Quinte Conservation
McLeod Dam Operating Plan

Operations, Maintenance, Surveillance and Safety Manual

Table of Contents

1. Introduction ............................................................................................................................................ 1
   1.1 Organizational Structure ................................................................................................................ 1
   1.2 Duties and Responsibilities ............................................................................................................ 1
   1.3 Training ......................................................................................................................................... 2

2. McLeod Dam........................................................................................................................................... 2
   2.1 Location and Site Access ................................................................................................................ 2
   2.2 Available Drawings and Reports .................................................................................................... 5
   2.3 Dam Characteristics and Components ............................................................................................ 6
      2.3.1 Main Dam Components ....................................................................................................... 6
      2.3.2 Waterpower Components ..................................................................................................... 9
      2.3.3 Spillway and Outlet Works................................................................................................... 9
      2.3.4 Benchmarks and Datums .................................................................................................... 10
      2.3.5 Water Level Sensors ........................................................................................................... 10
   2.4 Hazard Potential Classification ..................................................................................................... 10
   2.5 Inflow Design Flood ..................................................................................................................... 10

3. Operational Objectives ......................................................................................................................... 11
   3.1 Discharge Facilities and Capacities ............................................................................................... 11
   3.2 Water Management Plan .............................................................................................................. 11
   3.3 Head-Pond Target Operating Level Plot ....................................................................................... 11
   3.4 Minimum Flow Release ................................................................................................................ 11

4. Concerns, Problems and Constraints ..................................................................................................... 17
   4.1 Upstream ..................................................................................................................................... 17
      4.1.1 Flooding ............................................................................................................................. 17
      4.1.2 Winter Ice Control ............................................................................................................. 17
      4.1.3 Recreation .......................................................................................................................... 17
      4.1.4 Water Supply ..................................................................................................................... 18
      4.1.5 Hydropower Generation .................................................................................................... 18
   4.2 Downstream ................................................................................................................................ 18
      4.2.1 Flooding ............................................................................................................................. 18
      4.2.2 Erosion .............................................................................................................................. 18
4.2.3 Fisheries ................................................................. 18
4.2.4 Water Quality ........................................................... 19
4.3 Coordination with Upstream Dam Operations ......................... 19
4.4 Coordination with Downstream Dam Operations ..................... 19

5. Operational Procedures ............................................................................... 19

5.1 General ........................................................................ 19
5.2 Limits on Filling and Drawdown ........................................... 19
  5.2.1 Normal Drawdown ................................................. 20
  5.2.2 Maintenance Drawdown Procedure ............................. 20
  5.2.3 Normal Head-Pond Filling ....................................... 20
  5.2.4 Maintenance Head-Pond Filling ................................. 21
5.3 Seasonal Operations .......................................................... 21
  5.3.1 Operating Levels and Procedures ................................ 21
  5.3.2 Flow Forecasting ..................................................... 22
  5.3.3 Spring Operations ................................................... 23
  5.3.4 Summer Operations ................................................ 23
  5.3.5 Fall Operations ....................................................... 23
  5.3.6 Winter Operations .................................................. 23
5.4 Troubleshooting and Operational Procedures for Sensor Failures
  and/or System Irregularities .................................................. 24
  5.4.1 Water Level Sensors and Obermeyer Gate Bladder Pressure 24
  5.4.2 System Irregularities ................................................. 25
5.5 Debris and Ice Handling Procedures ......................................... 26

6. Equipment, Tools and Safety Procedures ........................................... 26

6.1 Equipment and Tools ............................................................ 26
  6.1.1 Equipment ............................................................. 26
  6.1.2 Tools .................................................................... 27
6.2 Equipment Maintenance ......................................................... 27
6.3 Safety Around the Dam ............................................................ 27
  6.3.1 Public Safety .......................................................... 27
  6.3.2 Worker Safety ........................................................ 27
6.4 Fall Arrest and Travel Restrictions ........................................... 28
6.5 Working with Ice ............................................................... 28
  6.5.1 Ice Booms ............................................................... 28

7. Maintenance ....................................................................................... 29

7.1 List of Components ................................................................... 29
7.2 Inspections and Testing ......................................................... 30
  7.2.1 Mechanical Equipment ............................................ 30
  7.2.2 Electrical Equipment ............................................... 30
  7.2.3 Communications Equipment .................................... 31
7.3 Maintenance of Hydropower Components .............................. 31
  7.3.1 Routine Checks ....................................................... 31
  7.3.2 Operating Equipment .............................................. 32
  7.3.3 Lubricating Moving Parts and Oil Level Top Ups ............ 32
  7.3.4 Corrosion Control .................................................. 32
  7.3.5 Ancillary Equipment ............................................... 32
7.4 Maintenance of Obermeyer Gate Components ................................................................. 33
  7.4.1 Routine Checks ........................................................................................................... 33
  7.4.2 Operating Equipment ................................................................................................. 33
  7.4.3 Lubricating Moving Parts and Oil Level Top Ups ...................................................... 34
  7.4.4 Corrosion Control ...................................................................................................... 34
  7.4.5 Ancillary Equipment ................................................................................................. 34
7.5 Maintenance of Dam Components ..................................................................................... 34
  7.5.1 Routine Checks ........................................................................................................... 34
  7.5.2 Debris Removal ......................................................................................................... 35
  7.5.3 Riprap .......................................................................................................................... 35
  7.5.4 Surface Drains and Drainage Systems ..................................................................... 35
  7.5.5 Vegetation Control on Embankment Portion of Dam .............................................. 35
  7.5.6 Concrete Repair ........................................................................................................ 35
7.6 Major Maintenance ............................................................................................................ 35
8. Surveillance and Performance Monitoring ............................................................................ 35
9. Records ................................................................................................................................. 36
  9.1 Operations Records ....................................................................................................... 36
  9.2 Maintenance Records .................................................................................................... 36
  9.3 Surveillance Records ...................................................................................................... 36
  9.4 Unusual Event Records ................................................................................................. 36
10. Public Safety ....................................................................................................................... 37
  10.1 Signage .......................................................................................................................... 37
  10.2 Barriers ........................................................................................................................ 37
  10.3 Safety Booms ................................................................................................................ 37
  10.4 Restricted Areas ........................................................................................................... 37

Appendix A As-Built Drawings
Appendix B Tailwater Rating Curve and Ice Boom Components
Appendix C McLeod Dam Water Management Plan
Appendix D Signage Map and Signs
Appendix E Contact List
Appendix F Forms and Worksheets
Appendix G - Operation and Maintenance Manual by Canadian Hydro Components
  - Operation and Maintenance Manual by Obermeyer
List of Tables

Table 3.1  McLeod Dam Gate Settings  ................................................................. 14

List of Figures

Figure 2.1  Location Map of McLeod Dam  ...................................................... 3
Figure 2.2  General Arrangement Drawing  ...................................................... 7
Figure 3.1  Stage Discharge Curve  ................................................................. 13
Figure 3.2  Operating Levels Plot  ................................................................. 15
1. Introduction

Quinte Conservation (QC) is an association of three conservation authorities, being the Moira River Conservation Authority (MRCA), the Napanee Region Conservation Authority and the Prince Edward Region Conservation Authority. QC is a community-based environmental protection agency that provides expertise and leadership in terms of environmental and water resource management. The mandate of the agency is to develop and deliver programs that ensure the healthy coexistence between the community, its environment and its economy.

