# KASHWAKAMAK LAKE DAM
# HYDRAULIC ANALYSIS MEMO

To: Mississippi Valley Conservation Authority

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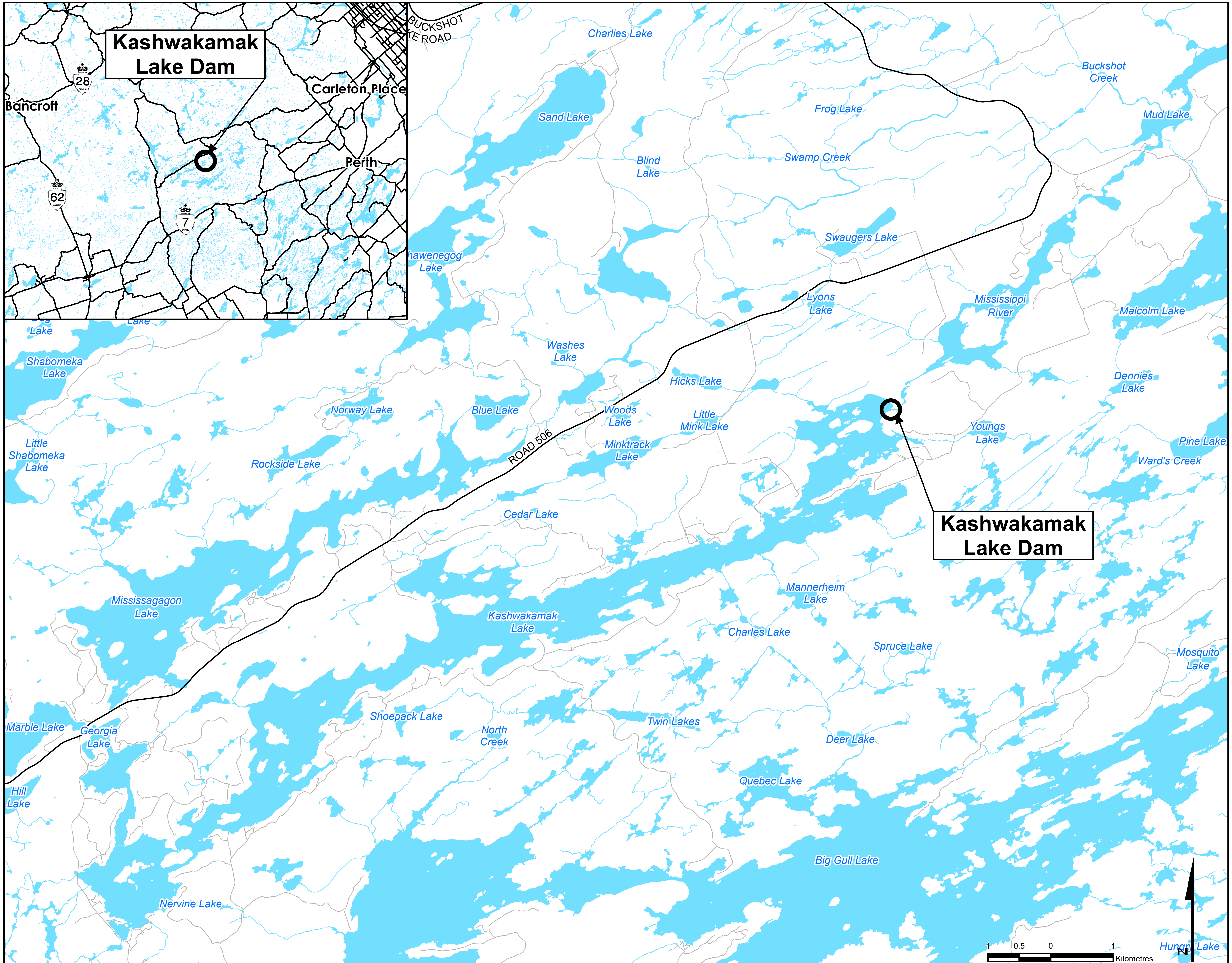
Date: December 22, 2023
Rev. 1 April 26, 2024
Rev. 2 May 8, 2024

Re: Kashwakamak Lake Dam – Hydraulic Analysis Memo

## 1.0 INTRODUCTION

Egis Group Construction Engineering Company (Egis) has been retained by the Mississippi Valley Conservation Authority as part of a Class Environmental Assessment to review options pertaining to the replacement of the Kashwakamak Lake Dam, in North Frontenac Township. Kashwakamak Lake is located along the main channel of the Mississippi River in the Mississippi River watershed and the Upper Mississippi sub-watershed. The Kashwakamak Lake Dam (the dam) is situated at the northeast side of Kashwakamak Lake, as shown in Figure 1 below. It is owned and operated by the Mississippi Valley Conservation Authority (MVCA). The dam is one of the major dams along the Mississippi River that is used to alleviate drought and flooding. The dam structure consists of an overflow weir spillway, two sluices that each contains 10 timber stop logs (0.3 m high x 0.3 m wide x 3.43 m long) and a small concrete saddle dam.

The dam, originally constructed in 1910, is now over 100 years old with deteriorating concrete in several areas. The proposed project aims to replace the Kashwakamak Lake Dam to mitigate the risk of overtopping or failing. A hydraulic analysis of the dam was carried out for various scenarios, including normal conditions, the probable maximum flood, and climate change to determine the impacts it may have on life safety, properties, the environment, and cultural-built heritage features. Assessing the degree of the potential impacts on the surrounding area in the event of a failure will provide confirmation of the Hazard Potential Classification (HPC) of Kashwakamak Lake Dam.




CLIENT: Mississippi Valley Conservation Authority

PROJECT: HYDRAULIC ANALYSIS MEMORANDUM

TITLE: SITE LOCATION

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# 2.0 BACKGROUND

The Kashwakamak Lake Dam was constructed in 1910 and was originally owned and operated by the Mississippi River Improvement Company. Ownership and operation of the dam were transferred to the MVCA in 1991. Throughout the lifespan of the dam, several maintenance programs have been undertaken, including:

- 1986-1987: Concrete repairs to the weir, last documented maintenance before the transfer of ownership to MVCA.
- 1995-1996: A grouting program was undertaken along the northern embankment to inhibit seepage through the embankment. It was noted to be effective at lower water levels, however, was not effective at preventing seepage at normal operating levels.
- 2000: A grouting program for the weir and abutments was undertaken and was noted to be successful at temporarily reducing seepage. Subsequent inspections have noted further seepage through the structure.
- 2001-2003: A new wooden deck was installed at the structure.
- 2005: An overhead gantry system was installed.

The above history and hydrologic information were obtained through a review of the following reports, provided by the MVCA at the onset of this assignment:

- Pre-Engineering Study, Kashwakamak Lake Dam (Terraprobe, January 1997),
- Kashwakamak Lake Dam Study (Terraprobe, July 1998),
- Kashwakamak Lake Dam Feasibility Study (EGA, August 1998),
- Kashwakamak Lake Dam Operation, Maintenance & Surveillance Manual (MVCA, October 2013),
- Dam Safety Assessment, Kashwakamak Lake Dam (Trow, November 2006),
- Kashwakamak Lake Dam Condition Assessment of Concrete Structure (Cleland Jardine, February 2016),
- Kashwakamak Lake Dam Structural Assessment (Hatch, May 2020),
- Kashwakamak Lake Dam Safety Review (Hatch, March 2022),
- HEC-HMS Model for the Mississippi River (J. Perdikaris, May 2023),
- Hydrology Memorandum (Innovative Defensive Options, September 2023).

## 2.1 Field Investigations

McIntosh Perry staff conducted a field visit on June 6th, 2023, to inspect and confirm the existing conditions of the main Kashwakamak Lake Dam and gates, as well as the saddle dam. The existing conditions of all structures including overflow weir, sluiceway, saddle dam, abutments, as well as upstream and downstream features, such as high-water indications, leakage, erosions/sedimentations, cut banks, and channel conditions were investigated. Photographs of the dam and surrounding area were taken as shown in Figure 2 below, including (a) the downstream side of the dam structure, (b) the top of the dam structure, and (c) the surrounding area. Additional photographs from the site visit can be made available to the MVCA upon request. During the field investigation, cracking and deterioration of the concrete material was observed.

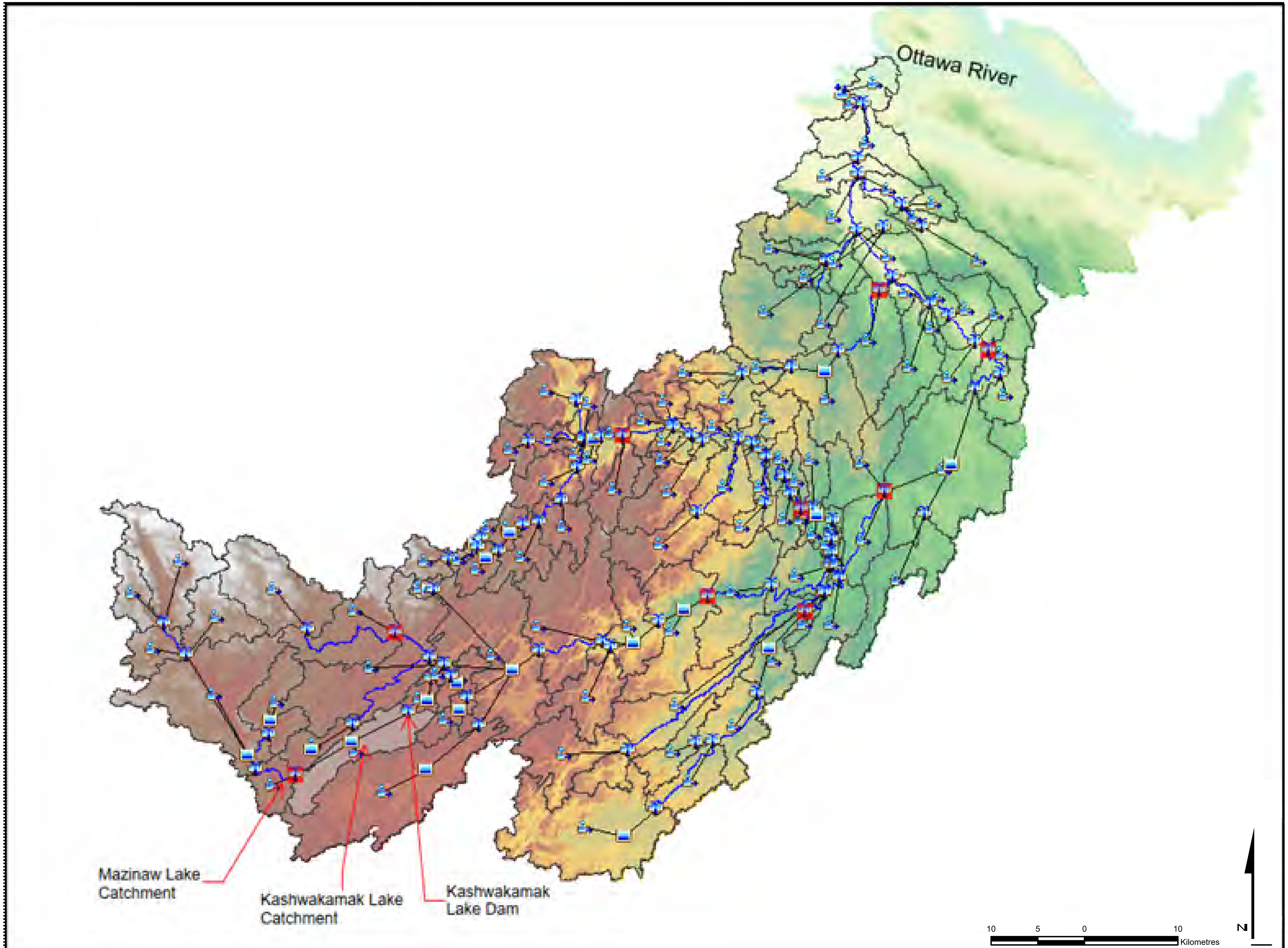
(a) (b) (c)

Figure 2. Dam Inspection Photos

# 3.0 HYDROLOGY

A comprehensive hydrologic study for the Mississippi River was completed using HEC-HMS software by J. Perdikaris in May 2023. The HEC-HMS models and report was provided by the MVCA. Various combinations of input for the modelling approaches were developed in the hydrologic model (event-based or continuous storms, Green-Ampt or soil moisture accounting soil infiltration, and outflow curve or specified release method for downstream conditions). Figure 3 below shows a general view of the Mississippi River HEC-HMS model. The results for different scenarios were summarized in a report. After a review of these submissions, it was noted that additional scenarios would be required to complete the hydraulic analyses for the Kashwakamak Lake Dam EA study.

