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Enabling Delta Life

Alberta Environment and Parks
Resilience and Mitigation
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Date	Our reference	Number of pages
7 October 2015	1220924-001-BGS-0003-c	1
From	**Direct line**	**E-mail**
Hans van Duijne	+31(0)88335 7776	hans.vanduijne@deltares.nl

Subject
Review of two flood mitigation projects: Bragg Creek / Springbank off-stream flood storage and McLean Creek flood storage

Dear Mr Wilson, H. Andrew,

Attached you find the letter-report on the Review of two flood mitigation projects: Bragg Creek / Springbank off-stream flood storage and McLean Creek flood storage. Our additional considerations are mentioned in this report.

We trust this review serves you in the decision making process.

Yours sincerely,

Original signed by:

ing. J.D.G. van Duijne
international project manager

Enclosures
1

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Date	Our reference	Number of pages
October 7, 2015	1220924-001-BGS-0001-lk	8
From	**Direct line**	**E-mail**
Hans van Duijne	+31(0)88335 7776	hans.vanduijne@deltares.nl

Subject
Review of two flood mitigation projects: Bragg Creek / Springbank off-stream flood storage and McLean Creek flood storage

ISSUE:
The southern part of the Province of Alberta suffered from severe flood in June 2013. The flood resulted in loss of life, considerable damage to houses and public infrastructure, and social disruption. Possible flood mitigation projects have been identified to lower the flood risk. The present summary reviews two flood mitigation projects proposed for the Elbow River, namely the Bragg Creek / Springbank off-stream flood storage (SR1) and the McLean Creek flood storage (MC1). Both projects aim at the storage of flood water and thus reducing the peak river discharge through Calgary.

We conclude that, based on the current design concepts, both storage sites can provide the **required storage** for the 1:200 event used as design flood. As with all detention measures, the effect of storage heavily depends on the expected range in possible flood hydrographs, accurate forecasts and quick response in the operation of the gates. Both schemes would be best positioned as a part of an overall plan for water management within the watershed. We estimate that MC1 and SR1 would achieve a similar reduction in flood risk once built. SR1 has a lower risk of catastrophic structure failure during construction than MC1. MC1 has a small advantage for the Hamlet of Bragg Creek because no additional measures are required to protect the hamlet. But since the proposal for SR1 also includes flood protection measures to be taken specifically for Bragg Creek, this difference is small.

Without additional information on **sediment transport**, it is difficult to express a well substantiated preference for either of the two projects from this point of view. However, given the fact that MC1 will trap all bed-material load, one might argue that MC1 is likely to have more impact on sediment transport. This would imply that SR1 could be preferred from this point of view. This needs to be verified by sediment transport studies. The impact of SR1 to the natural flow of the Elbow is smaller than MC1. **From an environmental point of view, SR1 leaves the river as a more natural system.**

SUMMARY:
The following table is a summary of our assessment of the two projects:

Subject		Comments	Recommende
Efficacy	Storage	Both storage facilities have sufficient storage capacity for 1:200 return period and can offer the same level of protection.	SR1/MC1
	Sedimentation	Both storage facilities are susceptible to sedimentation and need regular and timely maintenance; however SR1 is less sensitive	SR1
	Water Management	Both schemes provide similar value in terms of water management It is expected that SR1 is more sensitive for differences in flood hydrograph or inaccurate forecasts than MC1. The catchment area for SR 1 is much larger and located well downstream of MC1. The effect of storage at the MC1 site on the discharge in Calgary may, however, also depend on the runoff that is generated downstream of the proposed location. This seems to be less of a problem for the SR1 location. SR 1 is closer to the operational response teams (response time shorter), is easier accessible (more than one access route) and is less vulnerable to damage of these access roads during extreme weather conditions	SR1/MC1
	Climate Change	Both facilities can be adapted to climate change	SR1/MC1