QC manages 40 water control structures within the Moira River watershed as well as over 30,000 acres of conservation lands. Most of the water control structures have been constructed or are operated for the purposes of flood control or similar water management objectives (low flow augmentation, etc).

McLeod Dam was originally constructed in 1979 by the MRCA in conjunction with the City of Belleville and the Ministry of Natural Resources (MNR) to help reduce ice related flooding (due to frazil and block ice) in the City of Belleville. QC is now the owner and operator of the McLeod Dam and retrofitted the dam in 2007/2008 as a waterpower facility. Operation of the facility to fulfill its initial purposes (ice control to reduce flooding in the lower reaches of the Moira River) will remain its primary objective, with waterpower as a secondary benefit.

1.1 Organizational Structure

This manual has been organized according to the template outlined in Hatch 2007. Section 2 provides information on the physical characteristics of the dam. Section 3 presents operational objectives, while Section 4 describes known concerns, problems and constraints. Section 5 outlines operational procedures, and Section 6 identifies the equipment, tools and safety procedures for work at the site. Section 7 lists maintenance aspects, while Section 8 describes surveillance and performance monitoring practices. Section 9 contains operational, maintenance and surveillance records. Section 10 describes public safety features that are present at the site. Appendix A contains as-built drawings of the facility, and Appendix B provides hydrologic background information. Appendix C contains the Water Management Plan, while Appendix D provides a signage location map and visual representations of the signs that are deployed at specific locations (keyed to site map) around the site. Appendix E provides the contact list for the facility. Appendix F contains forms and worksheets, while Appendix G contains manufacturer’s equipment manuals and specifications for the turbine and associated waterpower components, the Obermeyer gate and the PLC and site communications system.

1.2 Duties and Responsibilities

The following QC staff have primary responsibility for the day-to-day and overall operation of McLeod Dam:

- Bryon Keene 613-968-3434 613-968-8240 Cell 921-2768
  Email: bkeene@quinteconservation.ca
- Terry Murphy 613-968-3434 613-968-8240 Cell 391-4040
  Email: tmurphy@quinteconservation.ca
It is noted that the QC contact number is in operation 24 h/d, 365 d/yr. During non-work hours, the voice mail system provides alternate contact numbers to reach QC staff. Operations staff are equipped with cell phones, and designated individuals are on call 24 h/d to deal with operational issues and/or emergency situations.

The plant operator is Tom Sweet and he may be contacted at 613-392-6277.

Day-to-day operations of the hydro facility are being directly carried out by the plant operator. It is the plant operator’s responsibility to ensure the dam functions according to the approved operations plan. He will also be on call to respond to outages or other alarms.

However, flooding concerns will continue to be the primary responsibility of the three conservation authority staff listed above. The plant operator will coordinate his activities under the direction of Bryon Keene (Water Resources Manager) or alternate during periods of flood concerns. The contact list for the facility is contained in Appendix E.

### 1.3 Training

Conservation Authority staff are trained annually in flood forecasting and flood response. Staff are to be trained in fall arrest and safety precautions around dams. Staff entering the electrical room must also be trained in proper safety personal protection equipment due to the danger of arc flash. Only licensed electricians with training in handling 600-V, 1200-A equipment are permitted to open or service the switch gear cabinets.

### 2. McLeod Dam

#### 2.1 Location and Site Access

The McLeod Dam is located on the lower reaches of the Moira River within the City of Belleville. It is the second dam upstream of a series of six dams on the lower Moira River (see Figure 2.1 for location within the river and within the watershed).

- Downstream dam: Lott Dam
- Upstream dams: Belleville Yardman Dam, Harry Mulhall Dam, George and Lois Wishart Dam, and Arthur Holgate Dam.

<table>
<thead>
<tr>
<th>Geographic Twp</th>
<th>Lot and Concession</th>
<th>Area/Municipality</th>
</tr>
</thead>
<tbody>
<tr>
<td>former Thurlow</td>
<td>Part of Lot 6, Conc 2</td>
<td>City of Belleville</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UTM Zone</th>
<th>UTM East</th>
<th>UTM North</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>310000</td>
<td>4894250</td>
</tr>
</tbody>
</table>
Figure 2.1  Location Map of McLeod Dam
Access to the dam is via Cannifton Road on the east side of the Moira River, providing reliable, year-round paved road access.

2.2 Available Drawings and Reports
The dam was originally constructed in 1979 to assist with ice control/frazil ice formation in the lower reaches of the Moira River to address winter flooding within the City of Belleville. The dam consists of the following components:

- a rock-fill embankment dam along the left bank (≈70 m long x 7 m high) with two low-flow outlets containing 3-m x 3-m electrically controlled roller gates. These gates were operated to control head-pond elevation during spring break-up and to retain ice cover during the winter months. The gates were typically closed during spring and fall.

- a concrete spillway channel on the right bank (≈36 m wide x 160 m long), with a 68-m long upstream approach channel with invert elevation of 85.2 m, and a downstream 45-m long stilling basin with an average elevation of 80.5 m.

- a 0.3-m thick concrete training wall separating the spillway channel entrance from the head-pond area immediately upstream of the embankment dam/low-flow structures.

Figure 2.2 illustrates the General Arrangement of that original structure. Drawings are on file within the Highway 2 West offices of Quinte Conservation, and are as follows:

- Drawing 16597-C-001, Existing Site Conditions, Acres International Limited, July 27, 2005

Modifications to the dam were initiated in 2007/2008 to install waterpower production components into the site. The modifications were undertaken on a design/build basis, using tender documents and conceptual drawings prepared by Hatch Ltd. Design drawings are as follows:

- Location Plan and Drawing List 323478-G-001
- Project General Arrangement 323478-G-002
- Spillway Channel General Arrangement 323478-C-101
- Obermeyer Gate Foundation Concrete Plan and Sections 323478-C-102
- Obermeyer Gate Foundation Concrete and Reinforcing Sections and Details 323478-C-103
- Obermeyer Gate Foundation Concrete and Reinforcing Details 323478-C-104
- Existing Ice Boom Modifications Plan, Sections and Details 323478-C-105
- New Ice Boom Piers Plan, Sections and Details 323478-C-106
- Spillway Channel Profile, Sections and Trench Details 323478-C-107
- Powerhouse Layout Longitudinal Section A-A 323478-C-201
• Powerhouse Layout Plan Sections B-B and C-C 323478-C-202
• Powerhouse Layout Cross Sections D-D through J-J 323478-C-203
• Powerhouse Concrete and Reinforcing Longitudinal Section A-A 323478-C-210
• Powerhouse Concrete and Reinforcing Plans B-B, C-C, and D-D 323478-C-211
• Powerhouse Concrete and Reinforcing Sections E-E, F-F, G-G, and H-H, 323478-C-212
• Powerhouse Concrete and Reinforcing Beams B1, B2, and B3, Elevations and Sections 323478-C-213
• Powerhouse Concrete and Reinforcing Approach Channel Wingwalls and Concrete Plug 323478-C-214
• Powerhouse Miscellaneous Steel Stairs and Platforms 323478-C-220
• Powerhouse Miscellaneous Steel Stairs and Ladder Details 323478-C-221
• Powerhouse Miscellaneous Steel Ladder and Handrail Details 323478-C-222
• Powerhouse Miscellaneous Steel Hatch Frame and Cover Details 323478-C-223
• Powerhouse Miscellaneous Steel Trashrack Details 323478-C-224
• Powerhouse Building Services Single Line Schematics 323478-E-201
• Powerhouse Building Services Panel Schedules 323478-E-202
• Powerhouse Building Services Equipment List and Details 323478-E-203
• Powerhouse Electrical and Mechanical Specifications 323478-E-204

Reference drawings for the pre-existing structure are also on hand and kept by the Conservation Authority. These drawings were prepared by Crysler and Latham Ltd., 1979 representing the as-constructed conditions.

