DALHOUSIE UNIVERSITY

FACULTY OF ENGINEERING

Management Strategy for Williams Lake Watershed

Department of Civil and Resource Engineering

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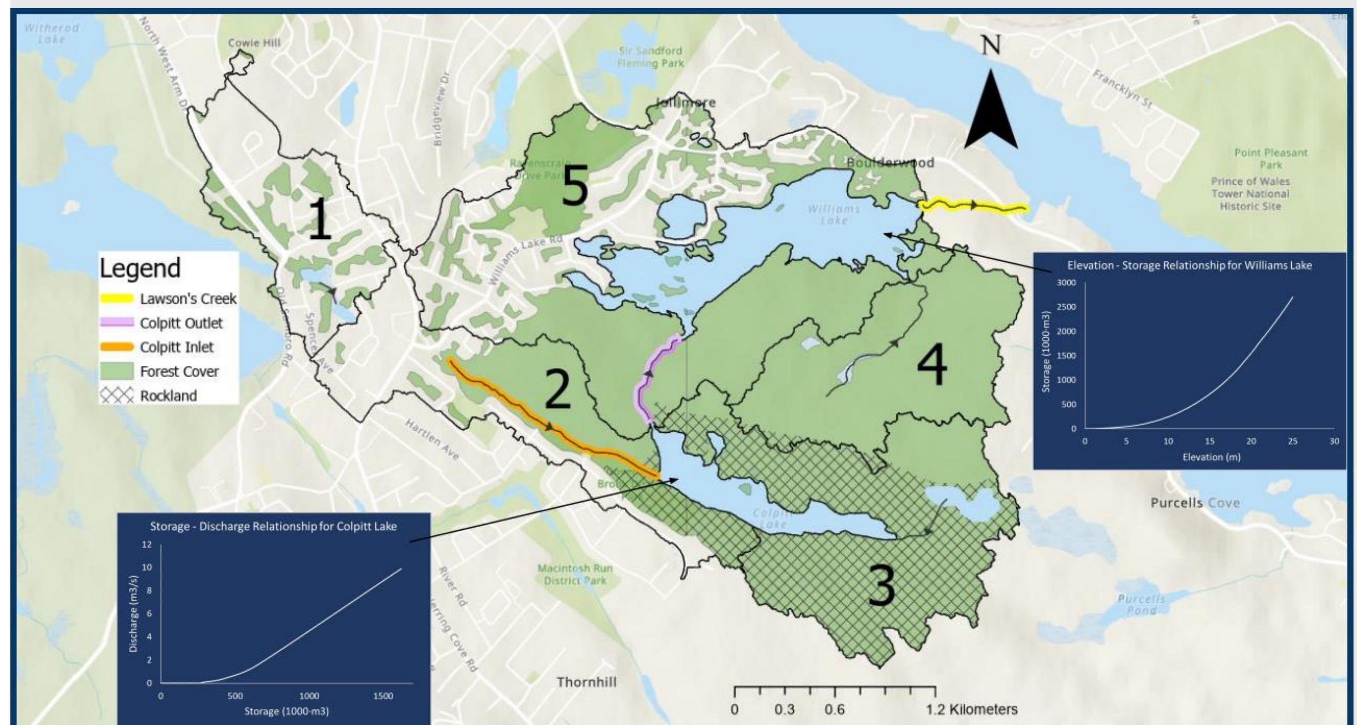
Client: Williams Lake Conservation Company (WLCC)

Scope of Work

Williams Lake is a reservoir in Spryfield, Nova Scotia which was created in the 1700s through the construction of an earthen dam. The Williams Lake Watershed includes both Williams Lake and Colpitt Lake. Due to the valuable ecological and recreational uses of Williams Lake, the Williams Lake Conservation Company (WLCC) has expressed concern regarding declining water levels and increasing lakebed exposure. The overall objectives of the project were to:

i. Develop a water management strategy to maintain water levels in Williams Lake.

ii. Assess the impacts of climate change on lake water levels.

