31	1105.12	1105.13	0	0.01
Bow River	KM 000	13874	1104.46	1104.46	1104.46	0	0	1104.12	1104.77	-0.34	0.31	1104.44	1104.47	-0.02	0.01
Bow River	KM 000	13626	1103.93	1103.93	1103.93	0	0	1103.58	1104.26	-0.35	0.33	1103.92	1103.94	-0.01	0.01
Bow River	KM 000	13399	1103.75	1103.75	1103.75	0	0	1103.47	1104.02	-0.28	0.27	1103.74	1103.76	-0.01	0.01
Bow River	KM 000	13018	1102.81	1102.81	1102.81	0	0	1102.45	1103.14	-0.36	0.33	1102.79	1102.82	-0.02	0.01
Bow River	KM 000	12701	1102.19	1102.19	1102.19	0	0	1101.87	1102.52	-0.32	0.33	1102.17	1102.21	-0.02	0.02
Bow River	KM 000	12451	1101.71	1101.71	1101.71	0	0	1101.30	1102.07	-0.41	0.36	1101.71	1101.71	0	0
Bow River	KM 000	12234	1101.31	1101.31	1101.31	0	0	1100.93	1101.65	-0.38	0.34	1101.30	1101.32	-0.01	0.01
Bow River	KM 000	11894	1100.98	1100.98	1100.98	0	0	1100.67	1101.28	-0.31	0.30	1100.97	1100.99	-0.01	0.01
Bow River	KM 000	11503	1100.14	1100.14	1100.14	0	0	1099.80	1100.45	-0.34	0.31	1100.11	1100.16	-0.03	0.02
Bow River	KM 000	11230	1099.57	1099.57	1099.57	0	0	1099.25	1099.87	-0.32	0.30	1099.53	1099.60	-0.04	0.03
Bow River	KM 000	10967	1099.21	1099.21	1099.21	0	0	1098.90	1099.49	-0.31	0.28	1099.17	1099.24	-0.04	0.03
Bow River	KM 000	10591	1098.70	1098.70	1098.70	0	0	1098.45	1098.96	-0.25	0.26	1098.65	1098.74	-0.05	0.04
Bow River	KM 000	10200	1097.87	1097.87	1097.87	0	0	1097.46	1098.21	-0.41	0.34	1097.84	1097.89	-0.03	0.02
Bow River	KM 000	10063	1097.79	1097.79	1097.79	0	0	1097.42	1098.10	-0.37	0.31	1097.76	1097.81	-0.03	0.02
Bow River	KM 000	9667	1097.21	1097.21	1097.21	0	0	1096.90	1097.49	-0.31	0.28	1097.16	1097.24	-0.05	0.03
Bow River	KM 000	9467	1096.76	1096.76	1096.76	0	0	1096.43	1097.07	-0.33	0.31	1096.73	1096.79	-0.03	0.03
Bow River	KM 000	9283	1096.29	1096.29	1096.29	0	0	1095.91	1096.62	-0.38	0.33	1096.26	1096.31	-0.03	0.02
Bow River	KM 000	9041	1096.12	1096.12	1096.13	0	0.01	1095.77	1096.43	-0.35	0.31	1096.11	1096.13	-0.01	0.01
Bow River	KM 000	8729	1095.35	1095.35	1095.37	0	0.02	1095.04	1095.64	-0.31	0.29	1095.32	1095.38	-0.03	0.03
Bow River	KM 000	8459	1094.95	1094.94	1094.97	-0.01	0.02	1094.68	1095.19	-0.27	0.24	1094.90	1094.98	-0.05	0.03
Bow River	KM 000	8192	1094.69	1094.68	1094.72	-0.01	0.03	1094.46	1094.92	-0.23	0.23	1094.64	1094.73	-0.05	0.04
Bow River	KM 000	7916	1094.06	1094.04	1094.13	-0.02	0.07	1093.70	1094.36	-0.36	0.30	1094.04	1094.07	-0.02	0.01
Bow River	KM 000	7653	1093.70	1093.67	1093.81	-0.03	0.11	1093.36	1093.99	-0.34	0.29	1093.68	1093.71	-0.02	0.01
Bow River	KM 000	7469	1093.39	1093.34	1093.53	-0.05	0.14	1093.05	1093.68	-0.34	0.29	1093.38	1093.39	-0.01	0
Bow River	KM 000	7251	1093.03	1092.97	1093.22	-0.06	0.19	1092.74	1093.29	-0.29	0.26	1093.01	1093.04	-0.02	0.01
Bow River	KM 000	7027	1092.80	1092.71	1093.06	-0.09	0.26	1092.52	1093.05	-0.28	0.25	1092.79	1092.80	-0.01	0