Cost Benefit	Construction	SR1 can be built off stream and is less dependent on (extreme) seasonal influences in river discharges, which might influence construction time outs. Both SR1 and MC1 have similar impact on existing infrastructure (road reallocation) and reconstruction of existing infrastructure. The total cost estimate for SR1 include protection for Bragg Creek and Redwood Meadows. The use for SR1 during flooding can(is to) be compensated for the damage to the owners after use. The option enables the current land owners to retain ownership and be compensated post flood events. Overall SR1 is less costly according to the consultants' reports. As the economic benefits are the same, the benefit/cost ratio is higher for SR1.	SR1
	Operational	Both storage facilities need a fast response to their operation; this is a critical issue, especially at SR1.	SR1/MC1
Risks		Timing: SR1 can be constructed one year quicker. Regulatory risk: It is expected that the regulatory process would be significantly longer for MC1 than SR1 due to the need for environmental mitigation and First Nations consultation. Construction: MC1 has potential for catastrophic failure during construction. Cost: the construction location has a higher risk of cost escalation due to topography.	SR1
Environmental Impacts		MC1 has detrimental effects to the environmental impact on spawning grounds and wild life trekking. SR1 is pasture land and its use does not change except during high river discharges.	SR1
Social impacts	Landownership	Affected residents are not in favour of SR1. MC1 is located on Crown land. There would be significant impact to First Nations traditional uses and recreational users of the MC1 area if MC1 went forward. Environmental NGO's are opposing the MC1 option, as MC1 is affects the natural system more than SR1.	SR1/MC1
Overall		Between the two schemes, SR1 is recommended	SR1

ADDITIONAL CONSIDERATIONS:

The province should continue to pursue the multiple layers approach to flood mitigation as outlined in previous work on Room for the River, structural mitigation is only one element. Programs like wetland restoration, flood way regulations and removal of obstructions should continue. Temporary storage of water in detention areas is not a very robust measure, in the sense that it is effective up to a certain design condition, but when it is overcharged its effect is reduced to nil. And, moreover, it is very sensitive to 'sound operation and fast response time'. When floods up to the size of the June 2013 flood would be avoided, but anything above would not be reduced in size, the awareness of the people in the floodplain will further decline, making them (and society at large) even more vulnerable.
Other considerations in relation to adopting Room-for-the-River principles were reported by Frans Klijn (memo October 29, 2014). Increasing the discharge capacity of rivers usually results in less sudden responses in terms of water level rise, less sudden flooding, and lesser flooding depths than embankments or detention in reservoirs.

BACKGROUND:

McLean Creek flood storage (MC1)

The Elbow River Dam at McLean Creak (MC1) site is located in the Green Zone on Crown Land approximately 10 km upstream of the hamlet of Bragg Creek, and immediately upstream of the confluence of McLean Creek with the Elbow River.

As described by AMEC (2014a), this project involves building an earth-fill dam across the main stem of the Elbow River. 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 (maximum height 50m). The dam includes a combined concrete outlet/service spillway structure for discharging normal and flood flows, and includes an auxiliary earth cut channel spillway to protect the dam from extreme floods up to the Probable Maximum Flood (PMF) event. The permanent outlet/service spillway is a gated conduit structure with its intake invert located about 21 m above the valley bottom. The concrete gates would typically be left in a wide-open position thereby allowing free passage of river water with minimum rise of the reservoir level during normal flow conditions (i.e., non-flood). The gates would be strategically closed during flood events thereby holding back a significant portion of the flow in reservoir storage. The concrete structure also serves as an emergency spillway designed to let above-design floods pass, thereby protecting the dam from potential overtopping or overloading and associated catastrophic failure.

The conceptual design includes a small permanent pool in the valley bottom, permanently containing approximately 4,000 dam^3 of water as dead storage. This storage should prevent incoming larger bottom sediment from plugging the intake area. There is no low level outlet to release the dead storage. Additional water could be contained above the dead storage El. 1,398.0 m (i.e., multi-use storage) by regulating the permanent outlet gates. The potential benefit and/or need for multi-use storage at this site has not yet been reported.