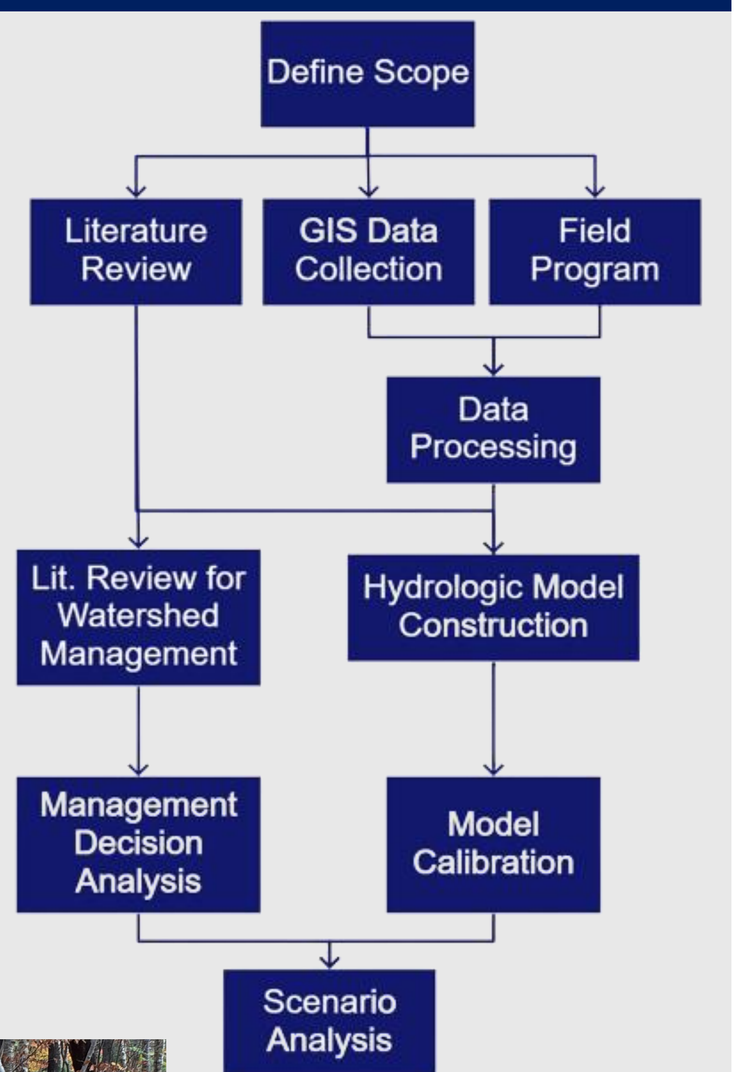


Design Process

Field Program

The field program included multiple site visits to characterize the watershed through stream-gauging and surveying. The following information was obtained:

- Continuous water depth from a pressure transducer
- Flow through Lawsons Creek and Colpitt Lake Inlet
- Inlet and outlet channel shapes and slopes



Decentralized Stormwater Management Strategy

The strategy focused on the use of low-impact development technologies (LID) on residential properties to restore the hydrologic regime of the watershed. Table 1 presents an option analysis [ranking scale from 1(poor) to 5(excellent)] of the different LID features against the five criteria of evaluation.

Table 1 Option Analysis	Porous Pavement	Bioretention Gardens	Rain Barrels
Infiltration Capacity	2	4	3
Capital Cost	3	4	5
Maintenance Cost	4	3	5
Applicability to Atlantic Climate	4	4	2
Feasibility at Site Location	1	4	3
Total	2.8	3.8	3.6

