



**Southern Alberta Flood Recovery Task Force  
Flood Mitigation Measures for the Bow River,  
Elbow River and Oldman River Basins  
Volume 1 – Summary Recommendations Report**

Submitted to:

**Southern Alberta Flood Recovery Task Force**  
Calgary, Alberta

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## TABLE OF CONTENTS

	PAGE
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SCOPE OF STUDY .....</b>	<b>1</b>
2.1 Geographic Extent.....	1
2.2 Design Standard of Protection .....	1
<b>3.0 REPORT FORMAT .....</b>	<b>2</b>
<b>4.0 MAJOR INFRASTRUCTURE .....</b>	<b>3</b>
4.1 Elbow River Dams .....	3
4.1.1 Dam at McLean Creek.....	3
4.1.2 Offline Storage at Springbank Road.....	4
4.1.3 Recommendations for Major Infrastructure .....	5
4.2 Bow River Dams.....	5
<b>5.0 GENERAL RECOMMENDATIONS .....</b>	<b>6</b>
5.1 Residual Flood Risk .....	6
5.2 Flood Forecasting and Warning Improvements.....	6
5.2.1 Central Flood Forecasting System .....	6
5.2.2 Replacement and Upgrade of Telemetry Outstations.....	7
5.2.3 Protection of Downstream Communities and Infrastructure .....	7
5.2.4 Improvements to Flood Hazard Mapping .....	7
<b>6.0 RECOMMENDATIONS FOR LOCAL MEASURES IN THE BOW RIVER BASIN.....</b>	<b>8</b>
6.1 Emergency Response Plan for Stoney Nakoda First Nation.....	8
6.2 Cochrane Flood Study Update .....	8
6.3 Allen Bill Pond .....	8
6.4 Highway 40 – Hood Creek Bridge .....	9
6.5 Siksika First Nation.....	9
6.6 Raising of Road and Dykes at Priddis.....	9
<b>7.0 RECOMMENDATIONS FOR LOCAL MEASURES IN THE ELBOW RIVER BASIN ....</b>	<b>10</b>
7.1 Channel Diversions .....	10
7.2 Flood Defences at Bragg Creek.....	10
7.3 Economic Appraisal for Dams on the Elbow River .....	10
<b>8.0 RECOMMENDATIONS FOR THE OLDMAN RIVER BASIN .....</b>	<b>11</b>
8.1 Pincher Creek.....	11



8.2	Fort MacLeod .....	11
8.3	Cardston .....	11
8.4	Piikani First Nation .....	12
<b>9.0</b>	<b>GENERAL RECOMMENDATIONS .....</b>	<b>12</b>
<b>10.0</b>	<b>CLOSURE.....</b>	<b>13</b>

## **1.0 INTRODUCTION**

Following the floods of June 2013, the Government of Alberta (GoA) set up the Southern Alberta Flood Recovery Task Force (SAFRTF). In October 2013, AMEC Environment and Infrastructure, a Division of AMEC Americas Limited (AMEC), was contracted to provide a flood mitigation feasibility study for the Bow River, Elbow River, and Oldman River basins.

This study was undertaken under contract to the SAFRTF (CON0015233) and in accordance with the agreed AMEC proposal document submitted to the SAFRTF on 16<sup>th</sup> September 2013.

## **2.0 SCOPE OF STUDY**

### **2.1 Geographic Extent**

AMEC was contracted to undertake a feasibility study of flood mitigation measures for the Bow River, Elbow River, and Oldman River basins, excluding areas within the City of Calgary. Although mitigation measures within the City of Calgary were not part of the project scope, AMEC was asked to review proposals made by the Flood Advisory Panel (FAP) for dry dams on the Elbow River (at sites EQ1 and EC1) as part of the project scope. It cannot be ignored that proposed dams are primarily for the benefit of Calgary as it would be unfeasible and unnecessary to construct a dam solely for the benefit of properties upstream of Calgary. It is therefore not possible to undertake a flood mitigation study for the Bow River or Elbow River, and to review proposals for dams in those basins, without considering the needs of Calgary to some degree.