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bow River	KM 000	6740	1092.39	1092.22	1092.78	-0.17	0.39	1092.13	1092.63	-0.26	0.24	1092.38	1092.39	-0.01	0
Bow River	KM 000	6416	1091.97	1091.63	1092.54	-0.34	0.57	1091.73	1092.19	-0.24	0.22	1091.96	1091.97	-0.01	0
Bow River	KM 000	6005	1091.74	1091.28	1092.41	-0.46	0.67	1091.56	1091.92	-0.18	0.18	1091.74	1091.74	0	0
Bow River	KM 000	5633	1091.61	1091.08	1092.33	-0.53	0.72	1091.46	1091.77	-0.15	0.16	1091.61	1091.61	0	0
Bow River	KM 000	5196	1091.51	1090.92	1092.28	-0.59	0.77	1091.38	1091.65	-0.13	0.14	1091.51	1091.51	0	0
Bow River	KM 000	4675	1091.36	1090.67	1092.19	-0.69	0.83	1091.26	1091.47	-0.10	0.11	1091.36	1091.36	0	0
Bow River	KM 000	4201	1091.23	1090.43	1092.11	-0.80	0.88	1091.15	1091.30	-0.08	0.07	1091.23	1091.23	0	0
Bow River	KM 000	3744	1091.15	1090.28	1092.07	-0.87	0.92	1091.10	1091.20	-0.05	0.05	1091.15	1091.15	0	0
Bow River	KM 000	3204	1091.06	1090.12	1092.02	-0.94	0.96	1091.04	1091.09	-0.02	0.03	1091.06	1091.06	0	0
Bow River	KM 000	2677	1091.05	1090.09	1092.01	-0.96	0.96	1091.03	1091.06	-0.02	0.01	1091.05	1091.05	0	0
Bow River	KM 000	2148	1091.04	1090.07	1092.01	-0.97	0.97	1091.03	1091.05	-0.01	0.01	1091.04	1091.04	0	0
Bow River	KM 000	1302	1091.02	1090.04	1091.99	-0.98	0.97	1091.01	1091.02	-0.01	0	1091.02	1091.02	0	0
Bow River	KM 000	329	1091.01	1090.03	1091.99	-0.98	0.98	1091.01	1091.01	0	0	1091.01	1091.01	0	0
Bow River	KM 000	12	1090.90	1089.90	1091.90	-1.00	1.00	1090.90	1090.90	0	0	1090.90	1090.90	0	0
Bighill Creek	KM 000	5030	1155.14	1155.14	1155.14	0	0	1155.08	1155.17	-0.06	0.03	1155.10	1155.18	-0.04	0.04
Bighill Creek	KM 000	4966	1154.34	1154.34	1154.34	0	0	1154.36	1154.38	0.02	0.04	1154.34	1154.36	0	0.02
Bighill Creek	KM 000	4883	1153.71	1153.71	1153.71	0	0	1153.66	1153.74	-0.05	0.03	1153.67	1153.74	-0.04	0.03
Bighill Creek	KM 000	4810	1153.39	1153.39	1153.39	0	0	1153.37	1153.41	-0.02	0.02	1153.35	1153.42	-0.04	0.03
Bighill Creek	KM 000	4715	1152.78	1152.78	1152.78	0	0	1152.75	1152.81	-0.03	0.03	1152.73	1152.84	-0.05	0.06
Bighill Creek	KM 000	4639	1152.30	1152.30	1152.30	0	0	1152.30	1152.31	0	0.01	1152.24	1152.34	-0.06	0.04
Bighill Creek	KM 000	4527	1151.52	1151.52	1151.52	0	0	1151.49	1151.53	-0.03	0.01	1151.44	1151.58	-0.08	0.06
Bighill Creek	KM 000	4461	1151.19	1151.19	1151.19	0	0	1151.15	1151.22	-0.04	0.03	1151.11	1151.26	-0.08	0.07
Bighill Creek	KM 000	4363	1150.59	1150.59	1150.59	0	0	1150.55	1150.63	-0.04	0.04	1150.53	1150.65	-0.06	0.06
Bighill Creek	KM 000	4357	1150.43	1150.43	1150.43	0	0	1150.36	1150.49	-0.07	0.06	1150.35	1150.50	-0.08	0.07
Bighill Creek	KM 000	4295	1150.09	1150.09	1150.09	0	0	1150.02	1150.15	-0.07	0.06	1150.03	1150.14	-0.06	0.05
Bighill Creek	KM 000	4203	1149.33	1149.33	1149.33	0	0	1149.25	1149.41	-0.08	0.08	1149.31	1149.36	-0.02	0.03
Bighill Creek	KM 000	4129	1148.37	1148.37	1148.37	0	0	1148.32	1148.40	-0.05	0.03	1148.29	1148.44	-0.08	0.07
Bighill Creek	KM 000	4055	1147.86	1147.86	1147.86	0	0	1147.83	1147.88	-0.03	0.02	1147.77	1147.94	-0.09	0.08
Bighill Creek	KM 000	3915	1147.07	1147.07	1147.07	0	0	1147.06	1147.10	-0.01	0.03	1147.01	1147.14	-0.06	0.07
Bighill Creek	KM 000	3851	1146.30	1146.30	1146.30	0	0	1146.24	1146.34	-0.06	0.04	1146.22	1146.35	-0.08	0.05
Bighill Creek	KM 000	3797	1145.91	1145.91	1145.91	0	0	1145.89	1145.93	-0.02	0.02	1145.89	1145.95	-0.02	0.04
Bighill Creek	KM 000	3790	1145.78	1145.78	1145.78	0	0	1145.76	1145.80	-0.02	0.02	1145.72	1145.84	-0.06	0.06
Bighill Creek	KM 000	3675	1145.22	1145.22	1145.22	0	0	1145.20	1145.24	-0.02	0.02	1145.16	1145.28	-0.06	0.06
Bighill Creek	KM 000	3563	1144.47	1144.47	1144.47	0	0	1144.44	1144.48	-0.03	0.01	1144.43	1144.49	-0.04	0.02
Bighill Creek	KM 000	3388	1143.90	1143.90	1143.90	0	0	1143.89	1143.92	-0.01	0.02	1143.86	1143.98	-0.04	0.08
Bighill Creek	KM 000	3382	1143.87	1143.87	1143.87	0	0	1143.87	1143.90	0	0.03	1143.83	1143.96	-0.04	0.09

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bighill Creek	KM 000	3263	1143.46	1143.46	1143.46	0	0	1143.42	1143.38	-0.04	-0.08	1143.43	1143.18	-0.03	0
Bighill Creek	KM 000	3094	1142.88	1142.88	1142.88	0	0	1142.79	1142.94	-0.09	0.06	1142.81	1142.91	-0.07	0.03
Bighill Creek	KM 000	2960	1142.41	1142.41	1142.41	0	0	1142.38	1142.43	-0.03	0.02	1142.31	1142.49	-0.10	0.08
Bighill Creek	KM 000	2905	1142.34	1142.34	1142.34	0	0	1142.34	1142.36	0	0.02	1142.25	1142.43	-0.09	0.09
Bighill Creek	KM 000	2848	1142.12	1142.12	1142.12	0	0	1142.13	1142.13	0.01	0.01	1142.03	1142.21	-0.09	0.09
Bighill Creek	KM 000	2826	1142.09	1142.09	1142.09	0	0	1142.11	1142.10	0.02	0.01	1142.01	1142.17	-0.08	0.08
Bighill Creek	KM 000	2804	1141.58	1141.58	1141.58	0	0	1141.53	1141.63	-0.05	0.05	1141.53	1141.64	-0.05	0.06
Bighill Creek	KM 000	2792	1141.55	1141.55	1141.55	0	0	1141.50	1141.59	-0.05	0.04	1141.49	1141.60	-0.06	0.05
Bighill Creek	KM 000	2780	1141.40	1141.40	1141.40	0	0	1141.35	1141.45	-0.05	0.05	1141.32	1141.47	-0.08	0.07
Bighill Creek	KM 000	2761	1141.32	1141.32	1141.32	0	0	1141.29	1141.35	-0.03	0.03	1141.24	1141.39	-0.08	0.07
Bighill Creek	KM 000	2748	1141.22	1141.22	1141.22	0	0	1141.20	1141.25	-0.02	0.03	1141.15	1141.28	-0.07	0.06
Bighill Creek	KM 000	2729	1140.87	1140.87	1140.87	0	0	1140.78	1140.94	-0.09	0.07	1140.77	1140.96	-0.10	0.09
Bighill Creek	KM 000	2676	1140.73	1140.73	1140.73	0	0	1140.71	1140.76	-0.02	0.03	1140.66	1140.79	-0.07	0.06
Bighill Creek	KM 000	2631	1140.48	1140.48	1140.48	0	0	1140.42	1140.52	-0.06	0.04	1140.42	1140.53	-0.06	0.05
Bighill Creek	KM 000	2573	1140.39	1140.39	1140.39	0	0	1140.36	1140.42	-0.03	0.03	1140.35	1140.42	-0.04	0.03
Bighill Creek	KM 000	2543	1140.10	1140.10	1140.10	0	0	1140.05	1140.14	-0.05	0.04	1140.07	1140.12	-0.03	0.02
Bighill Creek	KM 000	2517	1139.97	1139.97	1139.97	0	0	1139.96	1139.97	-0.01	0	1139.97	1139.96	0	-0.01
Bighill Creek	KM 000	2482	1139.00	1139.00	1139.00	0	0	1138.99	1139.07	-0.01	0.07	1138.99	1139.07	-0.01	0.07
Bighill Creek	KM 000	2387	1138.82	1138.82	1138.82	0	0	1138.80	1138.85	-0.02	0.03	1138.79	1138.85	-0.03	0.03
Bighill Creek	KM 000	2267	1138.15	1138.15	1138.15	0	0	1138.03	1138.23	-0.12	0.08	1138.09	1138.20	-0.06	0.05
Bighill Creek	KM 000	2161	1137.67	1137.67	1137.67	0	0	1137.68	1137.66	0.01	-0.01	1137.65	1137.69	-0.02	0.02
Bighill Creek	KM 000	2154	1137.40	1137.40	1137.40	0	0	1137.34	1137.46	-0.06	0.06	1137.36	1137.43	-0.04	0.03
Bighill Creek	KM 000	2106	1137.04	1137.04	1137.04	0	0	1137.00	1137.03	-0.04	-0.01	1137.03	1137.05	-0.01	0.01
Bighill Creek	KM 000	1937	1136.60	1136.60	1136.60	0	0	1136.57	1136.63	-0.03	0.03	1136.56	1136.63	-0.04	0.03
Bighill Creek	KM 000	1769	1136.09	1136.09	1136.09	0	0	1136.02	1136.13	-0.07	0.04	1136.06	1136.10	-0.03	0.01
Bighill Creek	KM 000	1723	1135.86	1135.86	1135.86	0	0	1135.81	1135.86	-0.05	0	1135.85	1135.85	-0.01	-0.01
Bighill Creek	KM 000	1720	1135.78	1135.78	1135.78	0	0	1135.69	1135.73	-0.09	-0.05	1135.76	1135.69	-0.02	-0.09
Bighill Creek	KM 000	1606	1135.11	1135.11	1135.11	0	0	1135.04	1135.16	-0.07	0.05	1135.07	1135.15	-0.04	0.04
Bighill Creek	KM 000	1536	1134.82	1134.82	1134.82	0	0	1134.81	1134.83	-0.01	0.01	1134.77	1134.85	-0.05	0.03
Bighill Creek	KM 000	1501	1134.58	1134.58	1134.58	0	0	1134.58	1134.60	0	0.02	1134.52	1134.63	-0.06	0.05
Bighill Creek	KM 000	1484	1134.01	1134.01	1134.01	0	0	1134.01	1134.00	0	-0.01	1134.00	1134.01	-0.01	0
Bighill Creek	KM 000	1395	1132.47	1132.47	1132.47	0	0	1132.46	1132.49	-0.01	0.02	1132.43	1132.52	-0.04	0.05
Bighill Creek	KM 000	1212	1131.77	1131.77	1131.77	0	0	1131.70	1131.81	-0.07	0.04	1131.72	1131.80	-0.05	0.03
Bighill Creek	KM 000	1202	1131.36	1131.36	1131.36	0	0	1131.25	1131.44	-0.11	0.08	1131.30	1131.39	-0.06	0.03
Bighill Creek	KM 000	1168	1130.99	1130.99	1130.99	0	0	1130.90	1131.08	-0.09	0.09	1130.98	1131.01	-0.01	0.02
Bighill Creek	KM 000	1095	1130.29	1130.29	1130.29	0	0	1130.19	1130.37	-0.10	0.08	1130.26	1130.31	-0.03	0.02