As-built drawings are contained in Appendix A.

2.3 Dam Characteristics and Components

• Date of last reconstruction 2008
• Date of previous construction 1979
• Datum GSC

2.3.1 Main Dam Components

• Crest elevation 88.4 m
• Crest width (maximum) 9 m
• Length 70 m
• Blank back
• Height 7 m
• Upstream Slope 2H:1V
• Downstream Slope 2H:1V
• Construction Rock fill with impermeable core
• Number of intakes 2
• Intake dimensions 3.05 m x 3.05 m per intake
• Trash rack construction/spacing Galvanized steel with 10 cm spacing
• Intake Structure Sill elevation 81.2 m
• Intake Structure Top elevation 84.28 m
• Water Barrier for embankment dam Steel sheet pile
• Control Gates 2 – 3.1m x 3.1m steel

2.3.2 Waterpower Components
• Turbines Kaplan, double regulated
• Turbine Flow Range/Capacity 2 – 11 m$^3$/s
• Generators Induction, 475 kW each
• Programmable Logic Control System American Hydro
• Switch Gear Cutler Hammer
• Voltage 600 V
• Phase 3
• Obermeyer Gate System 3.25 m x 36 m steel gate, pneumatically controlled

Head-Pond Characteristics
• Length at TOL 800 m
• Width at TOL 40 m
• Depth at TOL 6.5 m
• Storage volume at TOL 100,000 m$^3$

2.3.3 Spillway and Outlet Works
• Number of Sluices/Spillways 1
• Sluice/Spillway Characteristics
  • Width 36.3 m
2.3.4 **Benchmarks and Datums**

BM on dam is 88.39 finished floor elevation on gate house. City benchmark: top nut of fire hydrant #151 at intersection of Cannifton and Byron Streets = 88.49 m.

2.3.5 **Water Level Sensors**

Pressure sensors and manual staff gauges are used to measure water level in the head pond and tailrace channel. Gauges are also located inside the intake structure behind the trash racks. Specific location of sensors/gauges are as follows:

1. Head-pond staff gauge located on right bank within the spillway channel (approximately 2 m upstream of Obermeyer weir). A second head-pond staff gauge is located on right bank 4 m downstream of channel entrance and 120 m upstream of the Obermeyer weir.

2. Head-pond electronic water level sensor located within the head-pond upstream of the trash racks. The sensor is hardwired to PLC system and is the primary input. This gauge is USG1.

3. Trash rack staff gauge located inside the gate house in east intake on west side gain for gate.

4. Trash rack electronic water level sensor located within intake structure behind trash racks and also hardwired to PLC system. This gauge is USG2.

5. Tailwater staff gauge located on concrete wall downstream of west draft tube approximately 20 m from draft tube.

6. Tailwater gauge located at southeast corner of draft tube.

2.4 **Hazard Potential Classification**

A dam safety review was undertaken during the design process that lead to the reconstruction of the dam as a waterpower facility. The study was completed by Klohn Crippen in 2005 which concluded the dam classification is LOW incremental consequence category based on a dam break analysis. Hatch completed a dam safety update in June 2006 to consider the impact of modifications to the dam needed for the hydropower retrofit. Based on the draft Ontario Dam Safety Guidelines (MNR, 1999), the reconstructed dam is assessed as a Small dam based on height (7 m) and Small based on storage volume (100,000 m³).

These documents are on file at the main QC office.

2.5 **Inflow Design Flood**

The Inflow Design Flood (IDF) is selected on the basis of the Incremental Hazard Potential (IHP) of the dam. The IHP is defined as the potential for increase in the loss of life, property damage, disruption in social and economic activities and/or environmental impacts caused by the hypothetical failure of the dam, incrementally above those that would occur without failure of the dam. For the McLeod Dam, the rating for the normal (sunny day) failure is LOW and the rating for the flood failure is LOW. Hence the McLeod Dam is assigned an overall rating is LOW and is
classified as a Small dam. The IDF selected for the dam is the 100-yr event in accordance with the MNR guidelines.

Inundation mapping was prepared by Klohn Crippen for both failure scenarios; these are included in the 2005 DSR.

3. **Operational Objectives**

The dam will continue to be operated primarily as an ice control/flood control structure with run-of-river waterpower production as a secondary benefit.

3.1 **Discharge Facilities and Capacities**

The structure has two primary discharge facilities, being the Obermeyer gate and the two Kaplan turbines. The turbines have a combine capacity of 22 m³/s (11 m³/s each). The Obermeyer gate can pass 367 m³/s at a head-pond elevation of 87.8 m within the spillway, corresponding to a 100-yr event. A stage-discharge curve for the Obermeyer gate is provided in Figure 3.1, while the seasonal flow allocation (based on average monthly flows) is provided in Table 3.1. The tailwater rating curve is provided in Appendix B along with the Foxboro stage-discharge curve.

3.2 **Water Management Plan**

The McLeod Dam Water Management Plan is contained in Appendix C.

3.3 **Head-Pond Target Operating Level Plot**

The Target Operating Level (TOL) of the head pond is 87.0 m, while the Normal Operating Zone (NOZ) is 1.0 m, being 0.5 m above the TOL to 0.5 m below the TOL (i.e., 87.5 m to 86.5 m). The operating plan is shown in Figure 3.2.

3.4 **Minimum Flow Release**

No minimum flow release is required under normal operating conditions. The facility is operated in a run-of-river manner, which ensures that the hydrologic flow regime of the river is maintained.
### Table 3.1  McLeod Dam Gate Settings

| Max Flow Per Turbine | 10.8 cms | Sill Elevation | 84.4 | Top of Gate | 87 | Max Regulated Water Level | 87.5 | Lowest Regulated Water Level | 87.5 | Top of Dam | 88.4 | Width of Gate | 35.1 |