The scope of study evolved throughout the contract. Through consultation with the SAFRTF, the project scope can be summarized as:

- Flood mitigation measures for the Elbow River Basin upstream of Calgary city limits;
- Flood mitigation measures for the Bow River basin down to the confluence with the Oldman River, not including Land within Calgary city limits, Highwood River Basin, and Sheep River Basin;
- Flood mitigation measures for the Oldman River Basin;
- Review of proposals by the FAP for dry dams at EQ1 (Quirk Creek) and EC1 (Canyon Creek) on the Elbow River; and
- Review of anticipated flow reductions was made possible with the construction of dry dams on the Ghost River upstream of Waiparous Creek (site BG1) and Waiparous Creek upstream of the Ghost River (BW1).

### **2.2 Design Standard of Protection**

Though the 2013 flood event was the primary driver for these studies, in flood frequency terms, the storm was not uniform across all of the basins within the study area. The flood was much worse in the Elbow River than in the Oldman River Basin. Several estimates have been made of the flood frequency on the Elbow River and though there is variation, all estimates place the

2013 event somewhere between 0.1% annual exceedance probability (AEP) and 1% AEP, and generally in the region of 0.2% AEP.

Part of the problem with estimating the probability of the event is that the established stage discharge relationships for the gauging stations along the Elbow River were based on stream flow measurements that were far less than those experienced in June 2013, and as such, the rating curves could not be relied upon to produce accurate discharge estimates. There was also a large amount of out-of-bank flow and massive changes in channel morphology during the event which makes post event analysis very difficult and highly variable. The destruction of key gauging stations along the Elbow River meant that some of the data had to be “reconstructed” or estimated to produce a volumetric analysis.

Early on in the study, it was agreed with SAFRTF that the design standard of protection would be consistently be the 1% AEP flood and that the 2013 flood event (or other worst event on record) would be used as a check to determine if the proposed mitigation measures, with freeboard allowance, would have protected the infrastructure and people at risk.

The optimal design standard depends on the economic, social and technical feasibility of a scheme. There is a “sweet spot” that must be achieved between standard of protection, damage avoided and cost. The optimum may not necessarily be the worst event on record or even the 1% AEP flood. It may not always be possible to achieve the 1% AEP standard of protection; however, in economic terms, most of the damage avoided (benefit) during the design life of a flood defence is gained from protecting areas that flood with a high frequency.

This balance can only be struck with adequate time to survey past and future (predicted) flood damages and an economic benefit/cost appraisal.

To this end, there are specific recommendations related to the assessment of economic viability for each proposed scheme, as well as for communication of residual flood risk to the public.

### **3.0 REPORT FORMAT**

This suite of reports consists of four volumes as follows:

- Volume 1: Summary Recommendations Report (this report)
- Volume 2: General Information
- Volume 3: Stakeholder Engagement Report
- Volume 4: Flood Mitigation Measures

In recognition of the significance of the major infrastructure projects that are required to protect the City of Calgary to a standard of protection of at least 1% AEP, this report will commence with a description of two dam projects that AMEC has identified which, subject to ongoing geotechnical investigations, may be feasible. The report will also describe ongoing work to assess the flood storage potential in the Bow River basin.

Recommendations are set out in the four volumes of this report in the following format:

### **Recommendation V#.#:**

The V#.# refers to the volume number and sequential recommendation number from that volume. This is to enable the reader of this report to easily cross reference recommendations in later volumes should additional supporting information be desired.

## **4.0 MAJOR INFRASTRUCTURE**

### **4.1 Elbow River Dams**

#### **4.1.1 Dam at McLean Creek**

This project concept considers building an earth fill dam across the main stem of the Elbow River. It includes a combined concrete outlet/service spillway structure for discharging normal and flood flows, and includes an auxiliary earth cut spillway channel to protect the dam from extreme floods up to the probable maximum flood (PMF) event.

The proposed earth fill dam (main embankment) traverses a river gorge which is approximately 110 m wide at the base and is steep walled for a height of about 28 m. The river valley itself bends sharply to the north-northeast at the dam site, facilitating the construction of an auxiliary spillway on the right bank. Similarly, the topography and river alignment are well suited for construction of a permanent outlet/spillway structure in the left valley abutment.