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Bighill Creek	KM 000	995	1129.37	1129.37	1129.37	0	0	1129.32	1129.41	-0.05	0.04	1129.31	1129.41	-0.06	0.04
Bighill Creek	KM 000	989	1129.28	1129.28	1129.28	0	0	1129.22	1129.33	-0.06	0.05	1129.21	1129.31	-0.07	0.03
Bighill Creek	KM 000	915	1128.47	1128.47	1128.47	0	0	1128.44	1128.49	-0.03	0.02	1128.38	1128.53	-0.09	0.06
Bighill Creek	KM 000	822	1127.44	1127.44	1127.44	0	0	1127.36	1127.49	-0.08	0.05	1127.39	1127.47	-0.05	0.03
Bighill Creek	KM 000	740	1126.72	1126.72	1126.72	0	0	1126.69	1126.74	-0.03	0.02	1126.67	1126.76	-0.05	0.04
Bighill Creek	KM 000	617	1126.62	1126.62	1126.62	0	0	1126.62	1126.62	0	0	1126.61	1126.62	-0.01	0
Bighill Creek	KM 000	586	1126.61	1126.61	1126.61	0	0	1126.61	1126.62	0	0.01	1126.61	1126.62	0	0.01
Bighill Creek	KM 000	576	1126.61	1126.61	1126.61	0	0	1126.61	1126.61	0	0	1126.61	1126.62	0	0.01
Bighill Creek	KM 000	505	1126.58	1126.58	1126.58	0	0	1126.58	1126.58	0	0	1126.58	1126.58	0	0
Bighill Creek	KM 000	454	1124.27	1124.27	1124.27	0	0	1124.15	1124.36	-0.12	0.09	1124.23	1124.30	-0.04	0.03
Bighill Creek	KM 000	376	1123.74	1123.74	1123.74	0	0	1123.73	1123.75	-0.01	0.01	1123.70	1123.77	-0.04	0.03
Bighill Creek	KM 000	369	1123.49	1123.49	1123.49	0	0	1123.50	1123.48	0.01	-0.01	1123.48	1123.51	-0.01	0.02
Bighill Creek	KM 000	335	1122.79	1122.79	1122.79	0	0	1122.72	1122.99	-0.07	0.20	1122.69	1122.84	-0.10	0.05
Bighill Creek	KM 000	262	1122.71	1122.71	1122.71	0	0	1122.49	1122.91	-0.22	0.20	1122.64	1122.76	-0.07	0.05
Bighill Creek	KM 000	211	1122.70	1122.70	1122.70	0	0	1122.48	1122.90	-0.22	0.20	1122.63	1122.75	-0.07	0.05
Bighill Creek	KM 000	206	1122.70	1122.70	1122.70	0	0	1122.47	1122.90	-0.23	0.20	1122.63	1122.75	-0.07	0.05
Bighill Creek	KM 000	185	1122.70	1122.70	1122.70	0	0	1122.47	1122.90	-0.23	0.20	1122.63	1122.75	-0.07	0.05
Exshaw Creek	KM 000	1319	1342.75	1342.75	1342.75	0	0	1342.68	1342.82	-0.07	0.07	1342.75	1342.75	0	0
Exshaw Creek	KM 000	1182	1338.97	1338.97	1338.97	0	0	1338.81	1339.08	-0.16	0.11	1338.97	1338.97	0	0
Exshaw Creek	KM 000	1105	1335.69	1335.69	1335.69	0	0	1335.69	1335.69	0	0	1335.69	1335.69	0	0
Exshaw Creek	KM 000	1014	1331.54	1331.54	1331.54	0	0	1331.37	1331.69	-0.17	0.15	1331.54	1331.54	0	0
Exshaw Creek	KM 000	922	1328.19	1328.19	1328.19	0	0	1328.19	1328.19	0	0	1328.19	1328.19	0	0
Exshaw Creek	KM 000	838	1323.16	1323.16	1323.16	0	0	1323.01	1323.30	-0.15	0.14	1323.16	1323.16	0	0
Exshaw Creek	KM 000	708	1317.90	1317.90	1317.90	0	0	1317.88	1317.92	-0.02	0.02	1317.90	1317.90	0	0
Exshaw Creek	KM 000	593	1313.16	1313.16	1313.16	0	0	1313.04	1313.28	-0.12	0.12	1313.16	1313.16	0	0
Exshaw Creek	KM 000	475	1307.83	1307.83	1307.83	0	0	1307.83	1307.83	0	0	1307.83	1307.83	0	0
Exshaw Creek	KM 000	454	1306.31	1306.31	1306.31	0	0	1306.28	1306.40	-0.03	0.09	1306.31	1306.31	0	0
Exshaw Creek	KM 000	449	1306.14	1306.14	1306.14	0	0	1306.05	1306.23	-0.09	0.09	1306.14	1306.14	0	0
Exshaw Creek	KM 000	434	1305.72	1305.72	1305.72	0	0	1305.68	1305.82	-0.04	0.10	1305.72	1305.72	0	0
Exshaw Creek	KM 000	352	1302.59	1302.59	1302.59	0	0	1302.48	1302.63	-0.11	0.04	1302.59	1302.59	0	0
Exshaw Creek	KM 000	233	1297.29	1297.29	1297.29	0	0	1297.24	1297.47	-0.05	0.18	1297.29	1297.29	0	0
Exshaw Creek	KM 000	219	1297.13	1297.13	1297.13	0	0	1297.04	1297.25	-0.09	0.12	1297.13	1297.13	0	0
Exshaw Creek	KM 000	198	1296.21	1296.21	1296.21	0	0	1296.13	1296.25	-0.08	0.04	1296.21	1296.21	0	0
Exshaw Creek	KM 000	190	1295.64	1295.64	1295.64	0	0	1295.64	1295.78	0	0.14	1295.64	1295.64	0	0
Exshaw Creek	KM 000	171	1294.23	1294.23	1294.23	0	0	1294.23	1294.23	0	0	1294.23	1294.23	0	0
Exshaw Creek	KM 000	161	1294.08	1294.08	1294.08	0	0	1293.97	1294.20	-0.11	0.12	1294.08	1294.08	0	0