<table>
<thead>
<tr>
<th>Month</th>
<th>Flow in River (cms)</th>
<th>Turbine 1 Opening</th>
<th>Turbine 2 Opening</th>
<th>Flow Required Over Obermeyer (cms)</th>
<th>Obermeyer Gate Setting (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>27.7</td>
<td>100.0%</td>
<td>10.8</td>
<td>6.1</td>
<td>86.8</td>
</tr>
<tr>
<td>Feb</td>
<td>23.9</td>
<td>100.0%</td>
<td>10.8</td>
<td>2.3</td>
<td>86.9</td>
</tr>
<tr>
<td>Mar</td>
<td>57.4</td>
<td>100.0%</td>
<td>10.8</td>
<td>35.8</td>
<td>86.3</td>
</tr>
<tr>
<td>Apr</td>
<td>111</td>
<td>100.0%</td>
<td>10.8</td>
<td>89.4</td>
<td>85.7</td>
</tr>
<tr>
<td>May</td>
<td>49.4</td>
<td>100.0%</td>
<td>10.8</td>
<td>27.8</td>
<td>86.4</td>
</tr>
<tr>
<td>Jun</td>
<td>21.1</td>
<td>97.7%</td>
<td>10.55</td>
<td>0.0</td>
<td>87</td>
</tr>
<tr>
<td>Jul</td>
<td>8.08</td>
<td>37.4%</td>
<td>4.04</td>
<td>0.0</td>
<td>87</td>
</tr>
<tr>
<td>Aug</td>
<td>4.44</td>
<td>41.1%</td>
<td>0</td>
<td>0.0</td>
<td>87</td>
</tr>
<tr>
<td>Sep</td>
<td>4.52</td>
<td>41.9%</td>
<td>0</td>
<td>0.0</td>
<td>87</td>
</tr>
<tr>
<td>Oct</td>
<td>8.48</td>
<td>39.3%</td>
<td>4.24</td>
<td>39.3%</td>
<td>87</td>
</tr>
<tr>
<td>Nov</td>
<td>20.4</td>
<td>94.4%</td>
<td>10.2</td>
<td>0.0</td>
<td>87</td>
</tr>
<tr>
<td>Dec</td>
<td>28.3</td>
<td>100.0%</td>
<td>10.8</td>
<td>6.7</td>
<td>86.8</td>
</tr>
</tbody>
</table>
Figure 3.1 Stage Discharge Curve
Figure 3.2 Operating Levels Plot

McLeod Dam Operating Plan

<table>
<thead>
<tr>
<th>Headpond Elevation (m)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>1/1/2002</td>
</tr>
<tr>
<td>87.5</td>
<td>2/1/2002</td>
</tr>
<tr>
<td>87</td>
<td>3/1/2002</td>
</tr>
<tr>
<td>86.5</td>
<td>4/1/2002</td>
</tr>
<tr>
<td>86</td>
<td>5/1/2002</td>
</tr>
<tr>
<td></td>
<td>6/1/2002</td>
</tr>
<tr>
<td></td>
<td>7/1/2002</td>
</tr>
<tr>
<td></td>
<td>8/1/2002</td>
</tr>
<tr>
<td></td>
<td>9/1/2002</td>
</tr>
<tr>
<td></td>
<td>10/1/2002</td>
</tr>
<tr>
<td></td>
<td>11/1/2002</td>
</tr>
<tr>
<td></td>
<td>12/1/2002</td>
</tr>
</tbody>
</table>

- **Top of Normal Operating Zone**
- **Target Operating Level**
- **Bottom of Normal Operating Zone**
4. Concerns, Problems and Constraints

4.1 Upstream

4.1.1 Flooding

*5-year Rainfall Event over Belleville*

A heavy rainfall event (at least a 5-yr event) over the City of Belleville would result in the surcharging of storm sewer systems that discharge into the head pond at a head pond elevation above 87.5 m. The surcharge event would produce minor ponding (up to 20 cm at a head pond elevation of 87.7 m) on the parking lots of two apartment buildings at 197 Cannifton Road and 203 Cannifton Road. Restricting the top of the operating range to 87.5 m eliminates this potential effect.

*Extreme Flow Events*

For large runoff events exceeding the average spring flow of about 150 m$^3$/s (up to 1 to 2 weeks), the Obermeyer gate will be opened completely to ensure that upstream levels do not exceed the pre-project elevation (88.0 m for 100-yr event). This procedure will remain in place until experience is gained with the gate in operation with large depths of overtopping (>1 m depth). The gate will be monitored carefully at various depths of overtopping to ensure that it is not damaged and experience may be gained with its operation under those conditions. This action during extreme flow events will also assist in reducing groundwater levels during this period.

4.1.2 Winter Ice Control

The primary objective of the McLeod Dam is winter ice control to reduce the potential for flooding within the City of Belleville due to frazil ice formation/ice jams within the Moira River. A ice boom is installed year-round across the entrance to the Obermeyer gate to retain chunk ice within the head pond.

The head pond suppresses rapids upstream of the dam to the ruins of the old Laziers Dam about 800 m upstream. This permits an ice sheet to form thereby insulating the river from subzero temperatures and eliminates frazil ice production. Conservation Authority staff monitor ice accumulation in the winter in this head pond and use this information to prepare for spring freshet and subsequent ice breakup. The dam is monitored visually during the freshet for accumulation of chunk ice.

Boom failures have occurred in the past at the ice control dams and the potential exists for large volumes of ice to be released past the booms. When this risk is apparent the Obermeyer control gates should be lowered completely to prevent damage.

4.1.3 Recreation

The east and west shores of the river are both bordered by parklands that contain walking trails and open space. Recreational fishing is undertaken along these shorelines, but is not encouraged due to the potential hazards associated with accidental entry into the head-pond waters. Boating (kayaking, canoeing) is also discouraged, with the area posted to prevent those uses.
4.1.4 **Water Supply**

There are no water supply intakes within the section of the Moira River affected by this facility.

4.1.5 **Hydropower Generation**

The facility was redeveloped for run-of-river hydropower generation in 2007/2008. Under normal operating conditions, the outflow from the facility is comprised of flow through the turbines, flow over the Obermeyer gate and seepage flow in the drain along the east side of the head pond which discharges below the embankment portion of the dam at the dam/left bank junction. Extremely low river flows (<1 m³/s) are at the limit of operations (insufficient water to operate one turbine), and will require the facility to be shut down until flows increase.

When the facility is not generating electricity (i.e., turbines are shut down) the Obermeyer gate will be used to control the head pond elevation to operating levels.

4.2 **Downstream**

The downstream reach extends from the tailwater of McLeod Dam to Lott Dam, a distance of approximately 1 km. Lott Dam is an overflow weir which serves to elevate water levels immediately upstream and reduce frazil ice formation/flooding potential during winter.

4.2.1 **Flooding**

Flooding has occurred in the downstream reach most recently in 1981 during a very large spring freshet with significant ice flow that affected the entire river system. Downstream of the dam is not prone to flooding. There are two bridges between the Lott Dam and this dam that are locations where ice jams may occur. In this system ice jams move successively downstream from restriction to restriction. Operation of the McLeod Dam during risk of ice jams in the downstream section should only be performed by Conservation Authority personnel with knowledge of ice movement within the reach. If all ice can be maintained behind the McLeod Dam, the risk of ice jam related flooding downstream is minimized.

Frazil ice production still occurs downstream in a short stretch of rapids that are not backflooded by the Lott Dam. The frazil ice will collect in the Lott Dam head pond or be transported downstream to the City downtown area. The operation of McLeod Dam will not affect frazil ice production downstream.

4.2.2 **Erosion**

There are no downstream erosion concerns or issues. The channel is deeply embedded within a limestone channel with essentially vertical banks. River substrate is a combination of limestone bedrock and associated debris (boulders, cobbles, etc) that is extremely resistant to erosion.