The project has been designed to contain a minimum 41,200 dam<sup>3</sup> of flood water which, when combined with the 15,400 dam<sup>3</sup> that can be made available with relatively short notice at the Glenmore Reservoir, would provide protection for the 1% AEP flood (41,200 dam<sup>3</sup>) to the existing works in the Elbow Valley floodplain downstream of the Glenmore Reservoir. Additional storage is provided above the minimum 41,200 dam<sup>3</sup> value which will provide significant additional protection for larger floods. As currently envisioned in this conceptual design, the maximum flood storage at this site is 58,000 dam<sup>3</sup> prior to auxiliary spillway activation (i.e., reservoir El. 1,426.5 m). Even more storage could be provided at this site with a higher dam; but project costs would be significantly higher.

This conceptual design includes a small permanent pool in the valley bottom extending from the river bottom elevation of 1,379.0 m to outlet structure intake invert elevation of 1,398.0 m, thereby permanently containing approximately 4,000 dam<sup>3</sup> of water as dead storage. This storage would serve to prevent incoming larger bottom sediment from plugging the intake area, and could also replace Allen Bill Pond, which was destroyed by the flood.

With capital and maintenance allowance and an assumed design life of 100 years, the estimated present value of the capital cost ( $PV_{\text{cost}}$ ) of construction and the annual or programmed maintenance to keep the structure or scheme operational for this project is \$290.7 million with a preliminary benefit cost ratio of 0.6.

The conceptual design (description and drawings) and estimated project costs are provided in **Appendix F of Volume 4**.

#### **4.1.2 Offline Storage at Springbank Road**

The off-stream dam site at Springbank Road (SR1) is located just west of Calgary, approximately 18.5 km upstream of the Glenmore Reservoir in a relatively undeveloped valley in a ranchland area.

This concept considers diverting extreme flood flow from the Elbow River into an off-stream storage reservoir where it would be temporarily contained and later released back into the Elbow River after the flood peak has passed. Project components include a diversion weir system constructed across the Elbow River, and a diversion channel system excavated through the adjacent uplands to transport flood water into an off-stream reservoir storage site. The storage site includes a main embankment to contain the diverted flood water and a low level outlet structure incorporated into the embankment to release the water back into the Elbow River after the flood peak has passed.

The offline storage has been designed to contain a minimum 41,200 dam<sup>3</sup> of flood water, which when combined with the 15,400 dam<sup>3</sup> that can be made available with relatively short notice at the Glenmore Reservoir, would provide full protection for the 1% AEP flood to the existing works in the Elbow Valley floodplain downstream of the Glenmore Reservoir. Additional storage is provided above the minimum 41,200 dam<sup>3</sup> value which will provide significant additional protection for larger floods, should they occur. As currently envisioned in this conceptual design, the maximum flood storage at the site is 57,000 dam<sup>3</sup> (i.e., reservoir El. 1,210.5 m). Even more storage could be provided at this site with a higher dam but project costs would be higher.

The project could be designed as a dry pond, or could include a smaller permanent storage pond (live storage). The permanent pond component would serve to dissipate energy when flood water enters the reservoir, and could be used for recreational/environmental purposes and/or an additional water supply source for the City of Calgary. For the purpose of this conceptual assessment a live storage containment of 9,000 dam<sup>3</sup> has been assumed providing a maximum pond depth of 10 m.

With capital and maintenance allowance and an assumed design life of 100 years, the estimated  $PV_{\text{cost}}$  for this project is \$193.8 million with a preliminary benefit cost ratio of 0.9. This  $PV_{\text{cost}}$  is for construction and maintenance only and does not include an allowance for land acquisition. This scheme does not protect Bragg Creek. Therefore, to achieve the same level of protection for communities along the Elbow River, the SR1 scheme would need to allow for an additional investment of \$6.2 million for flood dykes in Bragg Creek.

The conceptual design (description and drawings) and estimated project costs are provided in **Appendix G of Volume 4**.

### 4.1.3 Recommendations for Major Infrastructure

At the time of writing this report, only limited ground investigation data were available at McLean Creek (MC1) and Springbank Road (SR1). The data that is being obtained is vital in determining the viability of either scheme. Though the schemes are radically different in design, based on the information currently available there is little to choose between the two in terms of economics.

Since time is an important factor in this project and a decision cannot be made as to the viability of either scheme, it is recommended that environmental assessments and design for both MC1 and SR1 be taken forward until such time as one becomes the preferred project.

**Recommendation V1.1:** Environmental assessments and preliminary design for both MC1 and SR1 schemes should be progressed until such time as one becomes the preferred scheme.