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Exshaw Creek	KM 000	147	1294.03	1294.03	1294.03	0	0	1293.93	1294.14	-0.10	0.11	1294.03	1294.03	0	0
Exshaw Creek	KM 000	133	1293.90	1293.90	1293.90	0	0	1293.79	1294.01	-0.11	0.11	1293.90	1293.90	0	0
Exshaw Creek	KM 000	118	1293.69	1293.69	1293.69	0	0	1293.58	1293.80	-0.11	0.11	1293.69	1293.69	0	0
Exshaw Creek	KM 000	104	1293.27	1293.27	1293.27	0	0	1293.12	1293.40	-0.15	0.13	1293.27	1293.27	0	0
Exshaw Creek	KM 000	89	1292.47	1292.47	1292.47	0	0	1292.47	1292.47	0	0	1292.47	1292.47	0	0
Jumpingpound Ck	KM 000	5294	1154.88	1154.88	1154.88	0	0	1154.67	1155.09	-0.21	0.21	1154.90	1154.87	0.02	-0.01
Jumpingpound Ck	KM 000	5202	1154.07	1154.07	1154.07	0	0	1153.83	1154.30	-0.24	0.23	1154.07	1154.07	0	0
Jumpingpound Ck	KM 000	5101	1153.46	1153.46	1153.46	0	0	1153.25	1153.69	-0.21	0.23	1153.43	1153.49	-0.03	0.03
Jumpingpound Ck	KM 000	4984	1152.85	1152.85	1152.85	0	0	1152.71	1153.02	-0.14	0.17	1152.83	1152.87	-0.02	0.02
Jumpingpound Ck	KM 000	4882	1152.25	1152.25	1152.25	0	0	1151.96	1152.46	-0.29	0.21	1152.23	1152.27	-0.02	0.02
Jumpingpound Ck	KM 000	4791	1151.91	1151.91	1151.91	0	0	1151.55	1152.08	-0.36	0.17	1151.93	1151.90	0.02	-0.01
Jumpingpound Ck	KM 000	4648	1150.63	1150.63	1150.63	0	0	1150.63	1150.80	0	0.17	1150.63	1150.63	0	0
Jumpingpound Ck	KM 000	4550	1150.09	1150.09	1150.09	0	0	1149.89	1150.27	-0.20	0.18	1150.05	1150.12	-0.04	0.03
Jumpingpound Ck	KM 000	4463	1149.85	1149.85	1149.85	0	0	1149.62	1150.03	-0.23	0.18	1149.86	1149.84	0.01	-0.01
Jumpingpound Ck	KM 000	4369	1149.49	1149.49	1149.49	0	0	1149.35	1149.57	-0.14	0.08	1149.48	1149.48	-0.01	-0.01
Jumpingpound Ck	KM 000	4277	1148.43	1148.43	1148.43	0	0	1148.37	1148.68	-0.06	0.25	1148.44	1148.47	0.01	0.04
Jumpingpound Ck	KM 000	4168	1148.29	1148.29	1148.29	0	0	1148.17	1148.42	-0.12	0.13	1148.29	1148.29	0	0
Jumpingpound Ck	KM 000	4040	1147.04	1147.04	1147.04	0	0	1146.81	1147.22	-0.23	0.18	1146.94	1147.13	-0.10	0.09
Jumpingpound Ck	KM 000	3915	1146.85	1146.85	1146.85	0	0	1146.77	1146.89	-0.08	0.04	1146.76	1146.94	-0.09	0.09
Jumpingpound Ck	KM 000	3824	1145.98	1145.98	1145.98	0	0	1146.01	1146.06	0.03	0.08	1145.92	1146.01	-0.06	0.03
Jumpingpound Ck	KM 000	3672	1145.27	1145.27	1145.27	0	0	1145.18	1145.37	-0.09	0.10	1145.24	1145.29	-0.03	0.02
Jumpingpound Ck	KM 000	3591	1144.53	1144.53	1144.53	0	0	1144.39	1144.65	-0.14	0.12	1144.44	1144.59	-0.09	0.06
Jumpingpound Ck	KM 000	3503	1143.90	1143.90	1143.90	0	0	1143.77	1144.07	-0.13	0.17	1143.89	1143.91	-0.01	0.01
Jumpingpound Ck	KM 000	3363	1143.57	1143.57	1143.57	0	0	1143.49	1143.66	-0.08	0.09	1143.55	1143.63	-0.02	0.06
Jumpingpound Ck	KM 000	3202	1142.30	1142.30	1142.30	0	0	1142.16	1142.49	-0.14	0.19	1142.31	1142.30	0.01	0
Jumpingpound Ck	KM 000	3095	1141.43	1141.43	1141.43	0	0	1141.21	1141.65	-0.22	0.22	1141.42	1141.45	-0.01	0.02
Jumpingpound Ck	KM 000	3006	1140.83	1140.83	1140.83	0	0	1140.56	1141.05	-0.27	0.22	1140.79	1140.86	-0.04	0.03
Jumpingpound Ck	KM 000	2867	1140.28	1140.28	1140.28	0	0	1140.08	1140.47	-0.20	0.19	1140.24	1140.33	-0.04	0.05
Jumpingpound Ck	KM 000	2745	1139.86	1139.86	1139.86	0	0	1139.74	1140.00	-0.12	0.14	1139.84	1139.90	-0.02	0.04
Jumpingpound Ck	KM 000	2650	1139.11	1139.11	1139.11	0	0	1138.91	1139.26	-0.20	0.15	1139.07	1139.13	-0.04	0.02
Jumpingpound Ck	KM 000	2557	1138.57	1138.57	1138.57	0	0	1138.57	1138.66	0	0.09	1138.57	1138.62	0	0.05
Jumpingpound Ck	KM 000	2410	1137.99	1137.99	1137.99	0	0	1137.90	1138.04	-0.09	0.05	1137.98	1137.99	-0.01	0
Jumpingpound Ck	KM 000	2301	1137.42	1137.42	1137.42	0	0	1137.33	1137.53	-0.09	0.11	1137.36	1137.46	-0.06	0.04
Jumpingpound Ck	KM 000	2181	1136.72	1136.72	1136.72	0	0	1136.72	1136.74	0	0.02	1136.75	1136.72	0.03	0
Jumpingpound Ck	KM 000	2081	1136.33	1136.33	1136.33	0	0	1136.08	1136.49	-0.25	0.16	1136.31	1136.34	-0.02	0.01
Jumpingpound Ck	KM 000	1861	1134.61	1134.61	1134.61	0	0	1134.60	1134.62	-0.01	0.01	1134.63	1134.60	0.02	-0.01

