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northwest hydraulic consultants ltd

NHC Ref. No. 1005694

01 February 2022

Drumheller Resiliency and Flood Mitigation Program
Town of Drumheller
Box 1179
Drumheller, AB T0J 0Y0

Attention: **Drumheller Resiliency and Flood Mitigation Office**

Re: **Concept Evaluation for Drumheller Upstream Flood Storage**

1 INTRODUCTION

Northwest Hydraulic Consultants Ltd. (NHC) was retained by the Drumheller Resiliency and Flood Mitigation Program (DRFM Program) to estimate upstream flood storage volume required to mitigate flood impacts within the Town of Drumheller along the Red Deer River. Additionally, the scope included generation of a visual representation of the area that would be flooded and the approximate height of dam required to detain large floods.

2 BACKGROUND

NHC previously completed a river hazard study for Alberta Environment and Parks (AEP). That study assessed river hydraulics and flood hazards along the Red Deer River, Kneehills Creek, Michichi Creek, Rosebud River, and Willow Creek within the Town of Drumheller (NHC, 2020a). An open water hydrology assessment was carried out to provide estimates of flood frequencies for a range of return periods (NHC, 2020b). A one dimensional hydraulic model was developed to determine water levels for each of the flood frequencies and the associated flood inundation mapping was carried out.

Existing residences within the floodplain that are not behind flood control dikes are at risk of flooding when the Red Deer River exceeds a flow rate of approximately 1,100 m^3/s (equivalent to a 30-year return period[1]). **Figure 1** depicts the Town of Drumheller municipal boundary along with the extents of the hydraulic model used to determine flood inundation extents as part of the 2020 Flood Hazard Study (NHC, 2020a). The lines perpendicular to the river are surveyed cross sections used for one dimensional hydraulic modelling.

[1] All references to return periods are for regulated flow conditions that consider the effects of Dickson Dam.