The dam site and reservoir area are shown in Figure 1.

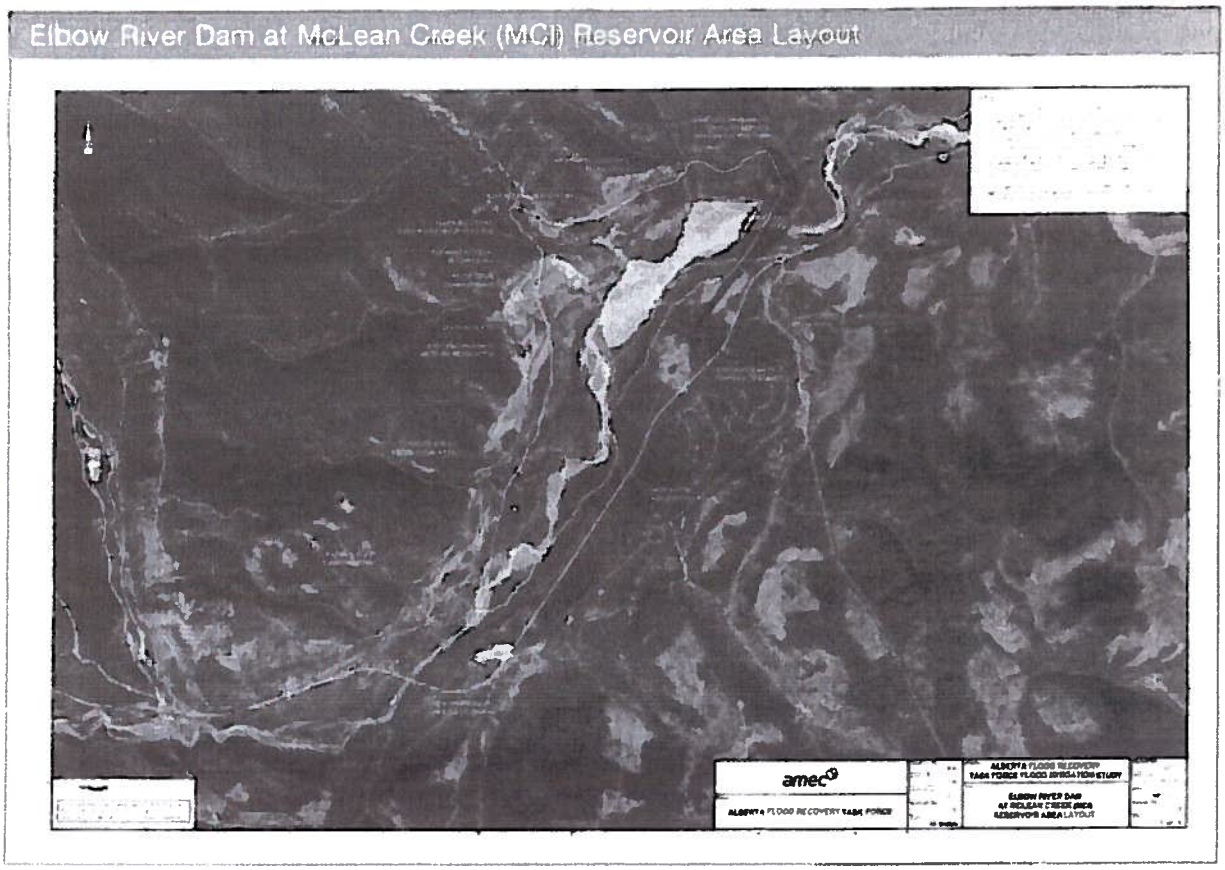

Figure 1 *L ocation and reservoir area of the Elbow River Dam at McLean Creak (MC1)*

Springbank off-stream flood storage (SR1)

The Springbank off-stream storage (SR1) site is located just west of Calgary approximately 18.5 km upstream of the Glenmore Reservoir in a relatively undeveloped farmland and ranchland valley. According to the concept prepared by AMEC (2014b), the SR1 concept involves 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.