4.2.3 **Fisheries**

The fisheries within the reach from McLeod Dam to Lott Dam (next dam downstream) are isolated from upstream and downstream reaches by the two structures, and consist of warm water species that are able to tolerate extremes of temperature, flow and water depth. Fish species found within the project area during pre-project investigations include bluegill, longear sunfish, pumpkinseed, rock bass, smallmouth bass, largemouth bass, logperch, yellow perch, northern pike, blunted nose minnow, creek chub, fallfish, fathead minnow, mimic shiner, brown bullhead, brook stickleback and
central mudminnow. These species have various habitat, foraging and spawning characteristics, but are all quite resilient, and able to adapt to a wide range of environmental conditions. None undertake significant migratory events, and are able to survive within the relatively confined extent of this area.

Aquatic and fish habitat is limited within the main channel as it flows over flat bedrock for most of the reach. Habitat features and in-water structure are limited to the occasional rock and boulder area. Seasonal high water flows, high temperatures and lack of structure limit the fish community within this reach. The Lott Dam head pond creates additional water depth and slower water velocities, and may act as a refuge for resident fish populations within this reach.

4.2.4 Water Quality
Water quality in the reach below McLeod Dam may be less than ideal during summer low flow conditions, but that is the natural consequence of low river flows. No actions can/will be taken to mitigate those problems should they arise.

4.3 Coordination with Upstream Dam Operations
Upstream dams are overflow weirs which are not operated by QC. Therefore, no coordination with these dams is required.

4.4 Coordination with Downstream Dam Operations
The downstream dam (Lott Dam) is also an overflow weir that is not operated. No coordination is required.

5. Operational Procedures

5.1 General
The dam will continue to be operated primarily as an ice control/flood control structure with run-of-river waterpower production a secondary benefit. The relationship between bladder pressure and gate crest elevation at various overtopping flows is being developed and will be used to guide facility operations. Detailed operating procedures for the turbine and the Obermeyer gate were provided by the respective manufacturers (Canadian Hydro Components and Obermeyer Hydro) and will be used as applicable to guide the operations of those components of the facility (see Appendix G for operating and maintenance manuals). All relevant contact numbers are provided in Appendix E.

5.2 Limits on Filling and Drawdown
Tether straps on the Obermeyer gate have been adjusted such that the maximum crest elevation that can be achieved by the gate is 87.4 m, and as such, elevation 87.5 m has been established as the upper limit of the NOZ. The relationship between bladder pressure and gate crest elevation at various overtopping flows is being developed and will be used to guide future operations during high flow periods. In the interim, the gate will be lowered to its maximum extent (i.e., to rest on sill plate) during extreme high flow events to ensure that the maximum level is not exceeded.
5.2.1 Normal Drawdown
Normal drawdown would not exceed elevation 86.5 m during operational periods. This maintains the waterpower capabilities of the site and maintains the head pond.

Filling and drawing down the head pond will have an effect on the river flow downstream of the dam. Care must be taken by the operators to make gradual changes to control gates to avoid total water stoppage or large releases. Software programming for computer controlled operations has ‘pulsed’ gate movements built in to reduce the potential for rapid changes.

In manual mode, the Obermeyer gate will take about half an hour to deflate from full upright position to completely open. This makes large releases of water less likely.

5.2.2 Maintenance Drawdown Procedure
If for maintenance purposes the head pond must be lowered below 86.5 m a Notice of Maintenance Drawdown will be sent to Ministries of the Environment and Natural Resources for their information. In addition, e-mail notification will be sent to the City of Belleville to advise of the date and time of the maintenance drawdown.

**Visual Check**
Ensure that there are no people in the downstream reach between the spillway exit and College Street bridge prior to any drawdown. Check head pond to ensure there are no boaters or swimmers. If so, advise to vacate area at once. Check to ensure compliance before proceeding with drawdown.

**Set Equipment to Manual Mode**
Ensure the controls on the PLC are turned to manual mode for protection of equipment and for safety.

**Open Valve**
There are two valves that will lower the Obermeyer gate. The first is in the white Obermeyer control cabinet with the handle marked ‘Inflate Bypass’ and the second is at the gate on the east side. Either may be used for manual lowering. While not as accessible, the valve by the gate is better to use for two reasons. It will discharge any moisture that has collected in the piping and the operator can easily monitor the gate position from that position. The handle for this valve is kept in the generation room.

**Monitor Gate Position**
Ensure that the gate is lowering as expected.

**Close Valve**
When gate is fully lowered return the valve to closed position.

5.2.3 Normal Head-Pond Filling
Normally, the head pond elevation is controlled by the PLC within a tight range. If for some reason the operator needs to manually raise water level in the head pond, this can be accomplished by either raising the Obermeyer gate (if water is spilling) or by closing down one or both of the wicket gates. It is important to allow some flow to remain in the river during filling operations. At a
minimum 50% of the river flow must be allowed to continue downstream during filling operations when river flows are 2 m³/s or greater. Head-pond filling will not be undertaken at flows less than 2 m³/s unless special circumstances apply (consultation with MNR prior to proceeding).

5.2.4 Maintenance Head-Pond Filling

This procedure may take upward of 24 hours in periods of low flow to refill the head pond. The plant would not be in operation during a maintenance dewatering condition so filling would be by use of the Obermeyer gate. The gate must be incrementally raised by the operator manually to permit some flow to remain in the river. Since the gate lists to one side when the bladders are partially deflated, the operator must check on its condition by walking over to the safety rail. Air is to be added to the bladders in 30 second bursts allowing several minutes between each burst for equalization. The volume of storage increases with elevation, so the latter portion to be filled will take longer.

5.3 Seasonal Operations

5.3.1 Operating Levels and Procedures

Head-pond elevation is controlled by a combination of flow passage over the Obermeyer gate (36.3 m in width) and flow through the two double-regulated Kaplan turbines. Normal operating flow will range from 22 m³/s with both turbines to approximately 2 m³/s with one turbine, with excess flow passing over the Obermeyer gate (see Figure 2.1 for site plan and layout). Table 3.1 illustrates the seasonal allocation of flow between the turbines and the Obermeyer gate based on the monthly average flows.

A Programmable Logic Control (PLC) system has been installed at the facility as the primary facility operator using data from the various electronic gauges and its decision-support software. An operator has been hired to monitor the system (weekly visit to site and remote daily access via computer link). All operational features that are available to the operator when on site are also available via the electronic link (i.e., can monitor and adjust pressure in the Obermeyer gate bladder, can turn units on/off and adjust their operation, etc). It is noted that QC staff will also closely monitor levels and flows during the first year of operation to ensure that the system is functioning as intended. The system is configured such that manual overrides take precedence over automated operations. Procedures to address potential sensor failures and/or system irregularities are noted in Section 5.4.

The operator will make a decision daily which units are to be employed and whether to use them in automatic mode (completely controlled by the PLC) or to set to manual mode. The following conditions will be considered by the operator for setting the operation:

1. **Flows exceed 22 m³/s.** The generator units do not control water levels when flows exceed 22 m³/s. The head-pond elevation is then controlled completely by the Obermeyer gate. At this condition, the generators may be turned to manual mode and wicket gates opened fully. To reduce the potential for higher fluctuations in head pond elevation, the offset can be set to 0.1 m on the PLC. The gate will control head pond elevation between 86.9 m and 87.1 m.