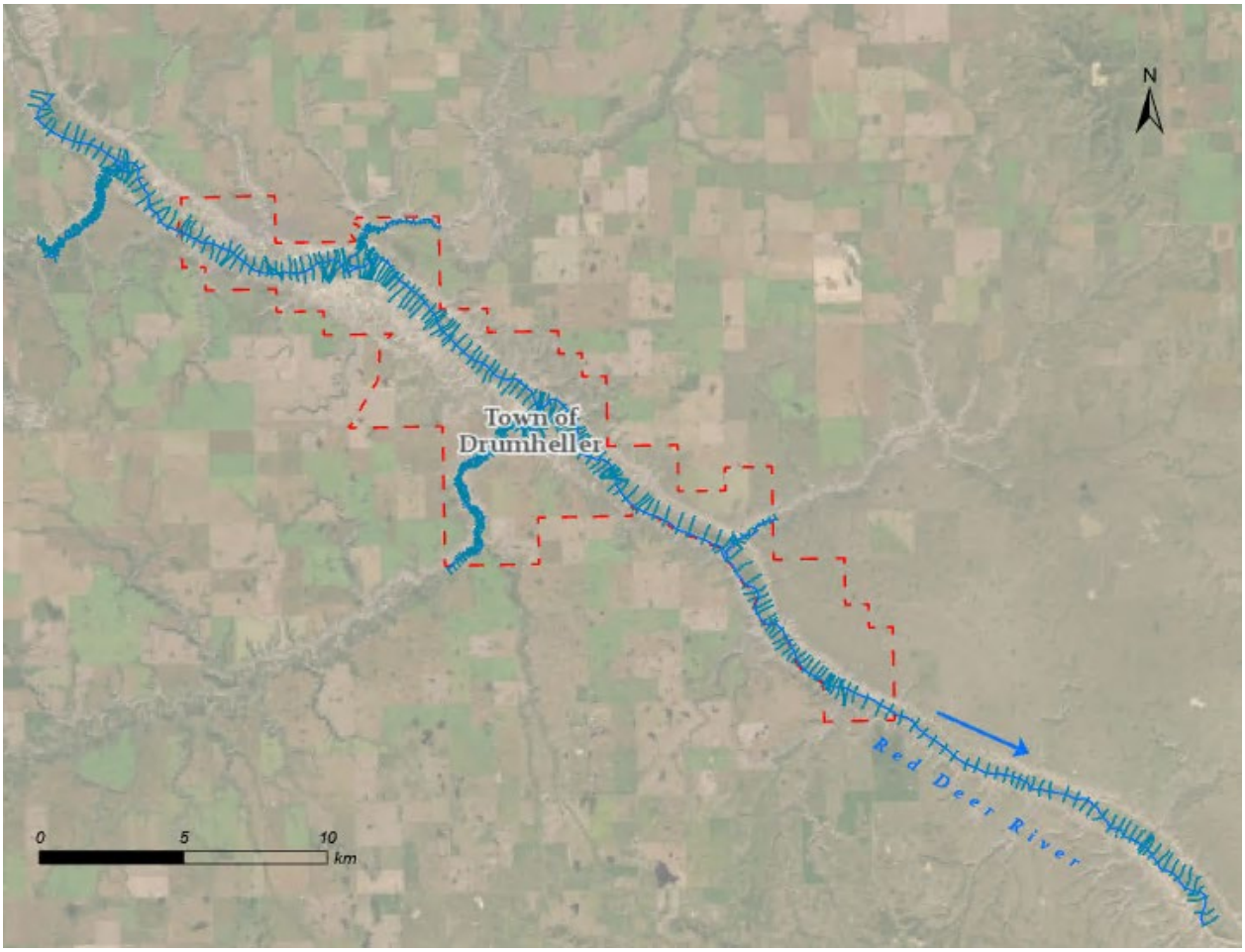


Figure 1: Extent of Flood Hazard Study Model

The hydrology previously developed for AEP as part of the Drumheller River Hazard Study was used to estimate reservoir volume required to mitigate flooding in Drumheller by means of an upstream dam. When considering flood storage volume, only the live (or useable) storage can be used to detain a flood. Dead storage refers to the minimum storage volume maintained by a dam below the low level outlet. The maximum reservoir level refers to the peak water level as a result of combined live and dead storage. A brief explanation of the approach taken, as well as live storage volume estimates and a comparison to the Springbank Off-stream Reservoir (SR1), are provided in the sections below.

3 METHODOLOGY

Synthetic flood hydrographs for the Red Deer River at Drumheller from NHC (2020b) were used to estimate flood volumes under regulated conditions (i.e. considering the effects of Dickson Dam). These hydrographs are reproduced in this report as **Figure 2**. It was assumed that a flood control dam would have the ability to release all incoming flood flows up to a maximum outflow of 1,100 m^3/s . Based on an understanding of regional hydrology, it was assumed that peaks on the Red Deer River and its tributaries would not be coincident; therefore, no significant flow contributions from tributaries were included. The excess volume under the 50-, 100-, and 200-year flood hydrographs, also shown in **Figure 2,** were compared to estimate live storage requirements and assess sensitivity with varying flood magnitudes.

A visual representation of the area that would be flooded due to the upstream storage reservoir was generated using the Canadian Digital Elevation Model (CDEM) data for the Red Deer River valley. CDEM is a freely available and relatively coarse dataset; however, it was considered sufficient for this concept evaluation. An approximate location for the reservoir was selected that was close to Drumheller and did not appear to impact any developed areas. For the purpose of this assessment, it was assumed there is no significant permanent dead storage. Therefore, the maximum reservoir level is estimated based on the flood storage volume determined above and the CDEM terrain data using GIS analysis tools.