The project consists of:

1 a diversion structure constructed across the Elbow River;
2 a diversion channel excavated through the adjacent uplands to transport flood water into an off-stream storage reservoir; and
3 an earth-fill dam to temporarily contain the diverted flood water and a low level outlet structure incorporated into the dam to later release the stored water back into the Elbow River after the flood peak has passed.

The diversion structure would consist of a concrete overflow weir section crossing the Elbow River, a gated concrete sluiceway/fishway located on the left valley abutment with its invert at the river thalweg level, and another gated diversion outlet structure located in the left valley abutment immediately upstream of the sluiceway.
The diversion weir component of the diversion structure is a 100 m long concrete structure with an ogee crest shape and a hydraulic jump stilling basin This structure serves to reduce approach velocities and increase the river water level to facilitate diversion through the outlet structure into the diversion channel.
The outlet structure invert level would be located approximately 1.5 m above the river thalweg in order to prevent that larger bottom sediment enters the diversion channel.

The diversion channel was originally designed to convey a peak diversion flow of 300 m^3/s[1] from the Elbow River into the off-stream storage reservoir. The channel is designed with a 24 m bottom width three horizontal to one vertical side slopes and a 3.6 m water depth.

A 3 km long earth-fill storage dam, having a maximum height of 24 m, is required to contain the diverted flood water. The dam system will include a gated low-level outlet structure. The structure will include a 1.5 m wide by 1.8 m high concrete conduit through the dam, including a gatewell tower located near the dam centerline. This structure will be used to release stored water back into the river after the flood has passed.

It should be acknowledged that detailed engineering design has not occurred for either scheme and both are subject to refinement.

[1] *In the Stantec adjusted design (April 2015) this seems to be removed, only a 40 m wide spillway/sluicegate in the river bed is assumed. Also Stantec adjusted the diversion channel capacity to 600 m^3/s, with design 6.4 m water depth. Also the storage dam is a bit higher and a few 100 m downstream. Same intake location from the river, and same outlet structure at the dam*