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Jumpingpound Ck	KM 000	1733	1134.29	1134.29	1134.29	0	0	1134.20	1134.37	-0.09	0.08	1134.25	1134.32	-0.04	0.03
Jumpingpound Ck	KM 000	1592	1134.02	1134.02	1134.02	0	0	1133.97	1134.04	-0.05	0.02	1133.95	1134.06	-0.07	0.04
Jumpingpound Ck	KM 000	1455	1132.92	1132.92	1132.92	0	0	1132.89	1133.13	-0.03	0.21	1132.93	1132.92	0.01	0
Jumpingpound Ck	KM 000	1327	1132.33	1132.33	1132.33	0	0	1132.08	1132.51	-0.25	0.18	1132.31	1132.35	-0.02	0.02
Jumpingpound Ck	KM 000	1224	1131.93	1131.93	1131.93	0	0	1131.76	1132.05	-0.17	0.12	1131.96	1131.93	0.03	0
Jumpingpound Ck	KM 000	1056	1131.01	1131.01	1131.01	0	0	1130.82	1131.13	-0.19	0.12	1130.91	1131.07	-0.10	0.06
Jumpingpound Ck	KM 000	901	1130.65	1130.65	1130.65	0	0	1130.52	1130.77	-0.13	0.12	1130.62	1130.66	-0.03	0.01
Jumpingpound Ck	KM 000	791	1130.52	1130.52	1130.52	0	0	1130.44	1130.58	-0.08	0.06	1130.53	1130.49	0.01	-0.03
Jumpingpound Ck	KM 000	722	1130.51	1130.51	1130.51	0	0	1130.48	1130.54	-0.03	0.03	1130.52	1130.50	0.01	-0.01
Jumpingpound Ck	KM 000	665	1130.29	1130.29	1130.29	0	0	1130.29	1130.29	0	0	1130.29	1130.29	0	0
Jumpingpound Ck	KM 000	625	1128.93	1128.93	1128.93	0	0	1128.77	1129.06	-0.16	0.13	1128.84	1129.00	-0.09	0.07
Jumpingpound Ck	KM 000	562	1128.76	1128.76	1128.76	0	0	1128.62	1128.85	-0.14	0.09	1128.59	1128.80	-0.17	0.04
Jumpingpound Ck	KM 000	501	1127.91	1127.91	1127.91	0	0	1127.91	1127.90	0	-0.01	1127.90	1127.93	-0.01	0.02
Jumpingpound Ck	KM 000	386	1127.34	1127.34	1127.34	0	0	1127.21	1127.47	-0.13	0.13	1127.27	1127.39	-0.07	0.05
Jumpingpound Ck	KM 000	232	1126.76	1126.76	1126.76	0	0	1126.70	1126.92	-0.06	0.16	1126.68	1126.81	-0.08	0.05
Jumpingpound Ck	KM 000	116	1126.27	1126.27	1126.27	0	0	1125.92	1126.56	-0.35	0.29	1126.20	1126.32	-0.07	0.05
Policeman Creek	KM 000	6465	1315.92	1315.92	1315.92	0	0	1315.92	1315.92	0	0	1315.92	1315.92	0	0
Policeman Creek	KM 000	6418	1313.76	1313.76	1313.76	0	0	1313.67	1313.85	-0.09	0.09	1313.76	1313.76	0	0
Policeman Creek	KM 000	6410	1313.73	1313.73	1313.73	0	0	1313.63	1313.82	-0.10	0.09	1313.73	1313.73	0	0
Policeman Creek	KM 000	6344	1313.64	1313.64	1313.64	0	0	1313.55	1313.72	-0.09	0.08	1313.64	1313.64	0	0
Policeman Creek	KM 000	6312	1313.57	1313.57	1313.57	0	0	1313.48	1313.65	-0.09	0.08	1313.57	1313.57	0	0
Policeman Creek	KM 000	6227	1313.37	1313.37	1313.37	0	0	1313.28	1313.44	-0.09	0.07	1313.36	1313.37	-0.01	0
Policeman Creek	KM 000	6126	1313.11	1313.11	1313.11	0	0	1313.04	1313.17	-0.07	0.06	1313.10	1313.11	-0.01	0
Policeman Creek	KM 000	6075	1312.98	1312.98	1312.98	0	0	1312.93	1313.03	-0.05	0.05	1312.97	1312.98	-0.01	0
Policeman Creek	KM 000	6023	1312.88	1312.88	1312.88	0	0	1312.86	1312.91	-0.02	0.03	1312.87	1312.88	-0.01	0
Policeman Creek	KM 000	5960	1312.81	1312.81	1312.81	0	0	1312.81	1312.82	0	0.01	1312.80	1312.80	-0.01	-0.01
Policeman Creek	KM 000	5946	1312.66	1312.66	1312.66	0	0	1312.65	1312.68	-0.01	0.02	1312.65	1312.67	-0.01	0.01
Policeman Creek	KM 000	5877	1312.65	1312.65	1312.65	0	0	1312.65	1312.65	0	0	1312.64	1312.66	-0.01	0.01
Policeman Creek	KM 000	5782	1312.64	1312.64	1312.64	0	0	1312.64	1312.64	0	0	1312.63	1312.66	-0.01	0.02
Policeman Creek	KM 000	5719	1312.64	1312.64	1312.64	0	0	1312.64	1312.64	0	0	1312.63	1312.65	-0.01	0.01
Policeman Creek	KM 000	5673	1312.60	1312.60	1312.60	0	0	1312.58	1312.60	-0.02	0	1312.59	1312.61	-0.01	0.01
Policeman Creek	KM 000	5666	1312.30	1312.30	1312.30	0	0	1312.24	1312.36	-0.06	0.06	1312.29	1312.31	-0.01	0.01
Policeman Creek	KM 000	5651	1312.15	1312.15	1312.15	0	0	1312.13	1312.18	-0.02	0.03	1312.15	1312.16	0	0.01
Policeman Creek	KM 000	5646	1311.93	1311.93	1311.93	0	0	1311.87	1311.98	-0.06	0.05	1311.90	1311.96	-0.03	0.03
Policeman Creek	KM 000	5599	1311.68	1311.68	1311.68	0	0	1311.63	1311.72	-0.05	0.04	1311.67	1311.68	-0.01	0
Policeman Creek	KM 000	5531	1311.67	1311.67	1311.67	0	0	1311.64	1311.68	-0.03	0.01	1311.66	1311.67	-0.01	0