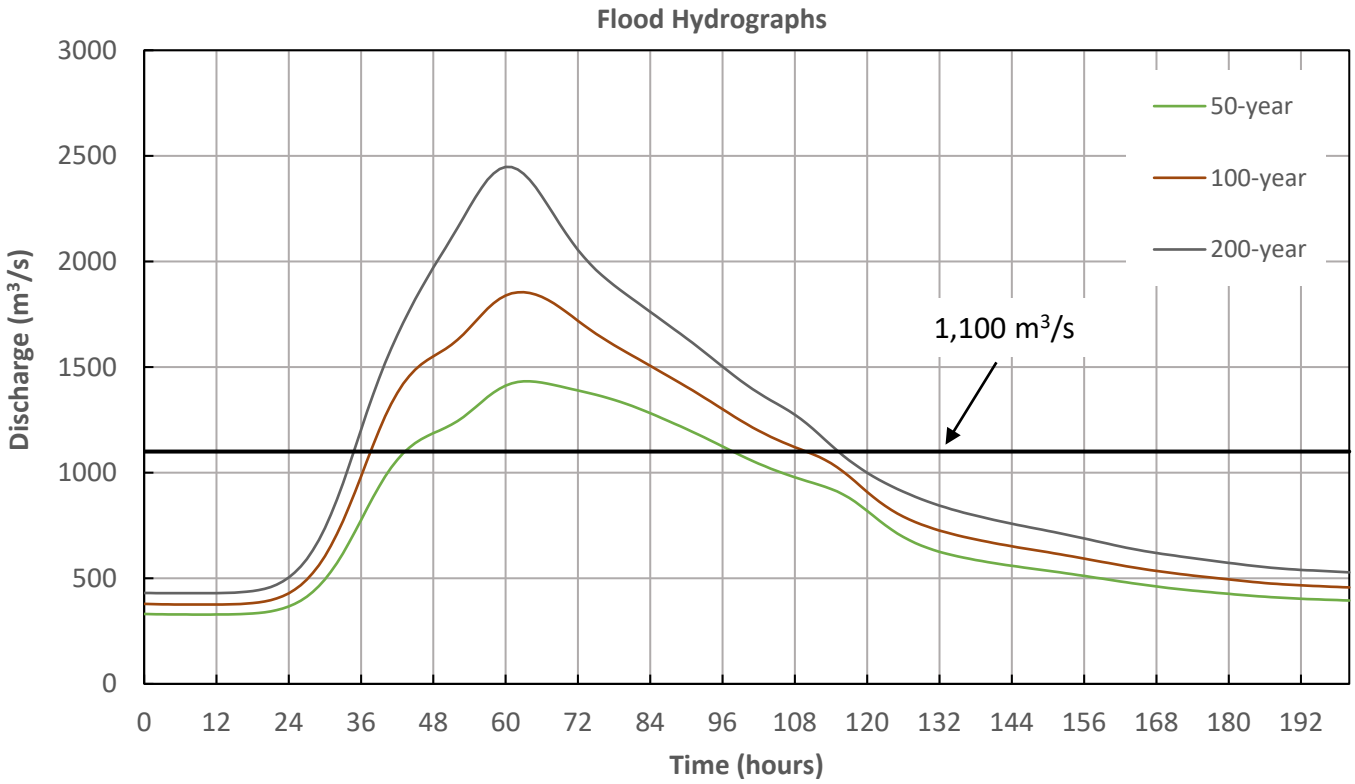
4 RESULTS

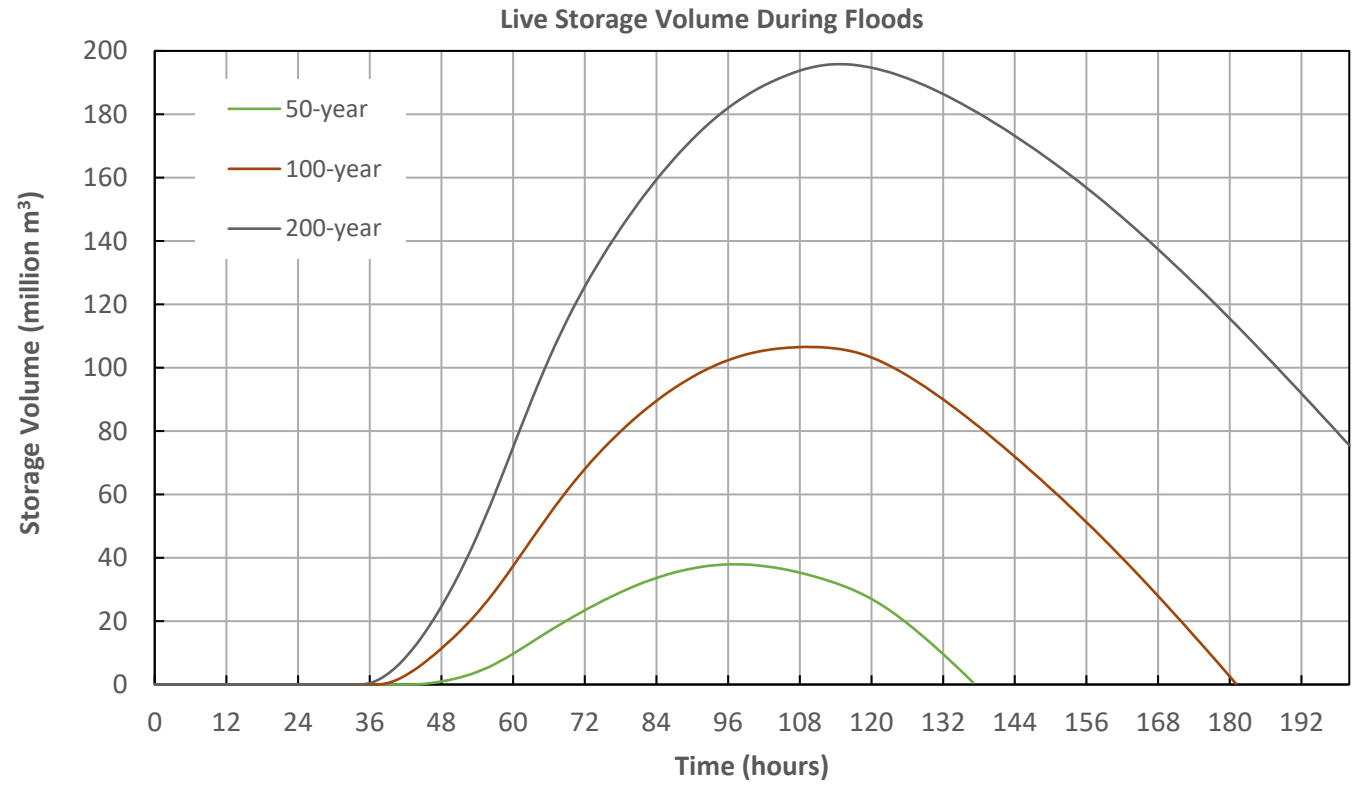
The estimated live storage volumes required for flows greater than 1,100 m^3/s under 50-, 100-, and 200-year return period flood conditions are presented below in **Table 1**. The results show that for the 100-year flood having a peak discharge of 1,850 m^3/s, approximately 106.55 million m^3 of live storage is required. For context, this volume of water would fill over 40,000 Olympic size swimming pools.

Table 1: Summary of Live Reservoir Storage Volume Requirements for Selected Return Periods

Return Period (Years)	Peak Discharge (m^3/s)	Required Live Storage Volume (million m^3)
200	2,450	195.80
100	1,850	106.55
50	1,430	37.97

The concept of storing these volumes in Glennifer Lake above Dickson Dam, which has a surface area of 1,760 ha, was explored. This would raise the lake level by several metres, flooding existing homes and properties around the lake, and therefore is not considered to be feasible.