## 4.2 Bow River Dams

The effects of constructing a dam on the Ghost River upstream of Waiparous Creek were assessed as part of this study at the request of the SAFRTF. A flood routing model was prepared using HEC-HMS to assess the regulating effect of Ghost Dam on downstream discharges. Two model scenarios were investigated. The first was storage of the whole hydrograph (i.e., no discharge from the Ghost River), to test the maximum achievable reduction in peak discharge, and 60% storage to simulate a more realistic scenario.

The modelling found that peak discharges would be reduced by 6% to 10% (77 to 129 m<sup>3</sup>/s) depending on the design capacity. The flow reductions were then compared with the rating curve at the Water Survey of Canada gauging station (WSC Site 05BH004 Bow River at Calgary) to indicate an expected water level reduction.

Water levels along the Bow River in Calgary would potentially be reduced by a maximum of 0.18 to 0.27 m if 100% of the Ghost River flow is retained. Retaining 60% of the discharge from the Ghost River would result in water level reductions in the range of 0.1 to 0.16 m.

The FAP also recommended the construction of a dam upstream of Benchlands on Waiparous Creek. Due to time constraints on this project, this scenario was not modelled. The basin area of Waiparous Creek is less than that of the Ghost River (upstream of Waiparous Creek) and; therefore, a logical conclusion can be drawn that the benefit of a dam on this creek would be less than that from a dam on the Ghost River.

To provide full protection to the City of Calgary, it is necessary to undertake a full and rigorous review of potential storage sites in the Bow River basin upstream of Calgary. This was not part of the project scope for this study. It is recommended that a detailed review of available storage capacity and operating procedures within existing TransAlta Corporation (TransAlta) facilities be coupled with the identification of new storage sites to determine whether a 1% AEP standard of



protection can be offered to the City of Calgary from the Bow River at an economically justifiable cost.

**Recommendation V1.2:** A detailed review of available storage capacity and operating procedures within existing TransAlta facilities should be coupled with the identification of new storage sites to determine whether a 1% AEP standard of protection can be offered to the City of Calgary using flood storage.

## 5.0 GENERAL RECOMMENDATIONS

### 5.1 Residual Flood Risk

Flood mitigation measures cannot guarantee that flooding will never occur in the protected area. In fact, the introduction of some structural mitigation measures merely changes the pathway to flooding or nature of the risk. For example, the construction of a flood control dam or levees may reduce fluvial flooding but a new risk of breach is introduced and must be taken into consideration in the design process. Risks are often highest during the construction of the mitigation measure, as a flood may occur before the structural integrity of the defence is assured by completion. A breach in a half finished flood defence presents a very serious hazard to those who are meant to be protected.

In view of this residual risk, it is recommended that the GoA communicate to the public that flood risk can only be reduced, not eliminated.

**Recommendation V2.1:** The GoA should make beneficiaries of flood mitigation schemes aware of the nature and extent of residual flood risk after a scheme is complete.

### 5.2 Flood Forecasting and Warning Improvements

#### 5.2.1 Central Flood Forecasting System

A centralized technical approach to flood warning covering the major urban areas of Alberta is required. The proposed development of a flood warning service aligns with the GoA's seven pillars of mitigation. This would build upon the work currently carried out by Alberta Environment and Sustainable Resource Development River Forecast Centre and would provide residential property owners, business owners and first responders with direct flood warnings via text and email for specific river reaches.

**Recommendation V4.1:** The GoA should seek to improve the flood forecasting and warning system by developing a Provincial Flood Forecasting Shell and introducing an SMS text messaging or email warning system for all members of the public who sign up to receive direct flood warnings for a given flood risk area.

## 5.2.2 Replacement and Upgrade of Telemetry Outstations

It is recommended that a major investment be made to replace the stations that were destroyed in June 2013 or in previous floods with a more robust system. This will require a planning study to determine which stations are critical for flood forecasting and for flood frequency analysis across the province and to identify improvements to these stations to ensure continuity and integrity of the gauge record.

**Recommendation V4.2:** It is recommended that a major investment be made to replace the destroyed telemetry outstations and to upgrade those that were damaged and other vulnerable stations to improve the robustness of the flood forecasting and warning system.