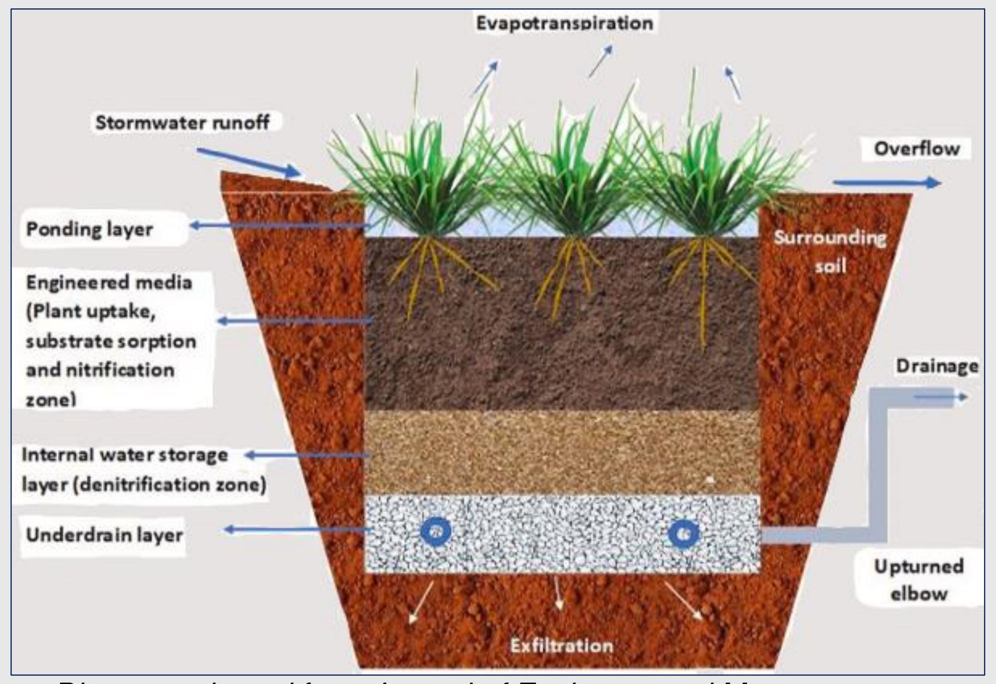


Diagram adapted from Journal of Environmental Management

Bioretention gardens were evaluated as the most preferred option for this watershed. Bioretention gardens store and infiltrate stormwater runoff near the source.

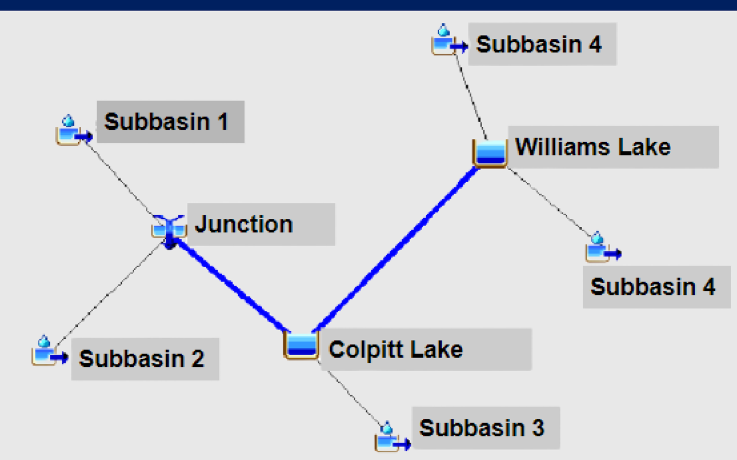
Bioretention Garden Design

Design proposal: Implementation of a 36 m^2 bioretention garden on each residential property will reduce the percent impervious surface area by 19.4%, creating more infiltration and groundwater recharge.The engineered bioretention garden will cost homeowners approximately $1550 to install, and $400 to maintain each year following installation.

Hydrologic Analysis

ArcGIS & HEC-HMS

ArcGIS and available spatial data was used to parametrize a hydrologic model (HEC-HMS) for the watershed-lake system. Stage-storage relationships were also created for Colpitt Lake.



HEC-HMS Watershed Discretization

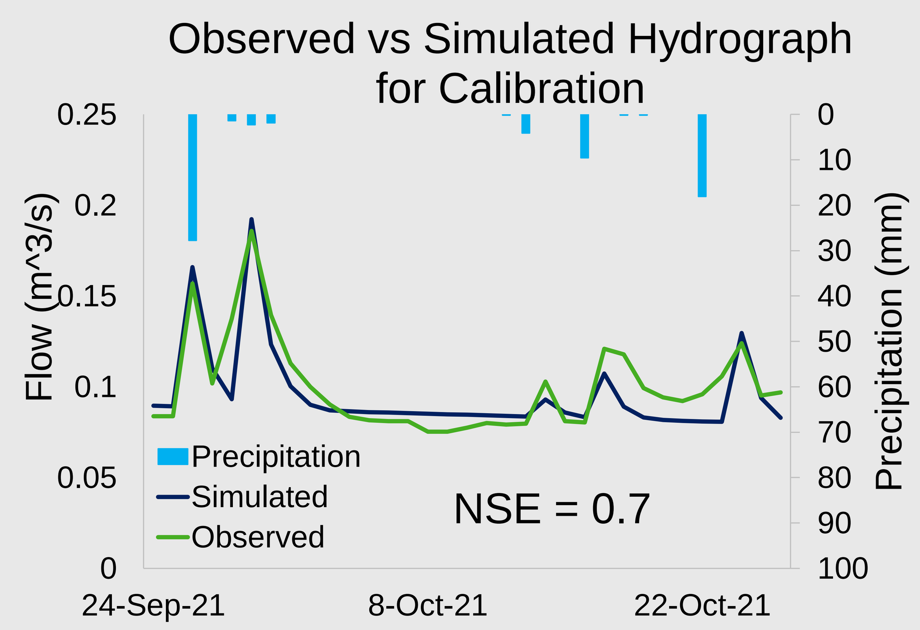
Theoretical Dam

It is suspected that declining water levels are due to dam seepage. Hydrological model simulations were conducted assuming a new dam is constructed. The size and elevations of the dam outlet structures were identified to maintain water levels and sustain ecological maintenance flows in Lawsons Creek.