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Policeman Creek	KM 000	5468	1311.64	1311.64	1311.64	0	0	1311.62	1311.65	-0.02	0.01	1311.64	1311.64	0	0
Policeman Creek	KM 000	5364	1311.61	1311.61	1311.61	0	0	1311.60	1311.61	-0.01	0	1311.60	1311.61	-0.01	0
Policeman Creek	KM 000	5257	1311.59	1311.59	1311.59	0	0	1311.58	1311.58	-0.01	-0.01	1311.58	1311.59	-0.01	0
Policeman Creek	KM 000	5248	1311.58	1311.58	1311.58	0	0	1311.58	1311.58	0	0	1311.58	1311.58	0	0
Policeman Creek	KM 000	5163	1311.58	1311.58	1311.58	0	0	1311.58	1311.57	0	-0.01	1311.58	1311.58	0	0
Policeman Creek	KM 000	5110	1311.58	1311.58	1311.58	0	0	1311.57	1311.57	-0.01	-0.01	1311.57	1311.57	-0.01	-0.01
Policeman Creek	KM 000	5101	1311.57	1311.57	1311.57	0	0	1311.57	1311.56	0	-0.01	1311.57	1311.57	0	0
Policeman Creek	KM 000	5023	1311.56	1311.56	1311.56	0	0	1311.56	1311.55	0	-0.01	1311.56	1311.56	0	0
Policeman Creek	KM 000	4985	1311.10	1311.10	1311.10	0	0	1311.09	1311.12	-0.01	0.02	1311.09	1311.11	-0.01	0.01
Policeman Creek	KM 000	4936	1311.00	1311.00	1311.00	0	0	1310.98	1311.00	-0.02	0	1311.01	1311.01	0.01	0.01
Policeman Creek	KM 000	4907	1310.77	1310.77	1310.77	0	0	1310.75	1310.78	-0.02	0.01	1310.77	1310.78	0	0.01
Policeman Creek	KM 000	4880	1310.51	1310.51	1310.51	0	0	1310.45	1310.56	-0.06	0.05	1310.47	1310.54	-0.04	0.03
Policeman Creek	KM 000	4855	1310.42	1310.42	1310.42	0	0	1310.42	1310.43	0	0.01	1310.40	1310.44	-0.02	0.02
Policeman Creek	KM 000	4852	1310.20	1310.20	1310.20	0	0	1310.21	1310.20	0.01	0	1310.20	1310.21	0	0.01
Policeman Creek	KM 000	4796	1310.08	1310.08	1310.08	0	0	1310.05	1310.10	-0.03	0.02	1310.05	1310.10	-0.03	0.02
Policeman Creek	KM 000	4726	1310.05	1310.05	1310.05	0	0	1310.01	1310.07	-0.04	0.02	1310.02	1310.07	-0.03	0.02
Policeman Creek	KM 000	4720	1310.01	1310.01	1310.01	0	0	1309.98	1310.04	-0.03	0.03	1309.99	1310.03	-0.02	0.02
Policeman Creek	KM 000	4714	1310.00	1310.00	1310.00	0	0	1309.96	1310.03	-0.04	0.03	1309.97	1310.02	-0.03	0.02
Policeman Creek	KM 000	4675	1309.95	1309.95	1309.95	0	0	1309.91	1309.97	-0.04	0.02	1309.92	1309.97	-0.03	0.02
Policeman Creek	KM 000	4603	1309.72	1309.72	1309.72	0	0	1309.68	1309.75	-0.04	0.03	1309.68	1309.75	-0.04	0.03
Policeman Creek	KM 000	4544	1309.47	1309.47	1309.47	0	0	1309.44	1309.50	-0.03	0.03	1309.44	1309.50	-0.03	0.03
Policeman Creek	KM 000	4463	1309.08	1309.08	1309.08	0	0	1309.02	1309.12	-0.06	0.04	1309.05	1309.10	-0.03	0.02
Policeman Creek	KM 000	4380	1308.81	1308.81	1308.81	0	0	1308.78	1308.86	-0.03	0.05	1308.80	1308.82	-0.01	0.01
Policeman Creek	KM 000	4337	1308.78	1308.78	1308.78	0	0	1308.75	1308.81	-0.03	0.03	1308.77	1308.78	-0.01	0
Policeman Creek	KM 000	4320	1308.62	1308.62	1308.62	0	0	1308.57	1308.68	-0.05	0.06	1308.62	1308.63	0	0.01
Policeman Creek	KM 000	4220	1308.50	1308.50	1308.50	0	0	1308.44	1308.55	-0.06	0.05	1308.49	1308.50	-0.01	0
Policeman Creek	KM 000	4184	1308.47	1308.47	1308.47	0	0	1308.41	1308.52	-0.06	0.05	1308.46	1308.47	-0.01	0
Policeman Creek	KM 000	4030	1308.32	1308.32	1308.32	0	0	1308.27	1308.38	-0.05	0.06	1308.32	1308.32	0	0
Policeman Creek	KM 000	3921	1308.24	1308.24	1308.24	0	0	1308.20	1308.29	-0.04	0.05	1308.24	1308.24	0	0
Policeman Creek	KM 000	3888	1308.18	1308.18	1308.18	0	0	1308.14	1308.23	-0.04	0.05	1308.18	1308.18	0	0
Policeman Creek	KM 000	3862	1308.00	1308.00	1308.00	0	0	1307.98	1308.03	-0.02	0.03	1308.00	1308.00	0	0
Policeman Creek	KM 000	3835	1308.01	1308.01	1308.01	0	0	1308.00	1308.04	-0.01	0.03	1308.01	1308.01	0	0
Policeman Creek	KM 000	3784	1308.00	1308.00	1308.00	0	0	1308.00	1308.03	0	0.03	1308.00	1308.00	0	0
Policeman Creek	KM 000	3713	1307.95	1307.95	1307.95	0	0	1307.95	1307.98	0	0.03	1307.95	1307.95	0	0
Policeman Creek	KM 000	3685	1307.53	1307.53	1307.53	0	0	1307.48	1307.58	-0.05	0.05	1307.53	1307.54	0	0.01
Policeman Creek	KM 000	3527	1307.40	1307.40	1307.40	0	0	1307.33	1307.46	-0.07	0.06	1307.39	1307.40	-0.01	0