Subsequently, additional scenarios that will go into the hydraulic models were requested. Results for the requested scenarios were summarized in a memo by Innovative Defensive Options Inc. (September 2023). Hydrographs for 2- to 1000-year return periods, 10-day intensity duration frequency snowmelt plus rainfall, and probable maximum flood (PMF) were developed and provided in an Excel spreadsheet. Simulations accounting for the climate change impact were also completed and provided. Calibration and validation of the hydrologic models were conducted through the streamflow gauge data for 12 Water Survey of Canada streamflow stations located within the Mississippi River watershed. Moderate and high emission climate change scenarios for Representative Concentration Pathway (RCP) 4.5 and 8.5 were applied for each event and hydrographs were accordingly developed. Two types of probable maximum precipitation (PMP) (winter/spring and summer) for two different storm centers (Dalhousie Lake-Point A and Ardoch-Point B) were simulated. After a review of the results, the winter/spring PMF at Ardoch (Point B) was recommended for the analyses. Table 1 summarizes the inflow hydrograph characteristics with and without climate change impacts that were used in the hydraulic modelling. Minor discrepancies were noted between the values reported in the Hydrology Memorandum (Innovative Defensive Options, September 2023) and the hydrologic model outputs.




CLIENT: Mississippi Valley Conservation Authority

PROJECT: HYDRAULIC ANALYSIS MEMORANDUM

TITLE: HEC-HMS MODEL VIEW OF MISSISSIPPI RIVER


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Table 1: Hydrograph Inputs to Hydraulic Model

| Event | No Climate Change | | With Climate Change | | Notes |
|---|---|---|---|---|---|
| | Peak Flow ($m^3$/s) | Volume (1000 $m^3$) | Peak Flow ($m^3$/s) | Volume (1000 $m^3$) | |
| 100-year | 72.70 | 13,304 | 90.60 | 16,656 | Hydrograph provided.<br>4 days with 6 mins time step. |
| 1000-year | 98.56 | 17,857 | 122.82 | 19,749 | Hydrograph provided.<br>4 days with 6 mins time step. |
| 1/3 PMF | 202.14 | 36,625 | 245.60 | 39,490 | Hydrograph manually developed using 1000-year and PMF [1000-year + 1/3*(PMF - 1000-year), herein referred to as 1/3 PMF].<br>4 days with 6 mins time step. |
| 2/3 PMF | 305.72 | 55,392 | 368.38 | 59,232 | Hydrograph manually developed using 1000-year and PMF [1000-year + 2/3*(PMF - 1000-year), herein referred to as 2/3 PMF].<br>4 days with 6 mins time step. |
| PMF | 409.20 | 217,547 | 491.04 | 261,056 | Hydrograph provided.<br>*25 days with 30 mins time step. |

* The hydrograph provided for the PMF scenario reaches a peak flow at 11 days and therefore could not be truncated to 4 days as done with the other scenarios. The PMF volumes should not be directly compared with those resulting from the 4-day hydrographs since the storm durations are different.

As noted in the above table, the 1/3 PMF and 2/3 PMF hydrographs were derived from the 1000-year and PMF hydrographs. The hydrographs with snowmelt plus rainfall were reviewed, however, they were observed to generate extremely large and unreasonable values and therefore were not used for the hydraulic modelling.

## 3.1 Stage-Storage Curve

Kashwakamak Lake is around 22 m deep at the lowest elevation point of 236.28 m, and covers approximately 13 $km^2$ in surface area. The lake is oriented from west to east with a 235 m span at the narrowest section and an approximate length of 15.5 km. The operational level (active storage) of the lake starts from 258.22 m, which is the sill elevation of the existing gates and the approximate bedrock outcrop elevation at the dam. The stage and storage data (from 258.22 m to 263.00 m) were provided by the MVCA and are summarized in Table 2 below. Minor differences were noted between the stage-storage data used in the HEC-HMS models (May 2023) and the Table 2 data provided by the MVCA.

Table 2: Kashwakamak Lake Stage-Storage Curve Data

| No | Elevation (m) | Volume (1000 $m^3$) | No | Elevation (m) | Volume (1000 $m^3$) | No | Elevation (m) | Volume (1000 $m^3$) | No | Elevation (m) | Volume (1000 $m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 258.22 | 0 | 8 | 259.27 | 13,377 | 15 | 260.32 | 26,754 | 22 | 261.22 | 38,220 |
| 2 | 258.37 | 1,911 | 9 | 259.42 | 15,288 | 16 | 260.47 | 28,665 | 23 | 261.37 | 40,131 |
| 3 | 258.52 | 3,822 | 10 | 259.57 | 17,199 | 17 | 260.62 | 30,576 | 24 | 261.52 | 42,042 |
| 4 | 258.67 | 5,733 | 11 | 259.72 | 19,110 | 18 | 260.77 | 32,487 | 25 | 261.67 | 43,953 |
| 5 | 258.82 | 7,644 | 12 | 259.87 | 21,021 | 19 | 260.92 | 34,398 | 26 | 262.00 | 50,323 |
| 6 | 258.97 | 9,555 | 13 | 260.02 | 22,932 | 20 | 261.06 | 36,182 | 27 | 262.50 | 56,693 |
| 7 | 259.12 | 11,466 | 14 | 260.17 | 24,843 | 21 | 261.07 | 36,309 | 28 | 263.00 | 63,063 |

The active storage capacity of the lake is approximately 63 million $m^3$ at an elevation of 263.00 m. Based on a review of the gauged water surface elevation data, the optimum summer operational level is 261.13 m as indicated in the MVCA Kashwakamak Lake Dam Operation, Maintenance & Surveillance Manual (October 2013). The highest recorded elevation is 261.53 m at which the storage available is approximately 42 million $m^3$.

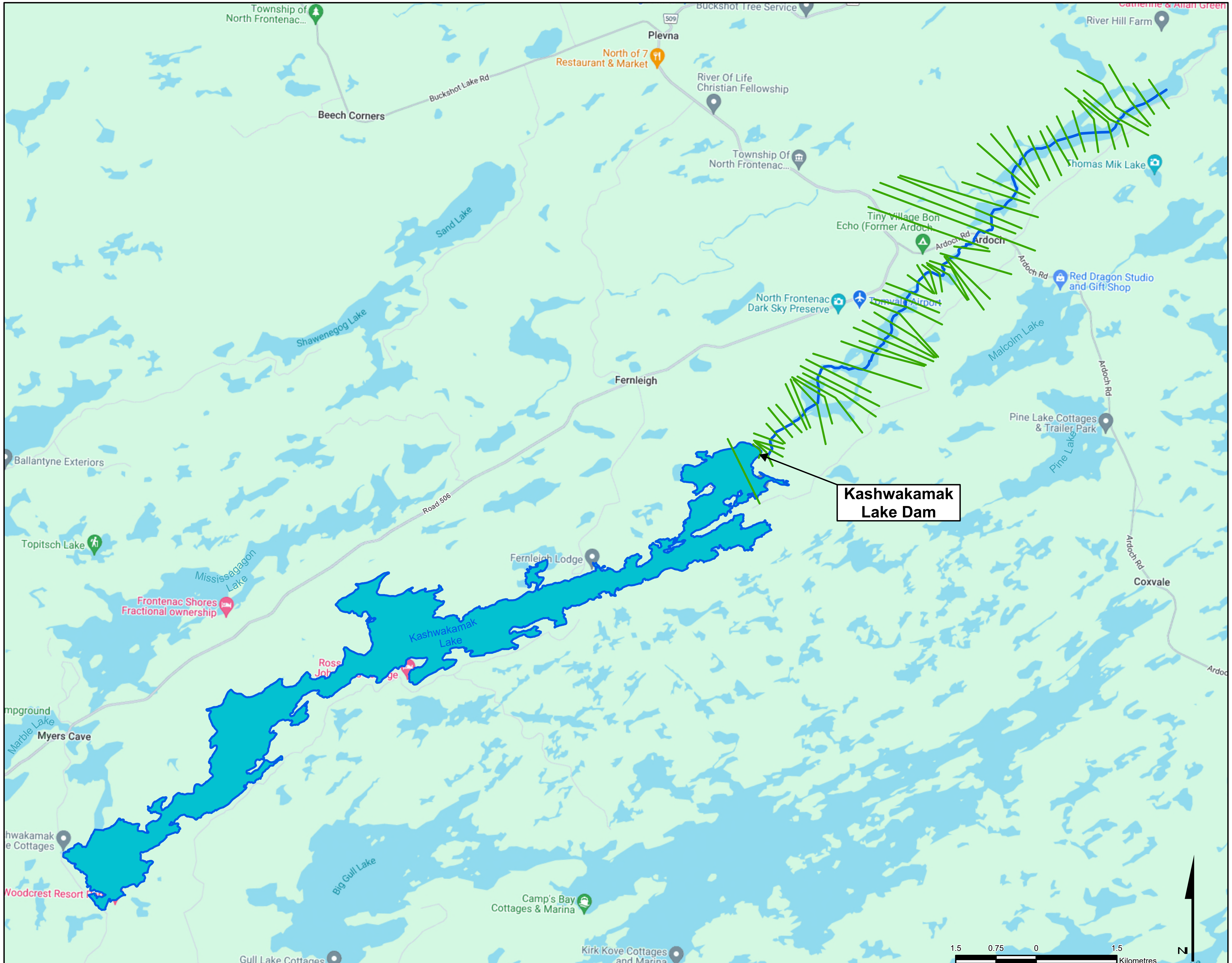
The hourly lake level data was downloaded from the MVCA website (Water Levels - Mississippi Valley Conservation Authority) and ranges from December 1993 to October 2023. Descriptive statistics and histogram analysis of the gauged data as well as the monthly summary of the lake levels are included in Appendix A. As a result of the statistical analysis, the mode of the lake level data was calculated to be 261.15 m. Additionally, as found in the histogram analysis, lake levels are maintained from 261.10 m to 261.20 m approximately 39% of time. Therefore, the initial lake level in the hydraulic analyses for all scenarios was taken as 261.15 m, as this level can be considered the most representative operational water level for Kashwakamak Lake.