2. **Flows are between 11 m³/s and 22 m³/s.** In this range, both units should be employed. It is best to leave them in automatic mode and the Obermeyer offset set at 0.2 m. The offset for the
generators should be set to 0.05. This allows the head pond to normally range between 86.95 m and 87.05 m. The computer matches the generator wicket gate openings to divide the flow evenly between the two units. Due to the efficiency curves of the units, it is more advantageous to have each unit running at about 50% to 80% capacity than it is to have one unit at full capacity and the other below 50%. The operator must observe the pressure in the Obermeyer gate bladders to ensure it remains between 13.5 and 14 psi. The bladders leak air and the gate will slowly deflate to the lower setpoint before the computer triggers air to be added. However, the wicket gates will be triggered to close before the lower Obermeyer setpoint is reached and generation will cease. The PLC will maintain the head pond in a range that will not trigger a restart of the generators and would result in production losses. In this range the operator must monitor bladder pressure and inflate as needed to ensure the plant makes most use of the flows.

3. **Flows are below 11 m³/s but above 2 m³/s.** In this range the operator will be attentive to total output and consider using two units in the 9 m³/s to 11 m³/s range and only one unit in the lower end of the range. It is important to consider the higher potential for ‘wandering’ of the head pond water level and the impact of changes to wicket gate settings. Flows can be more noticeably affected by small wicket gate opening changes. The units may trip out more easily in this range. Weighing these factors, the operator may find it less problematic to use only one unit in the high end of the range. At the low end of the range, it will be important to carefully monitor the power factor to ensure this stays at or above 0.9. This will generally happen near 2 m³/s.

4. **Flows are below 2 m³/s.** Both units will be turned off. The operator should be taking this opportunity to complete maintenance inspections on the units.

### 5.3.2 Flow Forecasting

QC utilizes the following information sources to obtain river flow and precipitation data:

1. Water Survey of Canada Station 02HL001 at Foxboro is closest to the site. Gauges upstream of Foxboro at Deloro on the Moira River (02HL005), Actinolite on the Black River (02HL003), Actinolite on the Skootamatta River (02HL004), Tweed on the Moira River (02HL007) and Clare River near Bogart (02HL008) are used for flood forecasting.

2. Precipitation data is obtained from the Environment Canada weather station in Belleville. Eight snow courses are recorded by QC staff within the watershed upstream of the site to provide flood forecasting information.

3. Snow surveys during winter months are performed by conservation authority staff. These data are kept by MNR and are available to the flood forecasting staff.

It is important for the operator to know the river flow in making a decision on the number of generator units to use and whether to place them in manual or automatic mode. There are three sources to obtain the flow. These are as follows:

1. The Water Survey of Canada Website for Foxboro Station 02HL001 at [http://www.wsc.ec.gc.ca/products/main_e.cfm?cname=products_e.cfm](http://www.wsc.ec.gc.ca/products/main_e.cfm?cname=products_e.cfm). This website returns
water levels only at Foxboro. Therefore the operator must convert water level to flow using the stage/discharge lookup tables in the appendix and also posted at the dam.

2. The second is by daily email from the Conservation Authority flood forecasting operations office.

3. The third is by approximation using the tailwater/flow relationship developed and posted at the dam.

5.3.3 Spring Operations
River flow is typically well above turbine capacity (22 m³/s) during this period. Under these conditions, both turbines are in operation and excess flow passes over the Obermeyer gate. The PLC system monitors head-pond water levels via USG1 and adjusts the pressure within the bladders of the Obermeyer gate to achieve the desired gate crest elevation. During rising river flows, wicket gates are adjusted by the PLC up to the maximum operational capacity of the turbines. The water level setpoints within the PLC for the turbines (0.03 m) are tighter than those for the Obermeyer weir (0.1 m), and are the first means of responding to upstream water level changes. If water levels reach the second setpoints, the Obermeyer gate is instructed to react to bring head-pond levels back to the TOL. Feedback loops within the system provide the information to allow the PLC to react to changing water levels. Setpoints are adjustable by the operator should the initial values result in too much head-pond level variation.

5.3.4 Summer Operations
River flow during the summer period is typically well below turbine capacity. Under these conditions, all flow is passed through the turbines and no flow is passed over the Obermeyer gate. Turbine wicket gates are adjusted by the PLC system to match the river flow and maintain the head pond at the TOL. When river flows are less than 2.0 m³/s, both turbines will be shut down and all river flow will pass over the Obermeyer gate. Head pond elevation may not be sustainable at the TOL (87.0 m) if the river flow becomes extremely low (i.e., below 0.5 m³/s). Leakage through the bedrock may pass a majority of the flow at that rate, and the head pond may fall below the NOZ. In that event, QC will notify the MNR Kingston office that the head pond cannot be maintained.

Low flow limitations on generation are based on system limitations. During low flow periods the power factor drops below 0.9 as output falls below 90 kW. This corresponds to a flow of about 2 m³/s. A decision to turn off the generators will be made by the operator as the power factor drops below 0.9.

5.3.5 Fall Operations
River flow typically increases toward turbine capacity during the fall. Operational procedures for this period will be similar to the summer period. Any flow in excess of turbine capacity will pass over the Obermeyer gate. The ice-boom is typically left in place, but if they have been removed for servicing they will be reinstalled during this period in anticipation of winter operating conditions.

5.3.6 Winter Operations
The operating levels to be maintained during winter ice-forming conditions are the same as during the ice-free operating plan. The facility will be operated to retain chunk ice within the head pond so as to avoid unacceptable accumulations of ice and ice jams in the reach leading to Lott Dam. River
flow will be routed through the turbines so as to avoid spill over the Obermeyer gate (to the extent possible) and potential ice accumulation below that structure. Specific measures that have been taken to manage operations during this time of year include

- installation of heaters within the Obermeyer gate abutment plates and flap seals to ensure that these areas remain ice free and operational. Drain channels at each end of the gate can be heated to ensure that there is no ice build up in these locations. Two heaters are in place in each channel. Heater thermostats will be set to activate the heaters at 34°F (~1°C) with heaters typically operated during the December-February period, as conditions warrant.

- daily monitoring of the area downstream of the Obermeyer gate to assess ice build up below the gate and the need for corrective measures (if required). A real-time closed circuit TV camera with zoom capability is located downstream of the Obermeyer gate to allow the area to be closely monitored from a remote location.

- checks of ice accumulation below the gate will be undertaken on a weekly basis when average river flows is sufficient to result in spill over the crest of the gate. Under these circumstances, the gate will be temporarily raised to allow an inspection of the area immediately below the gate (spaces between the gate and the bladders and the bladders and the dam sill) to assess ice accumulation.

- a steamer was utilized on a test basis during the winter of 2008/09, and found to be very effective in removing ice accumulations. The unit is locally available on short notice from David’s Mobile Wash, 2460 County Road 64, Trenton (phone: 613-392-0318, mobile: 613-921-2110).