Alberta	SCALE – AS SHOWN	*CONCEPT EVALUATION FOR DRUMHELLER UPSTREAM FLOOD STORAGE*
nhc northwest hydraulic consultants	Coordinate System: Units: As Shown	*FLOOD HYDROGRAPHS AND LIVE STORAGE VOLUME DURING FLOODS FOR RED DEER RIVER AT DRUMHELLER*
	Job: 1005694 / *Date: Dec-2021*	*FIGURE 2*

Figure 3 shows the approximate extent of the flooded area associated with the reservoir for the 100-year return period. The dam as shown is located about two kilometers upstream of the Highway 27 bridge between Starland and Wheatland counties, 25 km upstream of the Town of Drumheller. The reservoir would have a maximum level of about 711.0 m and a maximum depth of 17 m. The length of the reservoir would be approximately 20 km, extending just beyond the Highway 585 bridge. The surface area of the reservoir at the design storage capacity would be 1,270 ha. It should be noted that due to valley topography, off-stream storage outside the valley is not feasible.

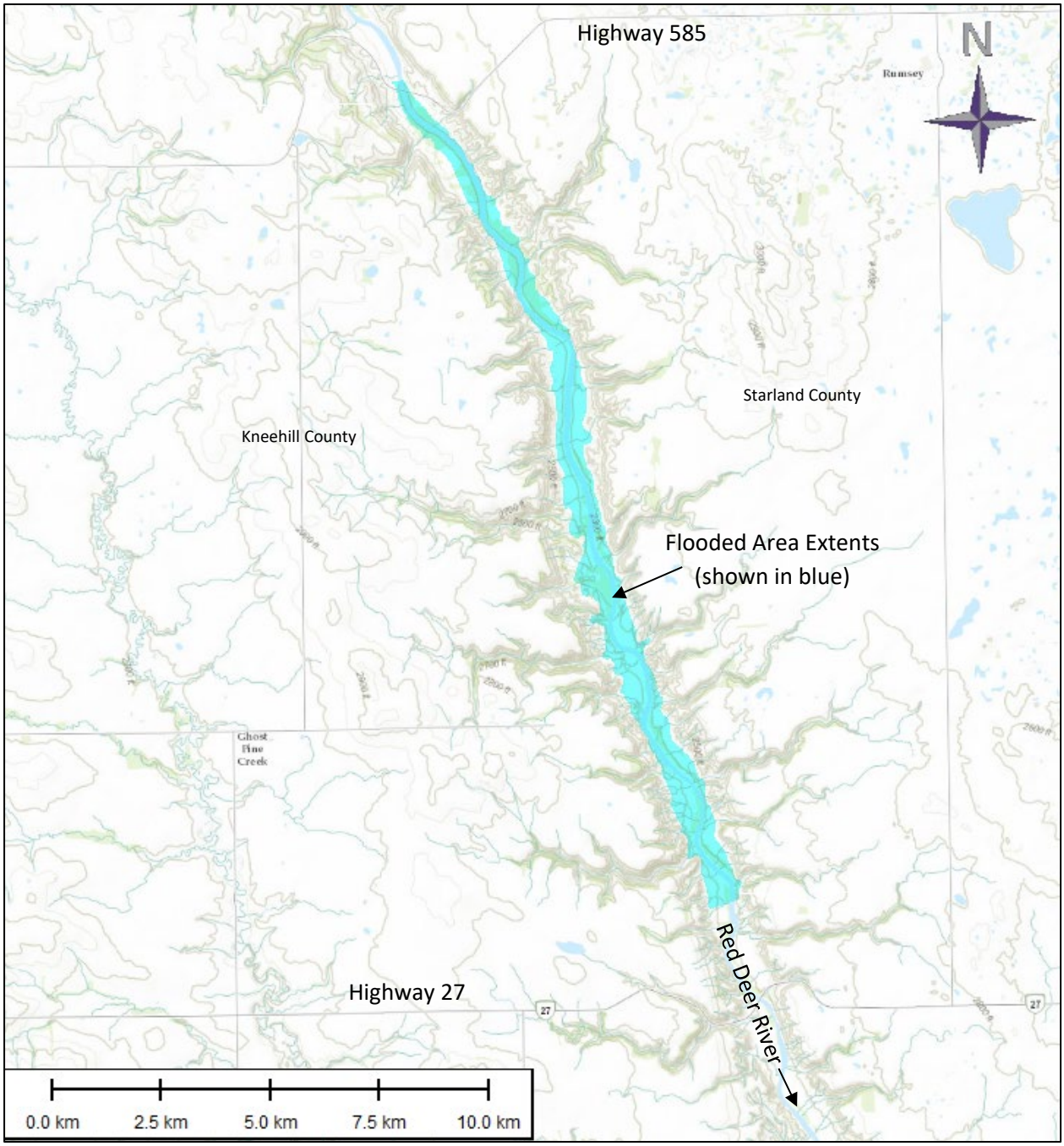


Figure 3: Extent of Flooded Area due to Upstream Storage Reservoir (1:100 flood)

The upstream storage reservoir required to mitigate flood damage within the Town of Drumheller was compared with SR1 near Calgary, Alberta. SR1 has a design live storage volume of 70.20 million m^3 (Stantec, 2016) to accommodate the 2013 flood event, approximately equivalent to a 200-year return period event. The surface area of the reservoir at the design storage capacity is 884 ha, with a maximum depth of 25 m (Stantec, 2016). A comparison of reservoir design parameters is contained in **Table 2**, below. This table illustrates that the Drumheller upstream flood storage concept would require a live storage volume at least 1.5 times larger than SR1.

Table 2: Comparison of Design Parameters for Upstream Storage Reservoir and SR1