# 4.0 HYDRAULICS

Hydraulic analyses of the Kashwakamak Lake Dam were completed using HEC-RAS software. MVCA provided a hydraulic model developed by Hatch for the Kashwakamak Lake Dam Safety Review (March 2022). A recent LIDAR survey (2023) and a bathymetric survey (2023) was conducted by the MVCA, and the resulting elevation data was also provided in DEM format. The received model was reviewed and revised with this newly obtained DEM data. The model extends from the Kashwakamak Lake Dam to 12.5 km downstream. There are two sharp elevation changes along the river course with a drop of approximately 17 m over the model extent. The dam was modelled as an inline structure with gated sections. Figure 4 below shows a general view of the HEC-RAS model. An electronic copy of the HEC-RAS model will be provided to the MVCA.

HEC-RAS base condition plans were initially created for 100-year, 1000-year, 1/3 PMF, 2/3 PMF, and PMF scenarios. These plans were then expanded with the climate change scenario, dam break scenario (DBR), and a combination of climate change plus dam break. The model was reviewed and adjusted upon this revision to confirm the results. The lake level, inflow, and outflow data for Kashwakamak Lake and Kashwakamak Lake Dam were taken directly from the HEC-RAS model results from the scenarios mentioned and are presented in Tables 3 to 6. For the analyses of the impacted properties, in addition to the described scenarios, the 'normal' event was modelled to represent the lake and dam on a day with no flooding events. The normal event with and without dam break cases were included in Tables 3 and 4, respectively. A peak inflow of 10 $m^3/s$ for Kashwakamak Lake was assumed to model the normal event. This value was taken as it is large enough to stabilize the model while still representing a scenario without other flood events. Examples of the floodplain maps for the 100-year, 1000-year, and PMF scenarios without dam break are included in Appendix B.

The saddle dam is located north of the Kashwakamak Lake Dam and directly west of the access roadway. A natural channel is noted immediately east of the saddle dam as evident from the DEM, which is part of the shoreline allowance for the North Frontenac Township according to land ownership details. The crest elevation of the saddle dam was indicated by previous reports and design drawings to be 261.66 m. Therefore, the saddle dam will be overtopped during any scenario where the Kashwakamak Lake water surface elevation exceeds the crest. Further discussion on the saddle dam is provided in the Section 6.0.




CLIENT: Mississippi Valley Conservation Authority

PROJECT: HYDRAULIC ANALYSIS MEMORANDUM

TITLE: PLAN VIEW OF HEC-RAS MODEL

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Table 3: Summary of Lake Level, Inflow and Outflow (Base Condition)

| Scenario | Kashwakamak Lake | | | Dam | |
|---|---|---|---|---|---|
| | Water Surface Elevation (m) | Inflow Peak ($m^3/s$) | Inflow Volume (1000 $m^3$) | Outflow Peak ($m^3/s$) | Outflow Volume (1000 $m^3$) |
| Normal | 261.17 | 10 | 828 | 40 | 3,080 |
| 100-year | 261.25 | 73 | 13,304 | 43 | 13,991 |
| 1000-year | 261.39 | 99 | 17,857 | 48 | 15,169 |
| 1/3 PMF | 262.14 | 202 | 36,625 | 99 | 25,021 |
| 2/3 PMF | 262.48 | 306 | 55,392 | 162 | 39,380 |
| PMF | 262.96 | 409 | 217,547 | 307 | 213,694 |

Table 4: Summary of Lake Level, Inflow and Outflow (Base Condition + DBR)

| Scenario | Kashwakamak Lake | | | Dam | |
|---|---|---|---|---|---|
| | Water Surface Elevation (m) | Inflow Peak ($m^3/s$) | Inflow Volume (1000 $m^3$) | Outflow Peak ($m^3/s$) | Outflow Volume (1000 $m^3$) |
| Normal | 261.17 | 10 | 828 | 94 | 5,773 |
| 100-year | 261.16 | 73 | 13,304 | 93 | 23,538 |
| 1000-year | 261.16 | 99 | 17,857 | 93 | 25,216 |
| 1/3 PMF | 261.38 | 202 | 36,625 | 112 | 35,195 |
| 2/3 PMF | 262.01 | 306 | 55,392 | 163 | 46,658 |
| PMF | 262.96 | 409 | 217,547 | 349 | 227,362 |

Table 5: Summary of Lake Level, Inflow and Outflow (Base Condition + Climate Change)

| Scenario | Kashwakamak Lake | | | Dam | |
|---|---|---|---|---|---|
| | Water Surface Elevation (m) | Inflow Peak ($m^3/s$) | Inflow Volume (1000 $m^3$) | Outflow Peak ($m^3/s$) | Outflow Volume (1000 $m^3$) |
| 100-year | 261.33 | 91 | 16,656 | 46 | 14,700 |
| 1000-year | 261.47 | 123 | 19,749 | 52 | 15,988 |
| 1/3 PMF | 262.19 | 246 | 39,490 | 107 | 27,174 |
| 2/3 PMF | 262.52 | 368 | 59,232 | 172 | 42,738 |
| PMF | 263.16 | 491 | 261,056 | 387 | 255,187 |

Table 6: Summary of Lake Level, Inflow and Outflow (Base Condition + Climate Change + DBR)

| Scenario | Kashwakamak Lake | | | Dam | |
|---|---|---|---|---|---|
| | Water Surface Elevation (m) | Inflow Peak ($m^3/s$) | Inflow Volume (1000 $m^3$) | Outflow Peak ($m^3/s$) | Outflow Volume (1000 $m^3$) |
| 100-year | 261.16 | 91 | 16656 | 93 | 24,581 |
| 1000-year | 261.16 | 123 | 19749 | 93 | 26,274 |
| 1/3 PMF | 261.47 | 246 | 39490 | 119 | 37,011 |
| 2/3 PMF | 262.09 | 368 | 59232 | 171 | 49,424 |
| PMF | 263.16 | 491 | 261056 | 414 | 268,728 |

The floodplains for these six (6) events were created and intersected with the buildings layer, which was provided by the MVCA. Table 7 summarizes the impacted buildings with no climate change. The provided buildings data was categorized into either seasonal residences or other structures, which includes boathouses, sheds, and any uncategorized buildings. No permanent residences were identified to intersect the floodplain limits.

Table 7: Impact to Buildings (No Climate Change)

| Flood Event | Dam Scenario | Impacted Buildings | | |
|---|---|---|---|---|
| | | *Seasonal Residence* | Other Structures | Total |
| Normal | No Dam Break | *1* | 7 | 8 |
| | With Dam Break | *3* | 9 | 12 |
| 100-year | No Dam Break | *1* | 7 | 8 |
| | With Dam Break | *4* | 9 | 13 |
| 1000-year | No Dam Break | *1* | 9 | 10 |
| | With Dam Break | *4* | 9 | 13 |
| 1/3 PMF | No Dam Break | *4* | 9 | 13 |
| | With Dam Break | *4* | 9 | 13 |
| 2/3 PMF | No Dam Break | *5* | 10 | 15 |
| | With Dam Break | *5* | 10 | 15 |
| PMF | No Dam Break | *10* | 15 | 25 |
| | With Dam Break | *11* | 17 | 28 |

The number of the total impacted buildings ranges from eight (8) to twenty-eight (28) from the normal to PMF dam break scenarios, respectively, while the number of seasonal residences impacted (habitable buildings) ranges from one (1) to eleven (11) from the normal to PMF dam break scenarios, respectively. Only the seasonal residences impacted were considered in the hazard potential classification evaluations for the risk to life safety.

The number of seasonal residences incrementally impacted, along with the corresponding building IDs (as labelled in the GIS layer) is provided in Table 8. There is no incremental impact for the 1/3 PMF and 2/3 PMF events, while three (3) seasonal residences are found to be impacted incrementally for the 100-year and 1000-year flood events, two (2) for the normal flood event, and one (1) for the PMF event. The depth and velocity values for the incrementally impacted seasonal residences resulting from each scenario are later explained and summarized in Table 10.

Table 8: Incremental Impact on Seasonal Residences

| Event | Dam Scenario | No Climate Change | | |
|---|---|---|---|---|
| | | Number of Seasonal Residences Impacted | Incremental Impact | Incrementally Impacted Building IDs |
| Normal | No Dam Break | 1 | 2 | 908, 814 |
| | With Dam Break | 3 | | |
| 100-year | No Dam Break | 1 | 3 | 908, 861, 814 |
| | With Dam Break | 4 | | |
| 1000-year | No Dam Break | 1 | 3 | 908, 861, 814 |
| | With Dam Break | 4 | | |
| 1/3 PMF | No Dam Break | 4 | 0 | None |
| | With Dam Break | 4 | | |
| 2/3 PMF | No Dam Break | 5 | 0 | None |
| | With Dam Break | 5 | | |
| PMF | No Dam Break | 10 | 1 | 749 |
| | With Dam Break | 11 | | |

# 5.0 HAZARD POTENTIAL CLASSIFICATION

The Ontario Ministry of Natural Resources and Forestry (MNRF) has developed the Hazard Potential Classification system to evaluate the potential hazards caused by the uncontrolled release of a reservoir, due to failure of the dam structure or appurtenances, such as gates or stoplogs. Additionally, the MVCA prepared a Methodology for Determining Environmental Losses & Classification memorandum in March 2024, which provided further details to supplement the MNRF criteria. The memo can be found in Appendix C. The HPC is determined by assessing the greatest incremental losses that could occur in the event of a dam failure and is split into four categories: (1) life safety, (2) property losses, (3) environmental losses, and (4) cultural / built heritage losses. An incremental loss is defined as losses from dam failure in excess of losses from a similar event (flood, earthquake, etc.) but without failure of the dam. Table 9 below defines the MNRF criteria for determining the dam HPC.

Table 9: Hazard Potential Classification: Technical Bulletin for Classification and Inflow Design Flood Criteria (Adapted from MNRF, 2011)

| Hazard Potential | Life Safety | Property Losses | Environmental Losses | Cultural – Built Heritage Losses |
|---|---|---|---|---|
| Low | No potential loss of life. | Minimal damage to property with estimated losses not to exceed $300,000 (1). | Minimal loss of fish and/or wildlife habitat with high capability of natural restoration resulting in a very low likelihood of negatively affecting the status of the population. | Reversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act. |
| Moderate | No potential loss of life. | Moderate damage with estimated losses not to exceed $3 million (2) to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or structures not for human habitation, infrastructure, and services including local roads and railway lines. The inundation zone is typically undeveloped or predominantly rural or agricultural, or it is managed so that the land usage is for transient activities such as with day-use facilities. Minimal damage to residential, commercial, and industrial areas, or land identified as designated growth areas as shown in official plans. | Moderate loss or deterioration of fish and/or wildlife habitat with moderate capability of natural restoration resulting in a low likelihood of negatively affecting the status of the population. | Irreversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act. Reversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or nationally recognized heritage sites. |
| High | Potential loss of life of 1-10 persons. | Appreciable damage with estimated losses not to exceed $30 million (3) to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or residential, commercial, industrial areas, infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services include regional roads, railway lines, or municipal water and wastewater treatment facilities and publicly owned utilities. | Appreciable loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/ or wildlife habitat with reasonable likelihood of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered, or reversible damage to the habitat of that species. | Irreversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or damage to nationally recognized heritage sites. |

| | | | | |
|---|---|---|---|---|
| Very High | Potential loss of life of 11 or more persons. | Extensive damage estimated losses in excess of $30 million (3) to buildings, agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, infrastructure, and services. Typically includes destruction of, or extensive damage to, large residential, institutional, concentrated commercial and industrial areas and major infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services include highways, railway lines or municipal water and wastewater treatment facilities and publicly owned utilities. | Extensive loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/ or wildlife habitat with very little or no feasibility of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a viable portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered or irreversible damage to the habitat of that species. | Irreversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or damage to nationally recognized heritage sites. |

Notes:
1. Dollar values associated with property losses are indexed to the Statistics Canada values for the year 2000. Current value (April 2024) would be approximately $506,000 according to the Bank of Canada Inflation Calculator.
2. Dollar values associated with property losses are indexed to the Statistics Canada values for the year 2000. Current value (April 2024) would be approximately $5,060,000 according to the Bank of Canada Inflation Calculator.
3. Dollar values associated with property losses are indexed to the Statistics Canada values for the year 2000. Current value (April 2024) would be approximately $50,600,000 according to the Bank of Canada Inflation Calculator.