River	HEC-RAS Model Sub-Reach	River Station (m)	Baseline 100-yr	Reservoir Level				Channel Roughness				Floodplain Roughness			
				Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
			W.S. Elev.	W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline		W.S. Elev.		Difference from Baseline	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
Policeman Creek	KM 000	3354	1307.36	1307.36	1307.36	0	0	1307.29	1307.42	-0.07	0.06	1307.36	1307.37	0	0.01
Policeman Creek	KM 000	3191	1307.34	1307.34	1307.34	0	0	1307.27	1307.40	-0.07	0.06	1307.33	1307.34	-0.01	0
Policeman Creek	KM 000	3154	1307.31	1307.31	1307.31	0	0	1307.24	1307.38	-0.07	0.07	1307.30	1307.32	-0.01	0.01
Policeman Creek	KM 000	3141	1307.29	1307.29	1307.29	0	0	1307.21	1307.35	-0.08	0.06	1307.28	1307.30	-0.01	0.01
Policeman Creek	KM 000	3002	1307.14	1307.14	1307.14	0	0	1307.06	1307.21	-0.08	0.07	1307.13	1307.15	-0.01	0.01
Policeman Creek	KM 000	2822	1306.99	1306.99	1306.99	0	0	1306.93	1307.04	-0.06	0.05	1306.98	1307.00	-0.01	0.01
Policeman Creek	KM 000	2804	1306.96	1306.96	1306.96	0	0	1306.89	1307.01	-0.07	0.05	1306.94	1306.97	-0.02	0.01
Policeman Creek	KM 000	2782	1306.94	1306.94	1306.94	0	0	1306.89	1307.00	-0.05	0.06	1306.93	1306.96	-0.01	0.02
Policeman Creek	KM 000	2666	1306.67	1306.67	1306.67	0	0	1306.61	1306.72	-0.06	0.05	1306.65	1306.69	-0.02	0.02
Policeman Creek	KM 000	2518	1306.53	1306.54	1306.54	0	0	1306.50	1306.56	-0.04	0.02	1306.49	1306.57	-0.05	0.03
Policeman Creek	KM 000	2394	1306.49	1306.50	1306.50	0	0	1306.46	1306.52	-0.04	0.02	1306.45	1306.54	-0.05	0.04
Policeman Creek	KM 000	2306	1306.48	1306.49	1306.49	0	0	1306.45	1306.51	-0.04	0.02	1306.44	1306.53	-0.05	0.04
Policeman Creek	KM 000	2128	1306.25	1306.25	1306.25	0	0	1306.21	1306.28	-0.04	0.03	1306.20	1306.29	-0.05	0.04
Policeman Creek	KM 000	1771	1306.19	1306.19	1306.19	0	0	1306.16	1306.23	-0.03	0.04	1306.15	1306.23	-0.04	0.04
Policeman Creek	KM 000	1560	1306.18	1306.18	1306.18	0	0	1306.15	1306.22	-0.03	0.04	1306.14	1306.22	-0.04	0.04
Policeman Creek	KM 000	1544	1306.18	1306.18	1306.18	0	0	1306.14	1306.22	-0.04	0.04	1306.13	1306.22	-0.05	0.04
Policeman Creek	KM 000	1373	1306.18	1306.18	1306.18	0	0	1306.14	1306.22	-0.04	0.04	1306.13	1306.21	-0.05	0.03

APPENDIX C
DIGITAL FILES

Digital files supplied via FTP

Table C-1 Hydraulic Model Creation and Calibration- Digital Data Deliverables

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
HYDRAULIC MODEL - STRUCTURES					
	Flood Control Structures (Dikes)	Dike and berm locations, based on field surveys and information from AEP and local agencies. Esri file geodatabase polyline feature class.	Name = descriptive name of structure; Owner = owner of structure; StreamName = stream name for hydraulic model; SurveyStatus = "NHC Surveyed 2015" or "NHC Surveyed 2016"; X_Start, Y_Start, X_End, Y_End = 3TM coordinates of upstream and downstream ends of the feature; ChainDS = river station at downstream end of feature; FeatureType = "flood control structure" or "other feature".	UpperBowFHS_HydraulicModel.gdb\	Structures\Dikes
	Hydraulic Structures - Bridges	Point locations of bridges for hydraulic modelling, based on field surveys. Esri file geodatabase point feature class.	NHC_ID = unique point ID assigned by NHC; StreamName = stream name for hydraulic modelling, or "side channel" for features not directly on modelled reaches; RiverStation = stream chainage; Municipality = municipality where bridge is located; RoadTrail = road or trail name; Owner = owner of structure, where known; OwnerID = ID assigned by owner; Type = bridge type (e.g., pedestrian, road); Desc = bridge description (e.g., timber, concrete, steel); Span = span in metres; Width = width in metres; NoPiers = number of piers; Elev_TC = top chord elevation; Elev_Deck = deck elevation; Elev_LC = low chord elevation (highest low chord elevation); SurveyStatus = "NHC Surveyed 2015" or "NHC Surveyed 2016"; Crew = NHC survey crew; InModel = indicates whether structure will be included in hydraulic model; Photo = indicates whether there is a field photo of the structure; ModelComment = explains why feature is not included in model; ToA_L, ToA_R = top of abutment elevation in metres, left and right; TC_L, TC_M, TC_R = top of curb elevation in metres, left, midspan, right; TD_L, TD_M, TD_R = top of deck elevation in metres, left, midspan, right; LC_L, LC_M, LC_R = low chord elevation in metres, left, midspan, right.	UpperBowFHS_HydraulicModel.gdb\	Structures\Bridges

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
	Hydraulic Structures - Culverts	Point locations of culverts for hydraulic modelling, based on field surveys. Additional descriptive information is given in the Culvert attribute table (below). Esri file geodatabase point feature class.	NHC_ID = unique point ID assigned by NHC;StreamName = stream name for hydraulic modelling, or "side channel" for features not directly on modelled reaches;RiverStation = stream chainage;Municipality = municipality or general location;Road_Trail = road or trail name;Owner = owner of structure;OwnerID = ID assigned by owner;InModel = indicates whether structure will be included in hydraulic model;ModelComment = explains why feature is not included in model;Photo = indicates whether there is a field photo of the structure.	UpperBowFHS_HydraulicModel.gdb\	Structures\Culverts
	Hydraulic Structures - Culvert attributes	Table describing culvert features. There may be more than one culvert at each point location. Use a "relate" in ArcMap to do a one-to-many join for culvert points to culvert attributes. Esri file geodatabase table.	NHC_ID = unique culvert point ID assigned by NHC (used to link this table to the culvert point table with a one-to-many relate); Info = indicates whether information was available from a design drawing; Survey = NHC survey crew; Shape = culvert shape; Material = culvert material; BarrelLen = barrel length in metres; Diameter = diameter, rise or height in metres; Span = span or width in metres; USInv, DSInv = upstream and downstream invert elevations; Entrance = entrance condition; Comment.	UpperBowFHS_HydraulicModel.gdb\	tabCulverts
	Hydraulic Structures - Dams	Point locations of dams, based on orthophoto. Esri file geodatabase point feature class.	Dam_ID = unique point ID assigned by NHC; Name = dam name; StreamName = stream name; Chain = chainage location of feature along stream; 3TM_X, 3TM_Y = easting and northing coordinates in NAD83 CSRS 3TM 114 metres	UpperBowFHS_HydraulicModel.gdb\	Structures\Dams
	Railway Embankments	Railways identified as embankments within the model area. Based on National Railway Network features. Esri file geodatabase polyline feature class.	OWNERENA = owner name; TRKUSR1ENA = track user name.	UpperBowFHS_HydraulicModel.gdb\	Structures\RwyEmbankments
	Highway Embankments	Highways identified as embankments within the model area. Based on National Road Network features. Esri file geodatabase polyline feature class.	ROADCLASS = road type; RTNUMBER = route number; RTENAME1EN = route name.	UpperBowFHS_HydraulicModel.gdb\	Structures\HwyEmbankments