## 5.2.3 Protection of Downstream Communities and Infrastructure

A fundamental aspect of undertaking to provide flood protection at a location is that the defences must not cause an increase in risk elsewhere. Construction of flood defences in one location can vary significantly, increasing the risk of flooding elsewhere. For example, building dykes or diversions that protect one area from flooding may jeopardize the operation or safety of a downstream asset such as a reservoir (dam) or downstream dykes. It is recommended that any proposals for flood defences be supported with sufficient engineering evidence that the downstream flood risk to communities or infrastructure will not be increased or that it is done so in a planned and manageable way.

**Recommendation V4.3:** It is recommended that any proposals for flood defences be supported with sufficient engineering evidence that the downstream flood risk to communities or infrastructure will not be increased or that it is done so in a planned and manageable way.

One way of ensuring that flood defence improvements in one area do not adversely affect flood risk in another is to take a basin wide approach to the planning of flood defence infrastructure. It is therefore recommended that the GoA undertake river basin flood management plans as part of the long-term flood management strategy, and that these plans are executed under a single responsible authority. Current studies being undertaken by consultants for the Athabasca River, Red Deer River, Highwood River, Sheep River, Elbow River, Bow River, and Oldman River and South Saskatchewan River basins could form the foundation for these plans.

**Recommendation V4.4:** It is recommended that the Government of Alberta fund the development of Basin Flood Management Plans for each of the major basins in the province and that these plans are developed and executed by a single responsible authority.

## 5.2.4 Improvements to Flood Hazard Mapping

There has been considerable improvement in the availability of high quality topographic data on a basin scale since the 1980s. The use of light detection and ranging (LiDAR) to undertake

flood mapping is now standard and the accuracy to which floodplain extents can be delineated has improved considerably as a result.

It is recommended that current flood mapping for the province be reviewed and that all flood studies undertaken without benefit of LiDAR or other high quality Digital Terrain Model (DTM), or those where there has been considerable development, be revisited to ensure accuracy.

**Recommendation V4.5:** It is recommended that current flood mapping for the province be reviewed and that all flood studies undertaken without benefit of LiDAR or other high quality DTM, or those where there has been considerable development, be revisited to ensure accuracy.

## **6.0 RECOMMENDATIONS FOR LOCAL MEASURES IN THE BOW RIVER BASIN**

### **6.1 Emergency Response Plan for Stoney Nakoda First Nation**

During engagements with the Stoney Nakoda First Nation, they indicated that there was a need to develop an emergency response plan (ERP) for the community. This ERP would cover more than flooding. Funding should be allocated to the Nation to hire consultants with specialist flooding and emergency response experience to undertake the work on their behalf.

**Recommendation V4.6:** It is recommended that an ERP be developed for Stoney Nakoda First Nation and for it to include a plan for post disaster recovery.

### **6.2 Cochrane Flood Study Update**

This study has identified deficiencies in the flood mapping at Cochrane. It is recommended that the 1990 flood study be updated with current modelling and mapping techniques. Though a 1-D modelling approach will be adequate, there should be some accounting for the likelihood of ice dams occurring downstream of Cochrane and the associated backwater affects.

**Recommendation V4.7:** It is recommended that an update of the 1990 flood study for Cochrane be undertaken to reflect new development and land raising. This assessment should include a reassessment of the risk of ice dams or blockages.

### **6.3 Allen Bill Pond**

This study considers the construction of a dam at MC1 downstream of Allen Bill Pond; the pond would be within the impoundment area of this dam. The conceptual dam design includes a permanent pond and this could be an effective replacement for the lost recreation at Allen Bill Pond. If reconstructed, this recreation area will be at risk of flooding in the future.

**Recommendation V4.8:** It is recommended that the Allen Bill Pond area be returned to nature.

#### 6.4 Highway 40 – Hood Creek Bridge

The Hood Creek crossing on Highway 40 is currently a 2 m diameter corrugated steel pipe (CSP). There is a long history of maintenance issues at this crossing because the watercourse flows through a narrow canyon just before reaching Highway 40. The high velocities through this reach carry debris (trees, boulders, gravel and silt) for deposition at the culvert inlet. In June 2013, the road acted effectively as a dam and a torrent of debris 10 m high built up to block the road.

In a memo provided to Alberta Transportation for another study, AMEC recommended that a bridge would require less maintenance and would provide a larger opening to allow debris flows from the Hood Creek basin to pass beneath the highway.