## 5.1 Life Safety

Flooding as a threat to life is directly related to the depth and velocity of the flooding at a specific location. As depth increases, the buoyant forces acting upon a person within the floodplain increase, ultimately resulting in the person floating in the flood. As velocity increases, the lateral force of the water increases, and at significantly high velocities can knock a person off their feet. The MNRF has developed the 2 x 2 Rule, which is a method to assess the combined factors of depth and velocity as described in the Technical Guide – Rivers & Stream Systems: Flooding Hazard Limit (2002). The 2 x 2 Rule states that if the product of the depth and velocity is greater than 0.4 $m^2/s$, there is a risk to the life safety of people within the floodplain. Additionally, if the flood depth is greater than 0.8 m, or the flood velocity is greater than 1.7 m/s in the floodplain, there is a risk to life safety, regardless of the product of the depth and velocity.

Several scenarios were modelled to evaluate the life safety risk of the Kashwakamak Lake Dam, including dam breaches under normal conditions, during a 1000-year storm event, and during the PMF event. As noted later under the Section 5.6 of this report, the 1000-year storm event will be used in the design of the future dam according to MNRF criteria (2011). Therefore, the depth and velocity values resulting from the 1000-year storm event under the base and dam break scenarios will be used to determine the life safety HPC for the dam, although a summary of multiple storm event impacts are provided. Additionally, given that the 2 x 2 rule applies to the life safety of people in the floodplain and that the lake levels upstream of the dam will lower as a result of a dam breach, the life safety hazard potential upstream of the dam is not anticipated to be impacted however there could be economical losses due to loss of access to waterfront structures.

In order to determine the hazard to life safety, the depth and velocity values were extracted from the HEC-RAS hydraulic model at the location of the seasonal residences within the varying floodplains. One seasonal residence (ID# 577) was found to be impacted by all storm events. However, since it is within the floodplain of the events under both base and dam breach conditions, it is not considered to be incrementally impacted by the dam. As mentioned in Table 8, two seasonal residences (ID# 908 and 814) were incrementally impacted during the normal conditions dam breach. These and another seasonal residence (ID# 861) were incrementally impacted during the 1000-year dam breach scenario. The incrementally impacted seasonal residences for these storm events were found to have flood depth and velocity values less than the threshold values outlined within the 2x2 rule. Therefore, the life safety HPC for Kashwakamak Lake Dam was concluded to be moderate as no loss of life is anticipated as a direct result of the dam breaking. Table 10 below shows the impacted seasonal residences and the approximate depths and velocities associated with each scenario. Values of 0.0 indicate that the seasonal residence remains outside of the floodplain in that scenario.

A total of 13 seasonal residences were impacted by the worst-case storm – the PMF event – while one (ID# 749) was incrementally impacted. Since the remaining 12 seasonal residences were impacted by both the PMF event and the PMF with dam break event, their impacts were not considered as part of the life safety classification. Nonetheless, it should be noted that five seasonal residences (ID# 908, 861, 859, 814, and 577) were observed to fail the 2x2 rule under both no dam break and dam break conditions during the PMF event.

Table 10: 1D Hydraulic Model Results – Impacts on Downstream Seasonal Residences

| Event | 2x2 Criteria | Seasonal Residence ID | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 908 | 861 | 859 | 857 | 853 | 836 | 850 | 3047 | 749 | 747 | 814 | 586 | 577 |
| Normal (Base) | Average Velocity (m/s) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 |
| | Approximate Depth (m) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 |
| | Depth x Velocity ($m^2/s$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Normal (Dam Breach) | Average Velocity (m/s) | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.19 |
| | Approximate Depth (m) | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.34 |
| | Depth x Velocity ($m^2/s$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| 1000-year (Base) | Average Velocity (m/s) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 |
| | Approximate Depth (m) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.37 |
| | Depth x Velocity ($m^2/s$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 |
| 1000-year (Dam Breach) | Average Velocity (m/s) | 0.01 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.20 |
| | Approximate Depth (m) | 0.06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.37 |
| | Depth x Velocity ($m^2/s$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| PMF (Base) | Average Velocity (m/s) | 0.05 | 0.13 | 0.21 | 0.19 | 0.22 | 0.07 | 0.49 | 0.44 | 0.00 | 0.46 | 0.05 | 0.22 | 0.41 |
| | Approximate Depth (m) | 1.39 | 1.32 | 0.95 | 0.05 | 0.30 | 0.64 | 0.62 | 0.31 | 0.00 | 0.67 | 1.44 | 0.07 | 1.00 |
| | Depth x Velocity ($m^2/s$) | 0.07 | 0.17 | 0.20 | 0.01 | 0.07 | 0.04 | 0.30 | 0.14 | 0.00 | 0.31 | 0.07 | 0.02 | 0.41 |
| PMF (Dam Breach) | Average Velocity (m/s) | 0.06 | 0.14 | 0.22 | 0.19 | 0.22 | 0.08 | 0.49 | 0.44 | 0.41 | 0.46 | 0.06 | 0.23 | 0.42 |
| | Approximate Depth (m) | 1.50 | 1.43 | 1.12 | 0.16 | 0.37 | 0.76 | 0.74 | 0.40 | 0.12 | 0.79 | 1.55 | 0.14 | 1.08 |
| | Depth x Velocity ($m^2/s$) | 0.09 | 0.20 | 0.25 | 0.03 | 0.08 | 0.06 | 0.36 | 0.18 | 0.05 | 0.36 | 0.09 | 0.03 | 0.45 |

Overall, failure of the Kashwakamak Lake Dam under normal conditions is unlikely to severely impact nearby residences, and failure of the dam during a large flood event is not expected to significantly impact the flooding extents or severity, as confirmed by the hydraulic model results.

The 1D HEC-RAS model was also converted into the 2D model and a copy of the 2D model will be submitted with this memorandum. When the models were compared, it was noted that the 2D models generate smaller flood extents that do not reach the seasonal residences impacted in the 1D model. Therefore, for the 2x2 rule evaluation, the velocity and depth values were derived from the 1D model, while the 2D model could be used during the detailed design stage for refined analyses at/around the dam or along the river.

The 1D HEC-RAS model was run for each storm event, which automatically generated maximum depth, velocity, and water surface elevation maps for the flood extents. These maps can be viewed in the RAS Mapper within HEC-RAS. The depth and velocity model outputs at each seasonal residence location intersecting with the floodplain of a given scenario were derived from the maps and are summarized in Table 10 above.

## 5.2 Property Losses

Under the MNRF HPC framework, property losses are evaluated based on the incremental losses incurred in the event of a dam failure and the estimated costs to restore impacted property. Based on the hydraulic modelling, there are no anticipated impacts to downstream infrastructure such as roads or bridges due to dam failure. The 1000-year storm event results in incremental losses due to dam failure at three seasonal residences. The depths and velocities shown in Table 10 above for these seasonal residences are a maximum of 0.12 m deep and 0.04 m/s in velocity, and thus the incremental losses associated with a dam failure scenario are not expected to result in the total loss of any seasonal residences. It is anticipated that these incremental losses would include landscape repairs and minor repairs to the seasonal residence structures. The cost of these repairs for the three incrementally impacted seasonal residences is unlikely to each exceed $1.0 million indexed to the year 2000, or the equivalent of approximately $1.7 million in 2024. Additionally, there are no other structures such as sheds or boathouses downstream of the dam that would be incrementally impacted due to a dam breach during the 1000-year design storm. Structures such as docks may be affected; however, they are located much closer to the channel compared to the seasonal residences and are therefore unlikely to be incrementally impacted.

The anticipated incremental impacts to infrastructure and property losses upstream of the dam were also considered. The dropping of lake levels resulting from dam failure has the potential to damage floating docks or boats what may become beached, thus requiring repairs. Additionally, economic losses for businesses may result from the lower lake levels until the dam can be reinstated. However, as the resulting economic losses are not included in the MNRF criteria for assessing property losses, it was not included in the property losses classification analysis.

Overall, it is not expected that the incremental property losses associated with the failure of the Kashwakamak Lake Dam would exceed $3.0 million (indexed to the year 2000) based on the high-level estimation explained above. Further, the inundation zone is mostly undeveloped, rural or agricultural, or is managed so that the land usage is for transient activities, and minimal damage to properties is anticipated. Therefore, since the risk to property losses is in line with the MNRF (2011) criteria for moderate property losses, it was concluded that the property losses component of the Kashwakamak Lake Dam HPC is moderate.

## 5.3 Environmental Losses

Significant fish habitat in the form of sport fish and baitfish spawning is located immediately downstream of Kashwakamak Lake Dam. It is anticipated that this would include species such as Walleye and White Sucker as well as several baitfish species. This type of habitat is limited in the watershed. Additionally, water levels upstream of Kashwakamak Lake Dam would be anticipated to drop for the entirety of the lake over several days to months.

The fish habitat located immediately downstream has the potential to be completely destroyed whether it be through transportation of the larger materials downstream or sedimentation with a dam breach. The area of most damage would be expected to be within the first kilometre downstream of the watercourse. Further downstream the potential impacts are expected to decrease and be significantly reduced. It is expected that the fish habitat downstream could be restored and that the fish habitat function and populations affected by the dam breach would recover with time.

Upstream of the dam, it is expected that several existing fish habitat types would be impacted for most of the species found within the lake and that spawn in depths under 6 feet. Depending on the timing, a dam breach could have more significant impact on fish population/spawning success than a breach at other times of the year (spring and summer months are more likely to affect spawning, feeding, and rearing). It is expected that the loss of fish habitat as a result of the breach would be only temporary and that there would be minimal requirements for restoration other than reestablishment of the historic water levels within the lake. The full impacts would be temporary and would naturally restore within a couple of years.

It is not anticipated that there would be significant impacts to Species at Risk (SAR) as a result of the dam breach. Any SAR that are known to the area, such as SAR turtles, are able to move/relocate. If the dam were to breach during their more vulnerable period of hibernation there could be impacts to species such as the Map Turtle which hibernates in lakes, however they are not completely dormant during the winter, and it is expected that they would be able to move locations as the lake slowly draws down. The wetland areas where species such as the Blanding's Turtle would be hibernating appear to generally be isolated from the lake and are approximately 1 km downstream of the dam or greater. An influx of water with oxygenation is not likely to impact hibernating turtles downstream of the dam. Additionally, although there will be an increased sediment load from scour resulting from the increased flows, it is expected that the sediment load will settle out as it travels downstream. The impact of the influx in sediments will have a greater impact on downstream fish species and spawning area habitats, whereas turtles use the sediments to overwinter in. It is anticipated that the suspended sediments would be fully settled out before reaching the larger wetland area downstream. There will be some loss of wildlife habitat, however species and impacts cannot fully be understood at this time. It is expected that this will be temporary, and most impacts would naturally recovery.