Current dam structure at Williams Lake

Calibration

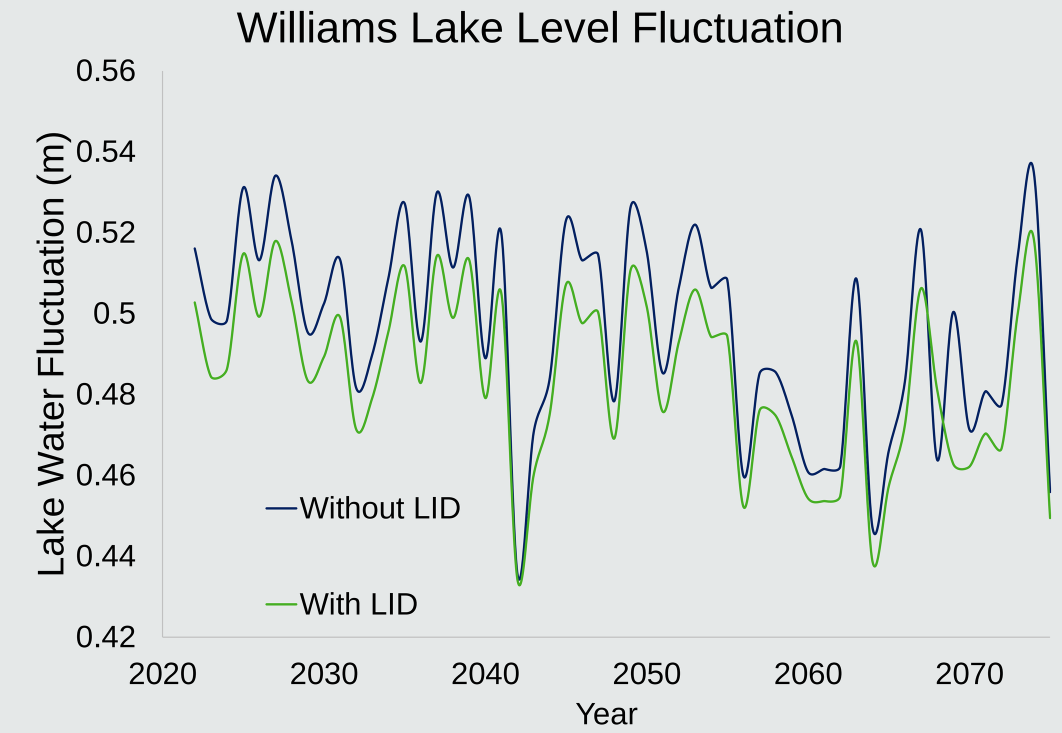
The model was calibrated by statistically comparing the simulated hydrograph to the observed and adjusting parameters such as base flow recession and groundwater storage values. The parameters were adjusted until a Nash-Sutcliffe Efficiency (NSE) of at least 0.5 was achieved (Moriasi et al., 2007).



Climate Change

The potential impacts of climate change were evaluated using statistically downscaled global circulation model (GCM) predictions for an RCP8.5 scenario to drive the hydrologic model simulations.

Results



Simulation results demonstrated that a properly engineered dam structure would stabilize water levels for both present day and future climate scenarios. The inclusion of LID throughout the watershed resulted in minor water level decreases due to increased groundwater recharge but lowered fluctuations further than the dam alone. The results show improvement from previous yearly fluctuations in Williams Lake water levels, which averaged 1.03 m from 2002-2017. More consistent lake levels will be beneficial to aquatic life and support recreational activities at Williams Lake.

Table 2 shows the results of low flow frequency analysis to estimate the probability of water availability in Lawsons Creek during low flow periods. The minimum flow to support ecology in Lawsons Creek is 605 m^3/d.

Table 2 Low Flow Frequency Analysis for Lawsons Creek

Return Period	10 years	50 years	100 years
Without LID	895 m^3/d	803 m^3/d	766 m^3/d
With LID	204 m^3/d	72 m^3/d	47 m^3/d

Conclusion

The goal of the project was to develop a climate resilient strategy for stabilizing water levels in Williams Lake. The analysis demonstrated that water levels could be stabilized with a new dual-outlet dam structure. The incorporation of LID throughout the watershed would have minor impacts on water levels and flow but would have other benefits such as water quality improvement and long-term storage in the watershed.

References and Acknowledgements

Moriasi et al., (2007). Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Transactions of the ASABE, 50(3), 885-900.

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Acknowledgments:

Dr. Rob Jamieson & Dr. Margaret Walsh- **Dalhousie University**

Dr. Melanie Dobson- **Williams Lake Conservation Company**

Lindsay Johnston- **Dalhousie University**