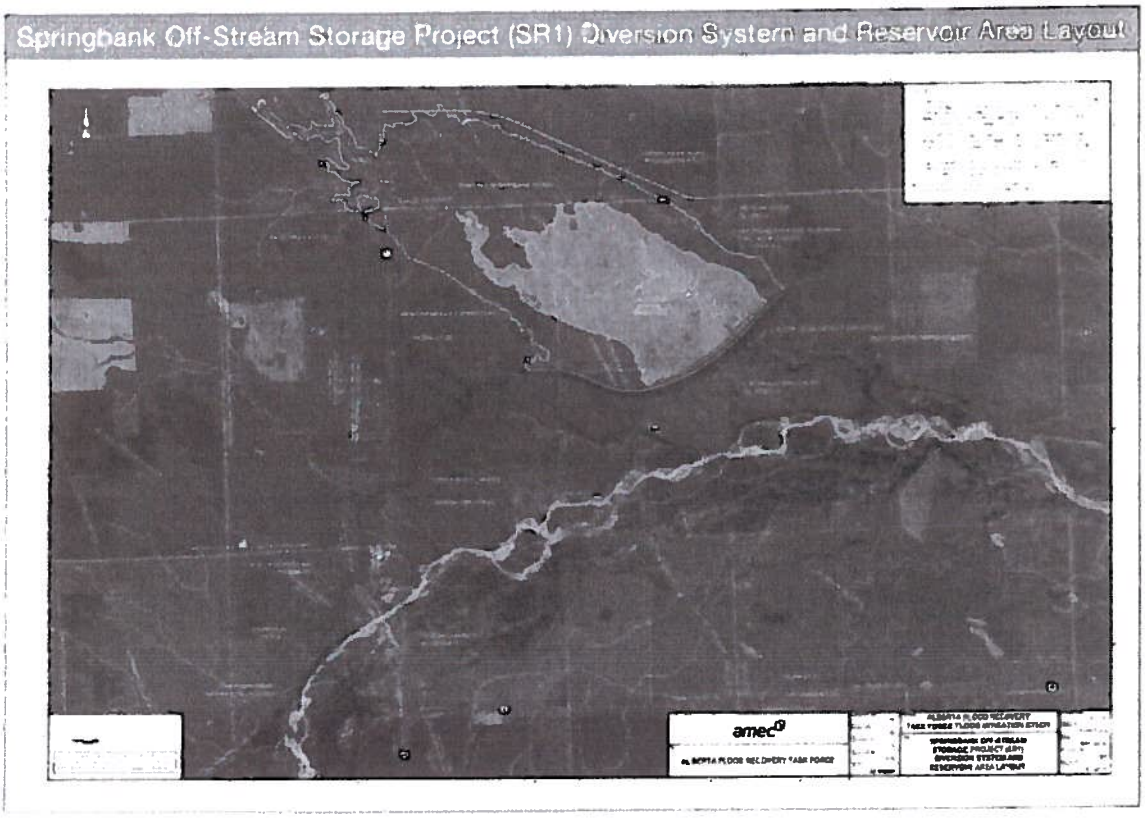

Figure 2 Location and reservoir area of the Springbank off-stream storage project (SR1)

DECISION CONSIDERATIONS:

Storage:
We conclude that, depending on the design, both storage sites can provide the required storage volumes. As with all detention measures, in-stream or off-stream, the effect of storage heavily depends on the expected range in possible flood hydrographs, accurate forecasts and quick operation of the gates. It is expected that SR1 is more sensitive for differences in flood hydrograph or inaccurate forecasts than MC1. However, the effect of storage at the MC1 site on the discharge in Calgary will also depend on the runoff that is generated downstream of the proposed location. This is likely to be less of a problem at the SR1 location.

Risk:
We think that MC1 and SR1 would achieve a similar reduction in flood risk once built. SR1 has a lower risk of cost escalation, regulatory risk leading to extended timing, and catastrophic structure failure during construction than MC1.

Cost estimate:

Item	Cost	
	MC1	SR1
Total 1:200 year protection	$343,581,000	$263,668,000

SR1 is cheaper (± 20 - 25%) than MC1 and therefore results in a higher benefit/cost ratio. It is recommended to consider compensating the damage after use instead of buying all of the reservoir land at SR1, if possible. Depending on the frequency of use and the extent of the damage, this might be more cost effective and supports future agricultural use. It is also recommended to explore possibilities for future modifications in reservoir design to cope with increased floods.
MC1 has a small advantage in that no additional measures are required to protect Bragg Creek and Redwood Meadows. But since SR1 costs also include flood protection for Bragg Creek and Redwood Meadows, this difference is small.

Erosion and sedimentation:
Without additional information on sediment transport, it is not possible to express a well substantiated preference for either of the two measures from this point of view. However, as MC1 will probably trap more bed-material load, it is likely that MC1 will have more impact on sediment transport at large. This would imply that SR1 could be preferred from this point of view.

Environmental Impact:
Based on the reports completed to date, environmental impacts (in terms of impact on endangered species) are less for SR1 than for MC1.

Timeliness of construction:
According to the reports, construction of SR1 will require at least 1 year, but a 2 to 3 year schedule is preferred. Construction of MC1 will require a minimum of two calendar years, but a 3-year process is preferred (AMEC, 2014a).This implies that construction time could be one year shorter for SR1 than for MC1. These construction times do not account for unforeseen issues during construction (eg. floods). They also do not address possible differences in the time required for regulatory and environmental review requirements, which are expected to be longer at MC1.