To evaluate the potential impact on the fish and fish habitat and endangered species, several scenarios were modelled, including dam breaches under normal conditions, during a 1000-year storm event, and during the probable maximum flood storm event (PMF). Additionally, the climate-adjusted 1000-year and the climate-adjusted PMF storm events were modelled as a baseline to evaluate the incremental losses in the event of dam failure. Based on the hydraulic output related to the depth and velocity of the flooding both upstream and downstream of the Kashwakamak Lake Dam, it has been concluded that failure of the dam under normal conditions and during a large flood event is anticipated to have significant impact on fish and fish habitat and a negligible impact on SAR. Fish habitat will be temporarily impacted upstream with natural recovery expected and permanently impacted downstream with the potential for restoration efforts to return the habitat to original conditions once the dam is reinstated at the lake outlet.

The MVCA also prepared a Technical Review Memorandum in March 2024 in response to the Kashwakamak Lake Dam Hazard Potential Classification, has been included in Appendix D. It concluded that the likelihood of negatively impacting the status of fish population and significant deterioration of critical habitat on a watershed scale would be low to moderate. Additionally, the MVCA recommended that the overall HPC for the environmental losses be considered as moderate. Egis is in general agreement with the review by the MVCA that the overall risk should be considered moderate when the assessment is based on a review at the watershed level. There are no known species at risk that will be significantly impacted by a dam failure. Fish habitat upstream of the dam is expected to be restored within one year of a dam failure and would reestablish itself almost immediately once the water levels are restored. It is expected that depending on timing, the fish within Kashwakamak Lake may find new viable spawning habitat in the year of the dam breach. Downstream habitat, suitable for a highly sought after sport fish (Walleye), is likely to be significantly impacted and may require more extensive habitat rehabilitation to restore it to its existing conditions. Based on the documentation provided by the MVCA this could indicate that this impact would be considered moderate to high. However, based on the other factors, the overall risk can be considered moderate when based on a review of the watershed.

Therefore, it is recommended that the potential environmental loss associated with the Fish and Fish Habitat receive a "moderate" HPC for the Kashwakamak Lake Dam. This rating is based mainly on the impacts immediately following the dam breach event, however both the immediate and future impacts were considered. It is not expected that all areas will be restored once the dam is replaced. Permanent changes would include areas of scour of the riparian vegetation that may remove watercourse shading. The watercourse is a warm/cool water habitat and therefore does not rely on shading for thermal regulation. It is also recommended that SAR/Wildlife habitat impacts receive a "low" HPC for the Kashwakamak Lake Dam.

The Manòmin (wild rice) crops are located approximately 7.0 km downstream of the Kashwakamak Lake Dam. Manòmin is an aquatic annual species of grass of cultural significance to the Algonquin First Nations. The species grows in brackish marshes, lacustrine, riverine, or along shored habitats where the water depth ideally ranges from 15 – 90 cm with a soft soil layer on the bottom (OMAFRA, 2012). Stable and minimal outflows are required through the watershed from early June through end of September to ensure growth and harvest of wild rice crops. Wild rice is also important for several different species, as it provides food for waterfowl and habitat for furbearing mammals, snails, and insects (MVCA, 2018). High water levels have the potential to flood the wild rice fields and may destroy the annual crop, as well as low water levels can also dry out the crops. To evaluate the potential impact on the wild rice fields, several scenarios were modelled, including dam breaches under normal conditions, during a 1000-year storm event, and during the probable maximum flood storm event (PMF). Additionally, the climate-adjusted 1000-year and the climate-adjusted PMF storm events were modelled as a baseline to evaluate the incremental losses in the event of dam failure. Based on the hydraulic output related to the depth and velocity of the flooding at a specific location throughout the wild rice fields, it has been concluded that failure of the Kashwakamak Lake Dam under normal conditions and during a large flood event is not anticipated to have an impact on the Manòmin. There was a negligible increase in surface water elevation of 0.1-0.2 m and 0.1 m/s for velocities. Therefore, it is recommended that the potential environmental loss associated with the Manòmin receive a "low" HPC for the Kashwakamak Lake Dam.

## 5.4 Cultural and Built Heritage Losses

Under the MNRF HPC framework, cultural and built heritage losses are evaluated by the potential for damage to municipally designated and/or provincially designated cultural heritage sites under the Ontario Heritage Act and/or nationally recognized heritage sites. Accordingly, municipal, provincial, and federal heritage registers and inventories have been reviewed to identify known heritage properties within and adjacent to the area potentially impacted. Based on the hydraulic modelling, there are zero (0) municipal, provincial and federally recognized built heritage resources or cultural heritage landscapes within the potentially impacted area, and therefore there are no anticipated impacts to downstream built heritage resources or cultural heritage landscapes due to dam failure. Therefore, it is recommended that the cultural and built heritage losses component of the Kashwakamak Lake Dam HPC is low.

## 5.5 Hazard Potential Classification Summary

The final Hazard Potential Classifications for the given categories are summarized in Table 11 below.

Table 11: Hazard Potential Classification Assessment

| Hazard Potential | Life Safety | Property Losses | Environmental Losses | Cultural and Built Heritage Losses |
|---|---|---|---|---|
| Class | Moderate | Moderate | Moderate (Fish and Fish Habitat)<br>Low (SAR, Wildlife, and Manòmin) | Low |

The overall hazard potential class for the existing Kashwakamak Lake Dam structure, including the overflow weir, sluiceway (gated section), and the north and south abutments is concluded to be moderate, as per the MNRF Technical Bulletin (2011). The proposed design options for replacing or rehabilitating the Kashwakamak Lake Dam will be consistent with the current conditions. Therefore, the HPC will be maintained, and the future structure will also have a moderate hazard potential.

The hazard potential class for the saddle dam is assessed to be low due to its location, height, length, and functionality. The saddle dam is not used for any operational purposes and is located immediately west of the access road. Any incremental impact due to the saddle dam failure would be none to low.

## 5.6 Selection of Inflow Design Flood

As described in the MNRF Technical Bulletin for Classification and Inflow Design Flood Criteria (2011), the range of Inflow Design Floods (IDF) based on the dam HPC are summarized in Table 12 below.

Table 12: Range of Minimum Inflow Design Floods (Adapted from MNRF, 2011)

<table>
<tr><th rowspan="2">Hazard Potential Classification</th><th colspan="4">Range of Minimum Inflow Design Floods</th></tr>
<tr><th colspan="2">Life Safety</th><th>Property and Environment</th><th>Cultural – Built Heritage</th></tr>
<tr><td>Low</td><td colspan="4">25-year Flood to 100-year Flood</td></tr>
<tr><td>Moderate</td><td colspan="4">100-year Flood to 1000-year Flood or Regulatory Flood whichever is greater</td></tr>
<tr><td>High</td><td>1-10</td><td>1/3 between the 1000-year Flood and PMF</td><td>1000-year Flood or Regulatory Flood which ever is greater to 1/3 between the 1000-year Flood and PMF</td><td rowspan="3">1000-year Flood or Regulatory Flood whichever is greater</td></tr>
<tr><td rowspan="2">Very High</td><td>11-100</td><td>2/3 between the 1000-year Flood and PMF</td><td rowspan="2">1/3 between the 1000-year Flood and PMF to PMF</td></tr>
<tr><td>Greater than 100</td><td>PMF</td></tr>
</table>

The selection criteria of the inflow design flood were outlined by the MNRF (2011), as shown above, which will be used in the design of the dam. The greater the HPC, or impact to the surrounding area under the condition of a dam break, the greater the severity of the design storm. The HPC for Kashwakamak Lake Dam was determined to be moderate, and thus the IDF for the dam should range from the 100-year flood to the 1000-year flood or regulatory flood events, whichever is greater. Therefore, as a conservative approach, the worst case of the 1000-year and 100-Year flood event was selected as the IDF, respectively, for the main dam and appurtenant structures, and the saddle dam.

# 6.0 FREEBOARD CALCULATIONS

Freeboard calculations were completed considering wind and wave impacts, as is generally done for dams and per MNRF requirements. Wind setup and wave runup for the site are calculated separately and combined to compare the existing crest elevation of the structures. The fetch at the dam is estimated to be approximately 780 m. According to the MNRF Technical Bulletin for Spillways and Flood Control Structures (August 2011), a minimum freeboard is recommended based on the fetch distances and as per the provincial guidelines applicable to this site should be 0.6 m. Therefore, final calculations for the freeboard for the flood conditions are completed using the minimum criterion of 0.60 m. The freeboard calculations are presented in Table 13 below. Water surface elevation (WSE) and flow information for the climate change scenarios are also included in Table 13. The difference in WSE for base and climate change scenarios is 0.08 m.

Based on the calculations, the minimum freeboard requirements for the abutments and saddle dam are not met. The south abutment, north abutment, and saddle dam are required to be raised by 0.36 m (to an elevation of 261.99 m), 0.32 m (to an elevation of 261.99m) and 0.19 m (to an elevation of 261.85 m), respectively. The freeboard for the climate change scenario for both the abutments and saddle dam would be 0.52 m when the crests are adjusted to the proposed elevations. However, it is recommended to adjust the saddle dam crest elevation to 261.99 m (or approximately 262.0 m) to be consistent with the abutment walls.

As previously noted, the saddle dam located north of the Kashwakamak Lake Dam and west of the access roadway overtops when water levels of Kashwakamak Lake exceed its crest elevation of 261.66 m. An existing natural channel east of the saddle dam and access roadway would function as an overflow channel. Under the proposed conditions, converting the saddle dam to an emergency spillway should be considered to maintain the existing conditions. The future access roadway should be designed to allow the overflow and convey it towards the downstream channel during flood events. If converted to an emergency spillway, additional property may be required due to it currently being part of the shoreline allowance for the North Frontenac Township but is closely neighbouring private property, according to land ownership details.

Table 13: Summary of Freeboard Calculations

| Features | Weir | Stop Logged Gates | South Abutment | North Abutment | Saddle Dam |
|---|---|---|---|---|---|
| Dam Hazard Potential Classification | F: Moderate, NF: Moderate | | | | F: Low, NF: Low |
| Inflow Design Flood (IDF) Selection Criteria (MNRF 2011) | 100-year to the 1000-year or Regulatory Flood whichever is greater | | | | 25-year to the 100-year |
| IDF Selected | 1000-year | | | | 100-year |
| IDF (1000-year) ($m^3/s$) (With Climate Change) | 99 (123) | | | | 73 (91) |
| Maximum Design Earthquake (MDE) AEP | 1000-year | | | | 500-year |
| Structure Crest Elevation (m) | 261.06 | 262.62 | 261.63 | 261.67 | 261.66 |
| Winter Drawdown Level (m) | 259.59 | | | | |
| Maximum Normal Lake Operating Level (m) | 261.20 | | | | |
| IDF Level (m) (With Climate Change) | 261.39 (261.47) | | | | 261.25 (261.33) |
| Stop Log Status | n/a | All Removed | n/a | n/a | n/a |
| Peak Inflow ($m^3/s$) | 99 | | n/a | n/a | n/a |
| Peak Inflow Volume (1000 $m^3$) | 17.9 | | n/a | n/a | n/a |
| Peak Outflow ($m^3/s$) | 48 | | n/a | n/a | n/a |
| Peak Outflow Volume (1000 $m^3$) | 15.2 | | n/a | n/a | n/a |
| Fetch (m) | 780 | | | | |
| Minimum Freeboard Criteria (m) (MNRF 2011) | 0.60 | | | | |
| Wind Set-up IDF (Normal) (m) | 0.01 (0.02) | | | | |
| Wave Run-up IDF (Normal) (m) | 0.34 (0.59) | | | | |
| Total Wind Setup & Wave Runup IDF (Normal) (m) | 0.35 (0.61) | | | | |
| Freeboard Normal Conditions (m) | n/a | n/a | -0.17 | -0.13 | -0.14 |
| Freeboard IDF Conditions (m) As per MNRF 0.60 m minimum[1] criterion | n/a | n/a | *-0.36* | *-0.32* | *-0.19* |
| Assessment of Freeboard (Normal) | n/a | n/a | Inadequate | Inadequate | Inadequate |
| Assessment of Freeboard (IDF) | n/a | n/a | Inadequate | Inadequate | Inadequate |

Notes:
1. Due to the calculated freeboard (0.36 m) is smaller than the MNRF minimum requirement, the minimum is applied in the calculations.