**Recommendation V4.9:** The corrugated steel pipe culvert at Hood Creek on Highway 40 is prone to blockages and it is recommended that this culvert be replaced with a new bridge at a capital cost of approximately \$2.9M.

#### 6.5 Siksika First Nation

The stakeholder engagement response identified that there were plans to move certain residences and infrastructure from the flood area. There is no detailed flood hazard mapping available for the Siksika reserve. It is therefore recommended that a flood hazard mapping study be undertaken prior to the relocation of this infrastructure to ensure it is moved sufficiently away from floodway and flood fringe areas where possible.

**Recommendation V4.10:** It is recommended that flood hazard mapping is undertaken and stakeholder engagement is held with the Siksika Nation to determine which properties are candidates for removal from the floodway. Flood defences should also be constructed at locations identified in **Appendix D** of **Volume 4**.

#### 6.6 Raising of Road and Dykes at Priddis

Though there is little infrastructure within the floodway, there is a risk to access and egress during a flood event at Priddis if Range Road 32 becomes impassable. Several properties will be cut off in this case. A simple means of protecting the integrity of this access is to raise the road and to armour the riverside of the road embankment to ensure that erosion does not become problematic.

No specific recommendation was made in the report because it is felt that this upgrade is unlikely to be economically viable. Upon implementing Recommendation V4.19 (below) the viability of the scheme at Priddis should be re-examined.

## **7.0 RECOMMENDATIONS FOR LOCAL MEASURES IN THE ELBOW RIVER BASIN**

### **7.1 Channel Diversions**

Previous studies have suggested that flow could be diverted from the Elbow River near Bragg Creek into Priddis Creek.

At Priddis, downstream of the confluence with Fish Creek, the 1% AEP estimate is 244 m<sup>3</sup>/s. There is already a considerable floodway area with infrastructure and properties at risk. Using Priddis Creek to carry Elbow River overflow would significantly extend the floodway and increase flood risk to properties already at risk. The Priddis flood study does not estimate flood frequency beyond the 1% AEP event. However, more than doubling the discharge through Priddis would require substantial buyouts or an engineered channel through the hamlet to ensure those risks are managed effectively. For this reason, AMEC does not feel that this is a feasible option for the protection of the City of Calgary.

**Recommendation V4.11:** It is recommended that the concept of diverting flow from the Elbow River into the Priddis/Fish Creek basin be abandoned.

### **7.2 Flood Defences at Bragg Creek**

If flood protection infrastructure for the City of Calgary is located downstream of Bragg Creek, there may be a need to protect the hamlet with dykes. Also, the construction schedule for a major infrastructure project may be long. If a decision is made to proceed with SR1 as the preferred flood storage scheme for the Elbow River, then the detailed design and planning for the dykes at Bragg Creek should be initiated as soon as possible.

**Recommendation V4.12:** It is recommended that once the preferred scheme for Calgary has been identified, flood defences, if necessary, be constructed as soon as possible at Bragg Creek.

### **7.3 Economic Appraisal for Dams on the Elbow River**

A flood mitigation scheme should be underpinned by a robust economic assessment. In order to determine whether it makes economic sense to repair damage or to protect assets at risk, a detailed economic appraisal should assess damages avoided for the lifetime of the proposed scheme. This is important both for major infrastructure projects where the investment is potentially in the hundreds of millions of dollars and local schemes costing much less. The probability of an event occurring again is a major consideration.

It is recommended a complete economic appraisal be undertaken for all technically feasible projects including the 58<sup>th</sup> Avenue tunnel (being studied by the City of Calgary) and dams at MC1 and SR1.

**Recommendation V4.13:** It is recommended a complete economic appraisal of feasible engineering flood mitigation options be undertaken following completion of the conceptual design for the Calgary (58<sup>th</sup> Ave) tunnel and the dams at MC1 and SR1.

## 8.0 RECOMMENDATIONS FOR THE OLDMAN RIVER BASIN

### 8.1 Pincher Creek

There are areas in the floodway and flood fringe which may be viewed as potential development lands. It is recommended that no further development should be allowed in these areas subject to the provision of a site specific flood risk assessment demonstrating that the development lies outside the 1% AEP flood area.