- if it is deemed that ice accumulation has the potential (or future potential) to impede/impair gate operation, the gate will be cycled (down and up again) to vary flow and dislodge ice to maintain functionality.

Experience has shown that the generators can be left in manual position when flows exceed their capacity. When this is the situation for winter operation, the Obermeyer gate offset can be reduced to 0.1 m and water levels are completely controlled by the Obermeyer gate. This also forces the Obermeyer gate to operate more frequently and reduces the opportunity for ice to accumulate at the gate.

5.4 Troubleshooting and Operational Procedures for Sensor Failures and/or System Irregularities

5.4.1 Water Level Sensors and Obermeyer Gate Bladder Pressure
As part of the initial set-up, the PLC system will be configured to send an alarm to QC under any of the following conditions:

- no signal from either of the upstream WL gauges (i.e., one has failed)
- WL reading of Gauge USG2 exceeds USG1 by >0.05 m
- WL differential between USG1 and USG2 exceeds 0.3 m.
Under condition 1, if the trash rack sensor fails no impairment to operation will occur. Sensor will need to be replaced, but operation may continue. If the head-pond sensor fails, the PLC will read a low head pond elevation and will send an alarm. The PLC program will shut down operation of the turbines. Obermeyer gate will be maintained and staff must respond by replacing the sensor. Normal operator response time under this condition will be 1 to 2 hours. The operator will assess the alarm condition and take corrective actions to ensure the water level remains within the normal operating zone by placing the plant on manual override and remaining on site until the sensor is replaced or other staff respond. Once the alarm condition has been corrected, the system will be switched back to PLC control and the operator can once again monitor/activate the system remotely (i.e. normal operating situation).

In addition, the Obermeyer gate will be operated such that the bladder pressure is the minimum required to obtain the desired crest height/flow. This is between 13.5 and 14 psi. The PLC monitors air pressure in the bladders and displays this on the screen. Should river flow unexpectedly increase, the added weight of water over the crest of the gate will force it lower and increase flow. Tethering of the gate crest to a maximum crest elevation of 87.4 m will further limit upstream water level.

Upon arrival at the site, QC staff will undertake the following troubleshooting procedures:

- access data from USG1 and/or USG2 to verify readings/potential inconsistencies and/or gauge failure
- compare electronic level readings to upstream staff gauge. Assess gate bladder pressure vs depth of flow over gate, tailwater elevation, etc to determine whether within normal operating parameters
- if comparison indicates that USG1 and/or USG2 has failed, take over manual control of dam operations and notify QC office of situation, and need for repairs/replacement components
- continue to monitor WL (by upstream staff gauge if necessary) and river flow. Refer to Table 3.1 to determine appropriate operational settings for turbine and Obermeyer gate to remain within NOZ.

### 5.4.2 System Irregularities

The PLC system will monitor facility operations, and will alarm to QC’s operator and central control under any of the following circumstances:

- upon failure/kick out of any electrical breaker
- upon generator kick-out/restart
- low pressure on the pressure accumulator
- low water conditions (below 86.5 m)
- high water conditions (above 87.5 m)
- high temperature alarms on generator equipment
- fire and intrusion detection.
5.5 Debris and Ice Handling Procedures
Floating debris (wood, plastics, etc) will accumulate on the facility trash racks and will be removed on an as-required basis so as to avoid constricting the water flow to the turbines. Trash rack sensors aid the operator in determining the degree of constriction at the trash rack and will trigger trash rack cleaning.

The facility will be operated so as to develop and maintain ice cover on the head pond. The ice boom across the entrance to the Obermeyer gate will ensure that sheet and chunk ice movement into that channel during flow periods that are moderately in excess of turbine capacity is limited. Head-pond ice (chunk and sheet) will be retained until spring river flows are adequate to flush the ice through the lower reaches of the river system and into Lake Ontario.

Frazil ice may accumulate in the intake of the turbines. This will reduce hydraulic efficiency and power output. Simple raking of the trash racks will not likely reduce this clogging. There are no heaters on the trash racks to melt the ice. Since this dam is an ice control dam it is intended to collect ice and reduce flood risk downstream. Therefore ice accumulation that inhibits power production cannot be avoided. Mechanical removal of the ice with a high hoe can also be attempted. However, little storage is available for ice that is removed.

Ice accumulation at the Obermeyer gate must be monitored carefully. Visual observation of the gate and spillway area is available through either a remote control camera with pan and zoom capabilities (located on light post downstream of gate) or on-site observations. The gate must be free to be lowered in the event of high flows. If the operator observes ice accumulation in the vicinity of the Obermeyer gate that may impair operations, the gate may be freed by lowering and raising the head pond 0.5 m. The heating system in the abutments ensures that the gate is free to move relative to the side plates. This may dislodge the ice sheet. If the gate cannot be freed due to ice accumulation adjacent to or below the abutments, a steamer would be utilized during normal working hours to remove ice that would adversely affect the operation of the gate. This work would be undertaken by the operator and the two-person crew from the steamer company (see Section 5.3.6 for name and phone number). The procedure would take place behind the existing safety rails.

Similarly, ice may also accumulate below the gate. The operator can attempt to cycle the gates (as above) taking care not to permit the gate to deflect or twist. The condition of the bladders must also be considered to avoid puncturing. In the event that a very serious flood risk is present and the gates have ice blockage excavation equipment is available with an 18 m reach from John Leavitt Excavating and Grading, RR1, Bloomfield (Phone 613-393-2963). Access is assured from the west (park) but may be restricted on the east between the gate house and the generation room. Ice removal on the east (powerhouse) side can also be undertaken with the steamer unit.

6. Equipment, Tools and Safety Procedures

6.1 Equipment and Tools

6.1.1 Equipment
In the generation and electrical rooms, equipment forms two distinct categories. One is the water-to-wire equipment that includes controls, switch gear, turbines, generators, intake, draft tube, switch
gearetc. The other is the Obermeyer gate operation equipment that includes air compressors, dryers, accumulator, and its controls. The operation and maintenance manuals for the turbine and the Obermeyer gate, as provided by the respective manufacturers (Canadian Hydro Components and Obermeyer Hydro) are contained within Appendix G.

6.1.2 Tools
Tools are not stored at the site. Any maintenance work that may be required from time to time will be performed by Conservation Authority staff or contractors who will bring tools with them. Exceptions within the powerhouse are
- overhead 3-ton crane that may be used to hoist equipment within the station
- grease gun that will be used frequently by the operator to add grease to the automatic greasers and fittings on the generators and turbine equipment
- ratchet to rack out the breakers which is stored in the main breaker cabinet.

A trash rack rake, fork and pike pole is stored in the upper gate house.

6.2 Equipment Maintenance
Maintenance of equipment is a vital component of dam operation. Section 7 provides detailed procedures for all equipment at site.

6.3 Safety Around the Dam
6.3.1 Public Safety
Public safety is promoted in three distinct areas. The first is signage. Public safety signage is displayed with consideration to all modes of access and from upstream and downstream of the dam. Signage warns of dangers faced by the public if they approach the dam. A map in the appendix shows placement of the signs.

Secondly, locks, fencing and handrails restrict access to the public from areas of specific danger.

Thirdly, the entire site is restricted to public access with ‘No Trespassing’ signs at the gate.