# 7.0 CONCLUSION

The hydraulic analysis and Hazard Potential Classification was completed for the Kashwakamak Lake Dam for the Mississippi Valley Conservation Authority as part of a Class Environmental Assessment for Remedial Flood and Erosion Control Projects in support of the proposed dam replacement. The existing hydrologic models and documentation were reviewed and incorporated into the hydraulic models. The existing hydraulic model was also reviewed and updated with new data for additional scenarios to model the impacts of various events on Kashwakamak Lake and the downstream channel. The impacts were analyzed to determine the HPC for the risk to life safety, property losses, environmental losses, and cultural-built heritage losses. It was determined that the life safety, property loss, and environmental loss (pertaining to fish and fish habitat) components of the Kashwakamak Lake Dam HPC are moderate, while the environmental loss (pertaining to SAR, Wildlife, and Manòmin) and the cultural-built heritage components of the Kashwakamak Lake Dam

HPC are low. Therefore, the overall HPC of the Kashwakamak Lake Dam structure was concluded to be moderate. Furthermore, freeboard calculations were performed for the main dam components and saddle dam, and it is recommended that the crest elevations of the abutments and saddle dam be raised to meet MNRF freeboard requirements.

This report is respectfully submitted by Egis-Group.

| Report Prepared By: | Report Prepared By: | Report Prepared By: |
| --- | --- | --- |
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# APPENDIX A:
# STATISTICAL ANALYSIS OF GAUGED WATER LEVELS

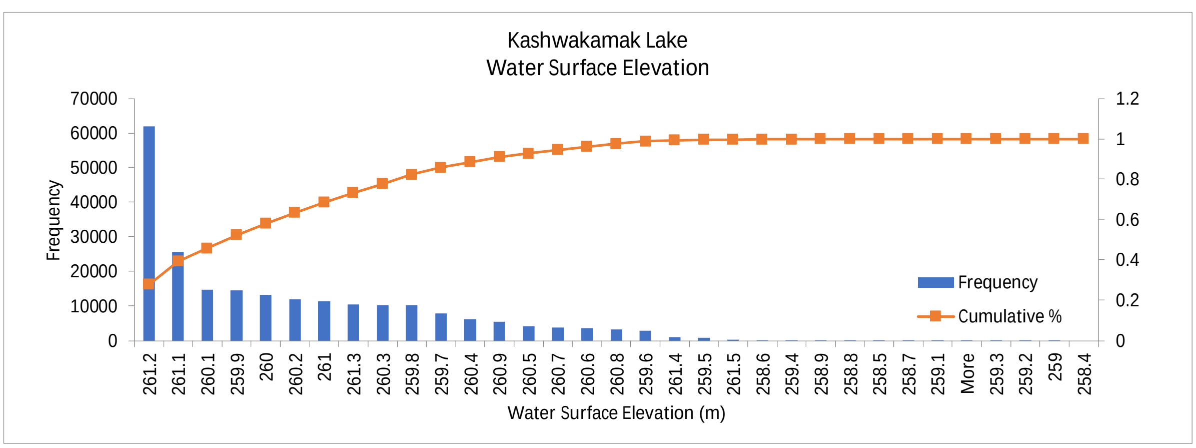
STATISTICAL ANALYSES OF GAUGED WATER LEVELS
KASHWAKAMAK LAKE

**Descriptive Statistics**

| *Statistical Parameter* | *Value* |
|---|---|
| | |
| Mean | 260.60 |
| Standard Error | 0.00 |
| Median | 260.89 |
| Mode | 261.15 |
| Standard Deviation | 0.57 |
| Sample Variance | 0.33 |
| Kurtosis | -1.27 |
| Skewness | -0.42 |
| Range | 3.1 |
| Minimum | 258.4 |
| Maximum | 261.5 |
| Sum | 58364421.5 |
| Count | 223961 |
| Largest(1) | 261.53 |
| Smallest(1) | 258.42 |
| Confidence Level(95.0%) | 0.00238 |

**Histogram**

| *Elevation (m)* | *Number of Measurements* | *Percentage (%)* | *Cumulative Percentage (%)* |
|---|---|---|---|
| 258.4 | 0 | 0 | 0 |
| 258.5 | 92 | 0 | 0 |
| 258.6 | 119 | 0 | 0 |
| 258.7 | 71 | 0 | 0 |
| 258.8 | 94 | 0 | 0 |
| 258.9 | 112 | 0 | 0 |
| 259 | 2 | 0 | 0 |
| 259.1 | 62 | 0 | 0 |
| 259.2 | 20 | 0 | 0 |
| 259.3 | 33 | 0 | 0 |
| 259.4 | 119 | 0 | 0 |
| 259.5 | 778 | 0 | 1 |
| 259.6 | 2863 | 1 | 2 |
| 259.7 | 7842 | 4 | 5 |
| 259.8 | 10194 | 5 | 10 |
| 259.9 | 14570 | 7 | 17 |
| 260 | 13167 | 6 | 22 |
| 260.1 | 14689 | 7 | 29 |
| 260.2 | 11978 | 5 | 34 |
| 260.3 | 10202 | 5 | 39 |
| 260.4 | 6226 | 3 | 42 |
| 260.5 | 4191 | 2 | 44 |
| 260.6 | 3656 | 2 | 45 |
| 260.7 | 3699 | 2 | 47 |
| 260.8 | 3213 | 1 | 48 |
| 260.9 | 5377 | 2 | 51 |
| 261 | 11301 | 5 | 56 |
| 261.1 | 25608 | 11 | 67 |
| 261.2 | 61998 | 28 | 95 |
| 261.3 | 10476 | 5 | 99 |
| 261.4 | 896 | 0 | 100 |
| 261.5 | 270 | 0 | 100 |
| More | 43 | 0 | 100 |
| *Total* | 223961 | 100 | |



| | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | | Total Max | Total Min |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | | |
| 1993 | | | | | | | | | | | | | | | | | | | | | | | 260.17 | 260 | 260.17 | 260 |
| 1994 | 260 | 259.72 | 259.74 | 259.67 | | | | | | | 261.15 | 261.02 | 261.24 | 261.08 | 261.3 | 260.68 | | | | | | | | | 261.3 | 259.67 |
| 1995 | | | | | | | | | | | | | | | | | 260.99 | 260.98 | 261.13 | 260.52 | 260.53 | 260.26 | 260.4 | 259.86 | 261.13 | 259.86 |
| 1996 | 259.99 | 259.61 | 260.14 | 259.98 | 260.16 | 259.85 | 261.16 | 260.16 | 261.17 | 261.07 | 261.16 | 261.06 | 261.1 | 261.07 | 261.15 | 261.06 | 261.16 | 261 | 261.14 | 260.45 | 260.45 | 260.17 | 260.31 | 260.12 | 261.17 | 259.61 |
| 1997 | 260.27 | 259.96 | 260.03 | 259.75 | 260.26 | 259.93 | 260.99 | 259.98 | 261.19 | 260.94 | 261.21 | 261.11 | 261.16 | 261.04 | 261.06 | 260.95 | 260.98 | 260.9 | 261.13 | 260.19 | 260.31 | 259.94 | 260.29 | 259.84 | 261.21 | 259.75 |
| 1998 | 260.04 | 259.88 | 259.88 | 259.6 | 260.16 | 259.62 | 261.29 | 260.17 | 261.19 | 261.13 | 261.21 | 261.14 | 261.16 | 261.14 | 261.14 | 261.03 | 261.07 | 260.97 | 261.17 | 260.39 | 260.39 | 260.1 | 260.21 | 259.76 | 261.29 | 259.6 |
| 1999 | 259.78 | 259.69 | 260.3 | 259.1 | 260.16 | 259.17 | 260.88 | 259 | | | 261.16 | 261.09 | 261.21 | 261.14 | | | 261.13 | 261.05 | 261.16 | 260.8 | 260.85 | 260.22 | 260.22 | 259.93 | 261.21 | 259 |
| 2000 | 259.93 | 259.78 | | | | | | | | | | | | | | | | | | | 260.28 | 260.15 | 260.16 | 259.85 | 260.28 | 259.78 |
| 2001 | 259.86 | 259.64 | 259.77 | 259.62 | 259.77 | 259.68 | 261.17 | 259.68 | 261.23 | 261.12 | 261.17 | 261.12 | 261.15 | 259.9 | 261.13 | 261.07 | 261.12 | 261.08 | 261.08 | 261.08 | | | 260.23 | 259.52 | 261.23 | 259.52 |
| 2002 | 260.01 | 259.68 | 259.7 | 259.59 | 260.42 | 259.59 | 261.08 | 259.14 | 261.21 | 261.05 | 261.42 | 261.12 | 261.3 | 261.1 | 261.12 | 259.76 | 261.06 | 260.97 | 261.09 | 260.6 | 260.6 | 260.05 | 260.05 | 259.64 | 261.42 | 259.14 |
| 2003 | 259.64 | 259.48 | 259.64 | 259.47 | 259.82 | 259.45 | 260.64 | 259.82 | 261.23 | 260.64 | 261.16 | 261.1 | 261.13 | 261.06 | 258.89 | 258.89 | 261.09 | 260.99 | 261.42 | 260.48 | 260.5 | 260.21 | 260.52 | 260.1 | 261.42 | 258.89 |
| 2004 | 260.11 | 259.66 | 259.66 | 259.55 | 261.08 | 259.6 | 260.94 | 260.01 | 261.18 | 260.94 | 261.49 | 261.09 | 261.15 | 261.03 | 261.19 | 261.07 | 261.25 | 261.11 | 261.14 | 260.38 | 260.27 | 260.09 | 260.35 | 260.01 | 261.49 | 259.55 |
| 2005 | 260.08 | 259.89 | 259.89 | 259.79 | 259.97 | 259.85 | 261.22 | 259.97 | 261.24 | 261.07 | 261.28 | 258.98 | 261.23 | 258.88 | 261.09 | 261.02 | 261.09 | 261.01 | 261.07 | 260.8 | 260.79 | 259.93 | 260.02 | 259.76 | 261.28 | 258.88 |
| 2006 | 260.04 | 259.06 | 259.86 | 259.78 | 260.41 | 259.78 | 261.03 | 260.41 | 261.2 | 261.03 | 261.5 | 260.83 | 261.53 | 261.09 | 261.3 | 258.42 | 261.07 | 260.93 | 261.2 | 260.55 | 260.55 | 260.18 | 260.56 | 258.83 | 261.53 | 258.42 |
| 2007 | 260.17 | 259.94 | 259.94 | 259.66 | 261.03 | 259.69 | 261.22 | 260.79 | 261.21 | 261.08 | 261.16 | 259.06 | 261.18 | 261.07 | 261.17 | 261.02 | 261.07 | 261 | 261.03 | 260.72 | 260.72 | 259.84 | 260.07 | 259.83 | 261.22 | 259.06 |
| 2008 | 260.4 | 260.05 | 260.34 | 259.87 | 259.93 | 259.81 | | | 261.16 | 261.07 | 261.23 | 261.11 | 261.19 | 261.1 | 261.22 | 260.64 | 261.16 | 261.09 | 261.14 | 260.28 | 260.53 | 259.72 | 260.2 | 260.01 | 261.23 | 259.72 |
| 2009 | 260.14 | 259.94 | 259.96 | 259.8 | 260.25 | 259.88 | 261.28 | 260.26 | 261.31 | 261.12 | 261.22 | 261.12 | 261.21 | 261.1 | 261.49 | 261.19 | 261.23 | 261.08 | 261.21 | 260.54 | 260.54 | 260.13 | 260.41 | 260.21 | 261.49 | 259.8 |
| 2010 | 260.23 | 260 | 260.08 | 258.74 | 260.57 | 259.73 | 260.86 | 260.56 | 261.25 | 260.85 | 261.24 | 261.18 | 261.21 | 261.12 | 261.16 | 261.1 | 261.21 | 261.14 | 261.15 | 260.51 | 260.51 | 260.21 | 260.64 | 260.22 | 261.25 | 258.74 |
| 2011 | 260.22 | 259.76 | 259.77 | 259.66 | 260.31 | 259.63 | 261.28 | 260.31 | 261.22 | 261.11 | 261.21 | 261.13 | 261.18 | 261.12 | 261.16 | 261.07 | 261.08 | 260.98 | 261.03 | 260.87 | 260.86 | 260.03 | 260.4 | 260.05 | 261.28 | 259.63 |
| 2012 | 260.33 | 260.12 | 260.12 | 259.97 | 260.97 | 259.86 | 261.15 | 260.92 | 261.2 | 261.11 | 261.21 | 261.12 | 261.12 | 260.97 | 260.99 | 260.76 | 260.93 | 260.88 | 260.93 | 260.83 | 260.83 | 260.08 | 260.13 | 260.07 | 261.21 | 259.86 |
| 2013 | 260.09 | 259.99 | 260.04 | 259.95 | 259.97 | 259.93 | 261.26 | 259.94 | 261.25 | 261.03 | 261.26 | 261.11 | 261.26 | 261.11 | 261.15 | 261.07 | 261.21 | 261.1 | 261.21 | 260.64 | 260.69 | 260.63 | | | 261.26 | 259.93 |
| 2014 | 259.9 | 259.86 | 259.89 | 259.8 | 259.84 | 259.81 | | | 261.3 | 261.12 | 261.25 | 261.14 | 261.19 | 261.1 | 261.16 | 261.07 | 261.17 | 261.09 | 261.2 | 260.59 | 260.59 | 260.02 | 260.24 | 259.85 | 261.3 | 259.8 |
| 2015 | 259.85 | 259.68 | 259.68 | 259.57 | 259.57 | 259.52 | 260.42 | 259.54 | 261.07 | 260.43 | 261.32 | 261.06 | 261.2 | 261.13 | 261.3 | 261.13 | 261.25 | 261.08 | 261.19 | 260.8 | 260.81 | 260.25 | 260.28 | 260.17 | 261.32 | 259.52 |
| 2016 | 260.27 | 260.03 | 260.15 | 260.07 | 260.99 | 260.05 | 261.2 | 260.99 | 261.17 | 261.11 | 261.23 | 261.15 | 261.16 | 261.05 | 261.08 | 261 | 261.01 | 260.93 | 260.95 | 260.4 | 260.4 | 259.88 | 260.14 | 259.94 | 261.23 | 259.88 |
| 2017 | 260.17 | 259.89 | 259.89 | 259.76 | 260.33 | 259.87 | 261.16 | 260.12 | 261.39 | 261.09 | 261.26 | 261.13 | 261.25 | 261.15 | 261.26 | 261.14 | 261.22 | 261.16 | 261.17 | 260.76 | 260.77 | 260.37 | 260.37 | 260 | 261.39 | 259.76 |
| 2018 | 260 | 259.9 | 260 | 259.9 | 260.08 | 259.95 | 261.08 | 260.08 | 261.28 | 261.1 | 261.26 | 261.11 | 261.16 | 261.02 | 261.17 | 261.13 | 261.18 | 261.1 | 261.21 | 260.55 | 260.55 | 260.13 | 260.32 | 260.2 | 261.28 | 259.9 |
| 2019 | 260.21 | 259.95 | 259.95 | 259.86 | 259.88 | 259.76 | 261.52 | 259.83 | 261.3 | 261.1 | 261.27 | 261.17 | 261.21 | 261.09 | 261.13 | 261.04 | 261.1 | 261.03 | 261.11 | 260.83 | 260.92 | 260.07 | 260.07 | 259.82 | 261.52 | 259.76 |
| 2020 | 260.01 | 259.75 | 259.98 | 259.71 | 260.4 | 259.69 | 261.16 | 260.41 | 261.32 | 261.13 | 261.26 | 261.15 | 261.17 | 261.11 | 261.2 | 261.11 | 261.2 | 261.11 | 261.23 | 260.91 | 260.91 | 260.2 | 260.32 | 260.18 | 261.32 | 259.69 |
| 2021 | 260.32 | 259.83 | 259.83 | 259.63 | 260.09 | 259.59 | 260.94 | 260.1 | 261.32 | 260.94 | 261.18 | 261.1 | 261.24 | 261.12 | 261.16 | 261.09 | 261.29 | 261.07 | 261.27 | 260.55 | 260.56 | 260.1 | 260.16 | 260.01 | 261.32 | 259.59 |
| 2022 | 259.97 | 259.78 | 259.77 | 259.65 | 260.3 | 259.68 | 261.04 | 260.3 | 261.19 | 261.04 | 261.36 | 261.14 | 261.17 | 261.1 | 261.21 | 261.11 | 261.18 | 261.14 | 261.16 | 260.95 | 260.96 | 260.15 | 260.21 | 260 | 261.36 | 259.65 |
| 2023 | | | 259.87 | 259.84 | 259.85 | 259.54 | 261.32 | 259.54 | 261.3 | 261.07 | 261.15 | 261 | 261.23 | 261.15 | 261.2 | 261.11 | 261.11 | 260.96 | 261.05 | 260.71 | | | | | 261.32 | 259.54 |
| Max/Min | 260.4 | 259.06 | 260.34 | 258.74 | 261.08 | 259.17 | 261.52 | 259 | 261.39 | 260.43 | 261.5 | 258.98 | 261.53 | 258.88 | 261.49 | 258.42 | 261.29 | 260.88 | 261.42 | 260.19 | 260.96 | 259.72 | 260.64 | 258.83 | 261.53 | 258.42 |

# APPENDIX B:
# FLOODPLAIN MAPS


LEGEND

- 100-Year Floodplain
- Building in Floodplain

CLIENT: Mississippi Valley Conservation Authority

PROJECT: HYDRAULIC ANALYSIS MEMORANDUM

TITLE: 100-YEAR FLOODPLAIN

egis
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742

| PROJECT NO:CCO-23-3603 | |
|---|---|
| Date | May., 07, 2024 |
| GIS | CZ |
| Checked By | MS |

FIGURE: B1


LEGEND

1000-Year Floodplain

Building in Floodplain

CLIENT: Mississippi Valley Conservation Authority

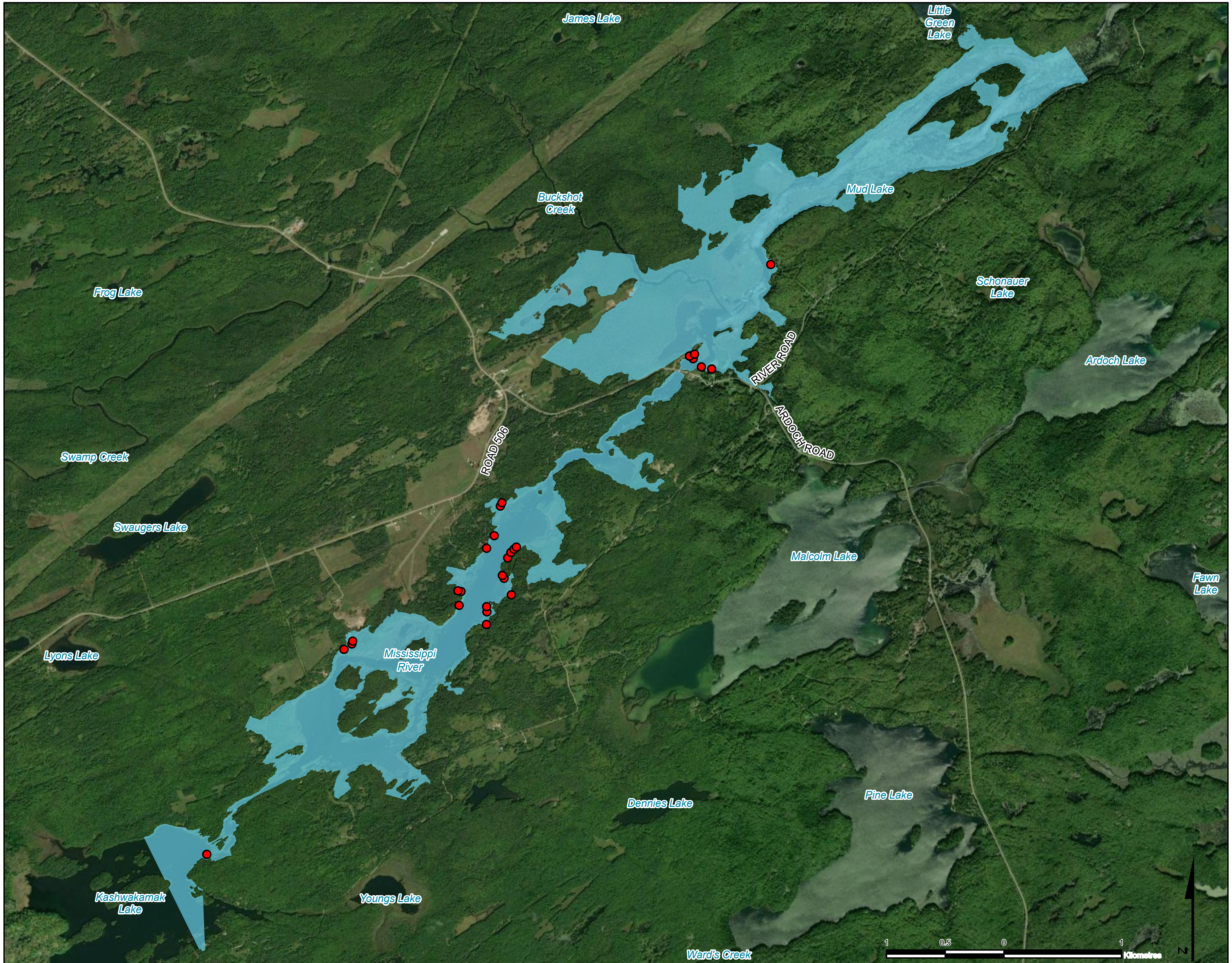
PROJECT: HYDRAULIC ANALYSIS MEMORANDUM

TITLE: 1000-YEAR FLOODPLAIN

egis
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742

| | |
|---|---|
| PROJECT NO: | CCO-23-3603 |
| Date | May., 07, 2024 |
| GIS | CZ |
| Checked By | MS |

FIGURE: B2




LEGEND

PMF Flood Scenario

Building in Flood Extents

CLIENT: Mississippi Valley Conservation Authority

PROJECT: HYDRAULIC ANALYSIS MEMORANDUM

TITLE: PMF FLOODPLAIN

egis

115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742

| PROJECT NO: | CCO-23-3603 |
|---|---|
| Date | May., 07, 2024 |
| GIS | CZ |
| Checked By | MS |

FIGURE: B3

# APPENDIX C:
# MVCA METHODOLOGY FOR DETERMINING ENVIRONMENTAL LOSSES & CLASSIFICATION

Dam Hazard Potential Classification (HPC)

# Methodology for Determining Environmental Losses & Classification

March 13, 2024

## PURPOSE

The purpose of the document is to establish an approach and methodology for determining the environmental classification per Table 1 of the Technical Bulletin: *Classification and Inflow Design Flood Criteria*, OMNR, August 2011.[1,2,3]

## TECHNICAL FRAMEWORK

*Table 1 – Hazard Potential Classification* identifies four categories:

- Life Safety
- Property Losses
- Environmental Losses
- Cultural/Heritage Losses

Each is to be scored either Low, Moderate, High, or Very High. The highest score amongst the four categories determines the overall dam classification. For example, three of the four categories can score Low, but if the fourth category scores High, the HPC for the dam is High.