**Recommendation V4.14:** It is recommended that development be restricted in the floodway and flood fringe areas in Pincher Creek subject to a site specific flood risk assessment demonstrating that the development lies outside the 1% AEP flood area.

Existing flood defences at Pincher Creek may be inadequate to protect to the 1% AEP flood. It is therefore recommended that a thorough condition survey of the existing defences be undertaken. This was not possible during this contract due to time constraints and winter weather. There are also signs of erosion on the left bank of Pincher Creek at the Kettle Creek confluence. This should also be repaired.

**Recommendation V4.15:** A thorough condition survey should also be undertaken for the existing flood defences in Pincher Creek. The survey should include an assessment of the standard of protection offered by the existing defences and raised where appropriate. The left bank of Pincher Creek should be armoured at the confluence with Kettle Creek.

### 8.2 Fort MacLeod

There are groynes to prevent the outflanking of the bridge at Highway 811. There is still considerable erosion on the left bank and abutment. This needs to be repaired. It is recommended that the left bank abutment at Highway 811 Oldman River Bridge be armoured as per the drawings in **Appendix J** of **Volume 4**.

**Recommendation V4.16:** It is recommended that the left bank bridge abutment at Highway 811 Oldman River bridge be armoured.

### 8.3 Cardston

The channel at Cardston has been dredged in the past. There appears to be some aggradation in the channel; however, the extent of dredging necessary cannot be determined without revisiting the channel hydraulic model. It is recommended that the flood study for Cardston be

updated with new modeling and mapping to reflect the current river bathymetry and development in the town.

**Recommendation V4.17:** The hydraulic model and flood mapping for Cardston should be updated to determine if dredging of the channel is necessary to improve conveyance.

#### 8.4 Piikani First Nation

The Piikani First Nation identified that erosion is problematic along the Oldman River through the reserve lands. Due to the timing of the Piikani engagement meeting and the completion of this study, AMEC cannot follow up this and make specific recommendations for erosion protection for the Oldman River through the Piikani Reserve. It is therefore recommended that further investigations are undertaken with regards to erosion control through the Piikani Reserve and also with regards to the provision of storm water drainage in Brocket.

**Recommendation V4.18:** It is recommended that further investigations are undertaken with regards to erosion control through the Piikani Reserve and also with regards to the provision of storm water drainage in Brocket.

#### 9.0 GENERAL RECOMMENDATIONS

If the GoA intends to embark on a major investment in flood defence infrastructure, this investment should be underpinned by economic appraisal and to achieve this, flood frequency/damage curves should be developed for all riverside communities where investments are planned. It is recommended that a study be undertaken to estimate flood damages using a common methodology to ensure that comparisons can be made for prioritisation of projects. This project could be undertaken on a province-wide basis.

**Recommendation V4.19:** It is recommended that a major study be undertaken to estimate flood damages using a methodology or approach similar to the 1986 Elbow River Floodplain Management Study Report.

It is recommended that a robust economic appraisal be undertaken prior to the investment in a flood control dam on the Elbow River. Based on the assumptions and limited data available for this report, it is likely that an economic case can be made to invest upwards of \$200 million on flood defence infrastructure in the Elbow River basin.

**Recommendation V4.20:** It is recommended that a robust economic appraisal be undertaken prior to the investment in major flood control infrastructure in the Bow River, Elbow River or Oldman River basins.

Given that the scope of work assigned to AMEC did not include specific measures for the City of Calgary, this study was limited in terms of investigations into the flood storage potential along



the Bow River. It is recommended that a comprehensive investigation into flood storage sites along the Bow River be undertaken.

**Recommendation V1.21:** It is recommended that further study is undertaken on potential reservoir sites within the Bow River basin and that this study be coordinated with GoA representatives who are negotiating with TransAlta.

## 10.0 CLOSURE

This report has been prepared for the exclusive use of the Southern Alberta Flood Recovery Task Force. This report is based on, and limited by, the interpretation of data, circumstances, and conditions available at the time of completion of the work as referenced throughout the report. It has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made.

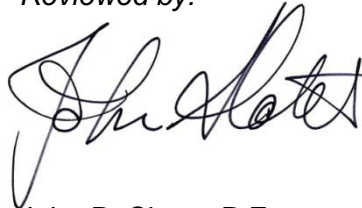
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**Permit to Practice No. P-4546**