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
HYDRAULIC MODEL - SURVEY					
	Bathymetry Extents	Portion of each model cross section where elevation values were extracted from bathymetric survey data rather than Lidar DEM data. For sections where no bathymetric survey data was used, a small polygon is included (required for HEC-GeoRAS use). Esri file geodatabase polygon feature class.	None.	UpperBowFHS_HydraulicModel.gdb\	Survey\BathyExtents
	Survey Points, NHC Fall 2015 and Spring 2016	Processed point survey data from NHC's fall 2015 and spring 2016 ground and bathymetric surveys of the Upper Bow River. Esri file geodatabase point feature class.	UnqID = unique ID number for each point; PtID = ID number assigned in field (not unique); N_3TM, E_3TM = northing and easting coordinates in NAD83 CSRS 3TM 114 metres; Elev = point elevation in metres; FieldCrew = field crew that collected the data; Date_x, Time_x = date and time in years, months, days, hours, minutes, seconds (where available); StdCode = standard point code; CodeDesc = description to match StdCode; BasePt = base point used to tie in survey data	UpperBowFHS_HydraulicModel.gdb\	Survey\SurveyPts
HYDRAULIC MODEL – MODEL INPUTS					
	Stream Centrelines	Stream network centrelines, developed for hydraulic modelling. Calibrated with reach length. Esri file geodatabase polyline feature class.	StreamName = name of stream to be modelled; Length_m = line length to nearest metre (used for chainage calibration); ReachName = name of reach to be modelled (based on chainage of downstream extent); StrmGeoRAS = stream name modified for use in GeoRAS (which has a 16 character limit); Strm_Reach = merge of StreamName and ReachName.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\StreamNtwk
	Stream Centrelines - modified in HEC-RAS	A copy of the original Stream Centrelines layer, with alignment of Policeman Creek modified in the HEC-RAS model to simulate backwatering of Bow River flood water. Esri file geodatabase polyline feature class.	RiverCode = name of stream to be modelled; ReachCode = name of reach to be modelled.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\StreamNtwk_ModifiedInModel

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
	Model Cross Sections	Cross section lines. Created for hydraulic modelling. Esri file geodatabase polyline feature class.	XSLnID = unique line ID assigned by NHC; River = stream name; Reach = reach name; RS = river station value to nearest metre; ModelXS = merge of River, Reach and RS; Version = "Historic" for existing section resurveyed by NHC, "NHC" for new section surveyed by NHC, "Dam" for interpolated section at dam location; SurveyStatus = "NHC Surveyed 2015" and "NHC Surveyed 2016" for sections surveyed by NHC, "Lidar/interp" for sections interpolated from Lidar.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\CrossSections
	Model Cross Sections - modified in HEC-RAS	A copy of the original Model Cross Sections layer, with modifications made in HEC-RAS to reflect changes along Policeman Creek. Esri file geodatabase polyline feature class.	See Model Cross Sections.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\CrossSections_ModifiedInModel
	Bridge and Culvert Sections	3D representation of bridge and culvert sections. Esri file geodatabase polyline feature class.	NHC_ID = NHC ID, based on Bridge and Culvert point layers; River = stream name; Reach = reach name; Station = river station; USDistance = distance from upstream side of bridge to upstream cross section (1 for all culverts, values to be adjusted in HEC-RAS); TopWidth = bridge width (null for all culverts); DEMSource = notes on source data used to derive 3D line elevation values; USXS = river station value for upstream cross section.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\BridgesCulverts3D
	Flow Zones	River separated into sub reaches, with inflow values for each sub reach. Esri file geodatabase polyline feature class.	FlowZone = unique ID; FlowZoneNa = flow zone name; US_RS = river station value for upstream end of flow zone; Q1000 to Q2 = open water flows (may be revised in future); Q2013, Q2012, Q2005, Q1990, Q1986 = calibration flows; Q100Hist = 100-year flows used in previous AEP flood hazard studies.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\FlowZones

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
	Banklines	Banklines digitized based on survey data, 2015 Lidar, and 2013 orthoimagery. Used as a guide in HEC-RAS model development, but banklines in HEC-RAS model have subsquently been changed. Esri file geodatabase polyline feature class.	BankDescription = location of bank.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\Banklines
	Bank Points	Bank points based on information from HEC-RAS model. Originally based on banklines, but modified in model. Esri file geodatabase point feature class.	River = stream name; Reach = reach name; ModelXS = merge of River, Reach and RS.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\Bankpoints
	Flow Path Centrelines	Flow path centrelines. Esri file geodatabase polyline feature class.	Location = left or right bank.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\FlowPathCentrelines
	Ineffective Flow Areas	Ineffective flow areas used for input to the model. Esri file geodatabase polygon feature class.	Permanent = y or n, indicates whether area is permanent or temporary; Elevation = elevation (in metres GD) for temporary IFA only, IFA is removed in model when elevation is exceeded; Descript = type of ineffective flow area and comments.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\IneffectiveFlowAreas
	Ineffective Flow Areas - point modifications	Points showing ineffective flow area values modified in HEC-RAS. Esri file geodatabase point feature class.	River = stream name; Reach = reach name; RS = river station value to nearest metre; GIS_ModelX = merge of River, Reach and RS; Left, Right = cross section stationing for left and right markers; Elev = marker elevation.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\IneffectiveFlowAreas_ModifiedInModel

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
	Roughness Polygons	Roughness polygons. Land cover was mapped in reference to 2013 and 2016 orthophotos and 2015 Lidar bare earth and full feature data. Roughness values were assigned based on land cover. Esri file geodatabase polygon feature class.	Type = land cover classification; Code = code assigned to each land cover and roughness zone (1 to 24); n_Value = Manning's n value will be assigned in final HEC-RAS model based on roughness code.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\Roughness
	Flow Transfer Locations	Location of lateral structures where flow is transferred from Bow River to Policeman Creek using rating curves developed using RAS2D model results.	Location = lateral structure ID number (from upstream to downstream); To = to river station value (in metres); From = from river station value (in metres).	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\FlowTransferPoints
	Canmore Boundary Line	Line delineating break between Bow River-influenced and Policeman Creek-influenced areas in the hydraulic model for Canmore floodplain. Determined based on flow conditions, topography, roads and property boundaries. Esri file geodatabase polyline feature class.	Comment = description of source of line segment.	UpperBowFHS_HydraulicModel.gdb\	ModelInputs\CanmoreBoundaryLine

CATEGORY	TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
HYDRAULIC MODEL – CALIBRATION					
	Historic Information - Highwater Marks	Point locations of highwater marks, based on past reports. There may be duplicate points, if the HWM was recorded at the same location on different dates. Esri file geodatabase point feature class.	NHC_ID = unique point ID assigned by NHC; Agency = name of agency that reported data; SiteID = point ID assigned by reporting agency; Year_ = year HWM elevation recorded; X, Y = easting and northing coordinates in NAD83 CSRS 3TM 114 metres; HWM = HWM elevation in metres; WL = water level in metres, if available; Report_Source = name of report; Location = description of HWM location; Notes1 = notes from original drawings or reports; Notes2 = NHC notes on usefullness of data for modelling; Date_Time = date and time HWM recorded, if available; StreamName = model stream name; ReachName = model reach name (NULL for points outside of modelling area); ChainModel = closest model river station (NULL for points outside of modelling area); ForCalibration = indicates whether HWM was used for calibration or not.	UpperBowFHS_HydraulicModel.gdb\	Historic\HWMs
	Hydrometric Gauges	Hydrometric gauges within study limits, operated by Water Survey of Canada (WSC) and TransAlta. Esri file geodatabase point feature class.	Station_Na = station name; Station_Nu = station number; Latitude, Longitude = latitude and longitude location; Ownership = "TransAlta" or "WSC"; Years_of_D = number of years of data; Status = "Active" or "Discontinued"; In_Study_A = in current study area or not; Bow_RS = river station (in metres) on Bow River; Water_Leve = period of record for water level data; Discharge = period of record for discharge data; Rating_Cur = latest year of rating curve data, where available.	UpperBowFHS_HydraulicModel.gdb\	HydrometricStns\HydrometricStns
	Lidar 2015 Coverage by Date	2015 Lidar topographic data coverage by date. Esri file geodatabase polygon feature class.	Date = date (YYMMDD) when Lidar data collected.	UpperBowFHS_HydraulicModel.gdb\	Topography\Lidar2015Coverage