Assessed "losses" are to be based upon the environmental impacts of a flood, earthquake or other event, and consider two scenarios:

- Event with dam intact
- Event plus dam failure

The objective of the dam failure scenario is to determine the ultimate discharge and outcome of a flood peak or flood wave immediately downstream of the dam. A "flood induced" failure is an event that the dam cannot safely pass that leads to its failure. The key is to determine what incremental losses would occur if the existing dam were to fail during the prescribed event.

The HPC must be based on the worst-case scenario of failure of the dam and at the worst possible time thereby resulting in the highest HPC of all realistic failure scenarios. The combination of a seismic event with a flood event is not considered for determining the HPC.

[1] https://www.ontario.ca/page/dam-management
[2] https://files.ontario.ca/technical-bulletin-classification-and-idf.pdf
[3] Other references used: 2007 CDA Tech Bulletin: Inundation, Consequences & Classification for Dam Safety; 2022 DSR for Carleton Plan Dam, Wills;

The assessment of environmental losses considers two main variables:

- Loss in species
- Loss of habitat

## PROPOSED APPROACH

### Competency

The evaluation of environmental losses should be carried out by a biologist, preferably a specialist in eastern Ontario aquatic species and habitats that is knowledgeable in federal and provincial species at risk legislation, no-net-loss and recovery methods, and who is familiar with recovery projects and their viability/success in comparable settings.

### Definitions

Table 1 of the 2011 Technical Bulletin refers to the following:

- the Ontario *Endangered Species Act*, 2007 and
- Critical Habitat (CH)
- Minimal, Moderate, Appreciable, and Extensive (loss of fish or habitat)
- Significant deterioration (of critical habitat)
- Reversible damage
- Viable population

There is no definition for "Critical Habitat" in the provincial legislation, but there is a definition in the federal *Species At Risk Act (SARA)*, S.C. 2002:

> "The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." [4]

None of the other terms are defined in either the provincial or federal legislation. Therefore, for the purpose of determining environmental losses at MVCA facilities:

- The evaluation should consider the "list of species" contained in the provincial *Endangered Species Act* and the federal *Species At Risk Act*. The species does *not* need to be listed in both.
- The presence of "critical habitat" is to be determined using the SARA definition, i.e. identified in an approved recovery strategy or action plan.
- Viable shall mean that proposed interventions will allow the specie to reach a self-sustaining population that no longer requires intervention.
- "Moderate loss" shall mean that the range, magnitude, and duration of impacts would not affect species viability in the watershed, and that species habitats will likely recover within a 5-year period.
- "Appreciable loss" shall mean that the range, magnitude, or duration of impacts to species numbers or their habitat may be apparent at a watershed level, but that the habitat and species will likely recover within a 5 to 10-year period.

[4] https://laws.justice.gc.ca/eng/acts/s-15.3/page-1.html#h-434504

- “Extensive loss” shall mean that the range, magnitude, or duration of impacts to species numbers or their habitat will likely occur at a watershed level, and that a recovery period >10-year period will be required, with extensive intervention.
- “Significant deterioration” shall mean that the loss of “critical habitat” or “listed species” will be very difficult to recover to current levels, with a projected recovery period >10-years.
- “Viable” shall mean that the specie will likely reach a self-sustaining population that no longer requires intervention within 10-30 years.

## Methodology

1. Literature review and field investigations to identify presence of habitat type and species at the dam site, and as far downstream and upstream as would likely be directly affected by a dam failure.
2. Confirm the presence of “listed species”.
3. Assess environmental impacts of the “event” scenario with the dam intact.
    a. Range of habitats and species affected
    b. Scale of those impacts
    c. Duration of those impacts
4. Assess environmental impacts of the “event” scenario with a dam failure.
    a. Range of habitats and species affected
    b. Scale of those impacts
    c. Duration of those impacts
5. Determine if there is an incremental difference in the impacts.
6. Identify and assess efficacy of proposed recovery methods.
    a. Suitability/appropriateness of measure
    b. Time required to implement and see measurable habitat/specie recovery
    c. Time for specie population to recover to viable levels

The following table contains parameters to be considered.

| Technical Bulletin Classification / Description | Environmental Information Required | Environmental Score Indicators |
|---|---|---|
| **LOW** - Minimal loss of fish and/or wildlife habitat with high capability of natural restoration resulting in a very low likelihood of negatively affecting the status of the population. | • Species and species habitats at the dam and within broader watershed (both up and downstream)<br>• Status of population(s) and vulnerability in the watershed<br>• Summary of potential for Species at Risk (SAR) and SAR habitat (in the influence zone (both up and downstream)<br>• Significance of dam in habitat availability, species health and population recovery<br>•<br>• | • No species at risk<br>• Species and relevant habitats prevalent at other locations in the watershed<br>• Incremental impact of dam failure does not materially impact habitat or species populations at the watershed level.<br>• Incremental losses are unlikely to extend beyond one year. |
| **MODERATE** – Moderate loss or deterioration of fish and/or wildlife habitat with moderate capability of natural restoration resulting in a low likelihood of negatively affecting the status of the population. | *Above and,*<br>• Discussion of the likely recovery period assuming natural restoration<br>• Demonstrated evidence that the recovery methods will be successful | • No species at risk.<br>• Incremental impact of dam failure does not materially impact habitat or species populations at the watershed level.<br>• Natural recovery of viable populations and habitat in the dam's zone of influence are feasible and likely with replacement of the dam. |
| **HIGH** - Appreciable loss of fish and/or wildlife habitat or significant deterioration of critical fish and/or wildlife habitat with reasonable likelihood of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels.<br>Loss of a portion of the population of a species classified under the *Ontario Endangered Species Act* as Extirpated, Threatened or Endangered, or reversible damage to the habit of that species. | *Above and,*<br>• Delineation of "critical habitat" types, locations, and discussion on severity of impact<br>• Activities required to allow for habitat recovery and "viability" population levels.<br>• Likely recovery period assuming assisted recovery.<br>• Demonstrated evidence that damage is reversible and/or no net loss is viable.<br>• Demonstrated evidence that recovery methods will work, that damage is reversible, with good probability of recovering viable population. | • Incremental impacts of dam failure could materially impact habitat or species populations at the watershed level.<br>• Assisted recovery of viable populations and habitat in the dam's zone of influence and at the watershed level are feasible and likely with replacement of the dam and other interventions.<br>• No-net-loss methods and sites are viable in the same watershed that can minimize permanent, irreversible damage to habitats and species at risk. |
| **VERY HIGH** - Extensive loss of fish and/or wildlife habitat or significant deterioration of critical fish and/or wildlife habitat with very little or no feasibility of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels.<br>Loss of a viable portion of the population of a species classified under the *Ontario Endangered Species Act* as Extirpated, Threatened or Endangered or irreversible damage to the habitat of that species. | | • Assisted recovery of viable populations and habitat in the dam's zone of influence and at the watershed level are NOT feasible.<br>• Significant, permanent, irreversible damage to habitats and species at risk. |

APPENDIX D:
MVCA TECHNICAL REVIEW MEMORANDUM

Mississippi Valley Conservation Authority

# Technical Review Memorandum

| | |
|---|---|
| **To:** | Juraj Cunderlik, Director of Engineering |
| **From:** | Kelly Stiles, Biologist |
| **RE:** | Kashwakamak Lake Dam HPC review |
| **MVCA File No.:** | Enter File No. |
| **Munic. Ref. ID.:** | |
| **Date:** | March 14, 2024 |

Mississippi Valley Conservation Authority (MVCA) has been circulated the following:

- "Kashwakamak Lake Dam – DRAFT Hydraulic Analysis Memo", by Egis (formally McIntosh Perry), December 22, 2023.
- "Classification and Inflow Design Flood Criteria, Technical Bulletin" by Ontario Ministry of Natural Resources, August, 2011.
- "Methodology for Determining Environmental Losses and Classification" by Mississippi Valley Conservation Authority, March, 2024.

MVCA generally concurs with the environmental site condition and losses summary for the areas up and downstream of the Kashwakamak Lake Dam provided in the Egis memo. We note that the OMNR Design Flood Criteria Technical Bulletin that ranks the potential environmental losses to be vague and further clarification is needed to address associated impacts in the local context.

The MVCA interpretation of the OMNR methodology assesses the dam and associated impact zones in the context of the Mississippi River watershed. MVCA provides the following summary of the site conditions and subsequent ranking.

Species composition:

- Any listed species identified in the Egis report as occurring in the area of the Kashwakamak Lake Dam will not be incrementally impacted by a flood + failure event.
- The fish species in the potential zone of impact are not listed as at risk provincially or federally.
- The fish species present up and downstream of the dam are found in other locations throughout the Mississippi River watershed.

Presence of critical habitat:

- The incremental damage to the fish spawning habitat from the dam failure + flood event vs solely the flood event is limited to the shallow water (less than 6 feet or 2 m) habitat within Kashwakamak Lake (as mentioned in the Egis report).

- The spawning habitat, noted above, that may be impacted by lake dewatering if the dam were to fail is not unique or at risk on the watershed scale.
- If the dam failed the impact would be temporary. It is anticipated repairs would be completed in a time frame that would minimize longer term seasonal impacts. Timely dam reinstatement should provide water depth sufficient for the successful spawning habitat use for the next year's generation.
- Restoration of habitat up and downstream of the dam would reasonably occur naturally with limited assisted efforts required to remove the dam debris from the river.

Conclusion on the incremental impact of flood event + dam failure on areas up and downstream of Kashwakamak Lake dam:

- The likelihood of "negatively affecting the status of the (fish) population" on the watershed scale is low to moderate.
- The likelihood of "significant deterioration of critical (fish) habitat" on the watershed scale is low to moderate.
- Natural and minor assisted recovery/restoration of fish and fish habitat is possible within one year after impact.

With those further clarifications in mind, MVCA recommends the Hazard Potential for the incremental environmental losses if the dam fails during a peak flood event be classed as moderate.

Kelly Stiles
MVCA Biologist