Item	New Upstream Storage Reservoir	Springbank Off-stream Reservoir (SR1)
Design Flood	100-year	200-year
Live Storage Volume (million m^3)	106.55	70.20
Reservoir Footprint (ha)	1,270	884
Maximum Depth (m)	17	25
Construction Cost ($)	>500M	432M

5 CONCLUSION

The upstream flood storage volume required to mitigate flood impacts within the Town of Drumheller was estimated. In order to limit flow along the Red Deer River through the town to 1,100 m^3/s during a 100-year flood, approximately 106.55 million m^3 of live storage is required. When compared with SR1, this amounts to a live storage volume that is at least 1.5 times larger. Based on estimated costs of SR1, the construction cost for this project would be greater than $500M. The Drumheller Resiliency and Flood Mitigation Office reviewed the results above and determined that upstream storage of such a magnitude is not feasible for the Town of Drumheller.

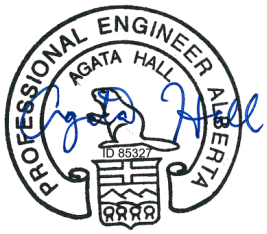
6 CLOSURE

The information provided in this document was prepared for the Drumheller Resiliency and Flood Mitigation Program office to support upcoming flood mitigation projects within the Town of Drumheller. Please feel free to contact the undersigned if any additional information or clarification are required.

Sincerely,

Northwest Hydraulic Consultants Ltd.

Prepared by:



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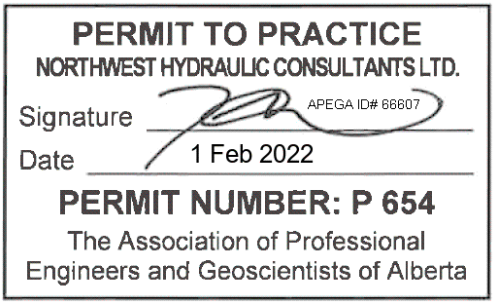

Robyn Andrishak, M.Sc., P.Eng.
Principal

References

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NHC (2020b). *Drumheller River Hazard Study: Open Water Hydrology Assessment Report*. Northwest Hydraulic Consultants Ltd. for Alberta Environment and Parks.

Stantec (2016). *Springbank Off-stream Reservoir Project*. Stantec Consulting Ltd. for Alberta Transportation.