6.3.2 Worker Safety
Contract workers and operations staff that must attend the site must have personal protective equipment for areas required by signage. Those entering areas within fall hazards are to have fall arrest equipment discussed in next section. Safety rails are installed in all areas within the generation room where a fall risk exists. There are three working levels in the generation room. Safety rails restrict workers from fall hazards on all levels. In the gate house grates cover openings in the floor for access and gate and stop-log operation. When these grates are removed, workers must wear fall arrest equipment.

Electric shock hazards exist in the generation and electrical rooms. Here all equipment is electrically grounded, including doors, cabinets, machines, etc. Workers must wear personal protective equipment and be trained to open switch gear cabinets. For this reason the electrical room is also
secured with a separate key so access can be restricted. Signage warning of hazards have been placed on various cabinets.

Fire extinguishers have been placed in the electrical room (two) and in the generation room (two) as well as in the control gate building (one). These are ABC type.

Emergency egress has been provided in the generation room via a ladder and access hatch to the roof of the building. Doors are equipped with panic exits permitting egress while locked.

The generation room has noise levels exceeding safe limits and access to this room requires hearing protection. Workers are also recommended to continue wearing hearing protection even while in the electrical room where compressors may start from time to time.

Within the electrical room is a cabinet that supplies backup power to the PLC cabinet using a bank of 12-V batteries. The batteries are lead-acid type and in the event of acid contact an eye wash station is located opposite the battery cabinet. The eye wash station is equipped with an automated dispensing system that will improve its effectiveness.

6.4 Fall Arrest and Travel Restrictions

The gatehouse is equipped with fall arrest, travel restriction and self-extraction equipment. Dam operation staff are to be trained in its usage. In the generation room, the fall arrest equipment can be connected to nearby handrails for any maintenance work required in the service pit.

6.5 Working with Ice

QC staff are trained to work on ice. The plant operator will not be directed to proceed onto an ice-covered head pond. Should there be a need for ice monitoring by direct measurements flood forecasting staff have the equipment and training to collect this information.

6.5.1 Ice Booms

Ice accumulation at the ice booms is a design condition. The booms will retain ice until it rots or until ice and water pressure exceeds the strength of the timbers. Plant operators will not be directed to engage any activity with respect to the booms.

Boom components are fabricated at the Vanderwater field office using select structural Douglas Fir timbers. The boom ‘sticks’ as they are called are left in place for a maximum of 3 years. After this they must be dried for a minimum of 1 year and redeployed. Most sticks are unusable after 10 years of deployment and must be replaced. Rot often occurs at the contact with metal parts so these areas should be carefully inspected before deployment. Failures occur at the ends of the sticks where chains under pressure pull out from the wood.

Chains were most recently purchased at Fastenal on Adam Street in Belleville. Two types are used. One connects to anchor points on the piers, and the other type connects stick to stick. A diagram is included in Appendix B showing the components. Also included are the original specifications for the chains and wood components.
7. **Maintenance**

Complete maintenance manuals for all equipment reside at the dam. This section attempts to incorporate all routine maintenance tasks from these manuals. Major maintenance issues would revert back to the particular maintenance manual for that component.

7.1 **List of Components**

In the **Control Gate Building** the following equipment is present:

- electric lifting motors for gates 208 V, 5 HP, 3 phase. Four of these are in place
- controls for operation – two control cabinets
- transformer – a 600-V to 120/208 45-kVA transformer for gate house service
- gates – two 3.1-m x 3.1-m steel with concrete fill lifted by 5/8 wire rope cables/pulleys by electric motors
- backup generator – Honda portable generator 3000 W
- 10-in. x 10-in. logs for servicing gates – approximately 20 logs
- chainfalls – two 5-ton chainfalls are located above the log bays for removing and placing stop logs
- building heater – a wall mount 208-V electric heater is installed.

**Electrical Room**

- Switchgear components
  - main cabinet – Beckwith 3410 relay, 1200-A Cutler Hammer breaker
  - unit cabinets (two) – GE Multilin 489 Relays (two), 600-A Cutler Hammer breakers (two)
- PLC cabinet – Modicon Momentum programmable logic controller assembled by North American Hydro
- battery backup cabinet – 48 V DC
- server – Dell Server 2003
- printer – HP Colour laser CP1215
- transformer – 112.5 kVA, 600 V to 120/208 V
- air compressors (two) – Ingersol Rand UP6 – 25 – 125 W
- air filters – Ingersol Rand HE 123
- dust particle filters – Ingersol Rand DP 123
- desiccant Air Dryer – Ingersol Rand TZM 106
- PLC alternator 4-logic controller for compressors
• air accumulator – Ingersol Rand 400 US Gallon
• control panel with air gauges and valves for operating Obermeyer gate
• fire extinguishers – two ABC type, 25 lb
• eye wash station.

Generation Room
• generators (two) – US Motors 650 HP, 3 phase, 575 V, induction type
• gearboxes (two) – Moventas
• turbines (two) – Canadian Hydro Components 1250 mm diameter
• high-pressure hydraulic pumps (two)
• oil pumps (two)
• oil cooler fans (two)
• ventilation fans (two) – controlled by humidistats. Auto shut down during fire.
• fire extinguishers – two ABC type, 25 lb
• automatic greasers (two) – for gearbox
• overhead lifting crane – 3 ton
• emergency egress – ladder to hatch in roof
• equipment hatch – for removal of large equipment
• fire alarm
• intrusion alarm.

7.2 Inspections and Testing

7.2.1 Mechanical Equipment
Testing of various mechanical components should be referred to the specific Operations and Maintenance manuals or the service manuals for those components. High pressure oil and air equipment should be maintained by qualified staff.

7.2.2 Electrical Equipment
Servicing electrical equipment requires lockout of panels or breakers. All equipment has shutoff switches for maintenance. Electrical repairs or inspections should be performed by licensed tradesmen. Original installation was inspected by ESA and repairs or upgrades should also be inspected.
7.2.3 Communications Equipment

External communications from the plant is provided by COGECO internet through an underground cable connected to the hydro pole across from the plant on Cannifton Road next to Slapshots bar. A server in the electrical room is connected by a modem and router to this service. Connected to the same router is a voice phone and metering equipment owned by Veridian. A security service (Alarm Systems) uses this phone access to provide alarm out to their monitoring service. The internet connection also provides remote monitoring of the plant to two cameras: one mounted on the south electrical room wall showing the PLC switches and the other mounted on the control gate building. The second camera is capable of panning and zoom and will be primarily used for viewing the condition of the Obermeyer gate.

These service contracts are maintained by QC administration department.

The modem is the property of COGECO and would be maintained through the service contract. The router and server are the property of QC and are maintained under contract with OT Group. The security systems (including cameras, data storage and retrieval system, alarm panels) are the property of QC and maintained under contract with Alarm Systems.

7.3 Maintenance of Hydropower Components

7.3.1 Routine Checks

Routine checks of hydropower components will be undertaken on a weekly basis by the operator. The operator will complete a checklist of equipment and completed checklist will be kept in a maintenance binder on site. Issues arising will be reported directly to the Water Resources Manager.

Weekly checks will include:

- signage
- safety rails or fencing in place
- trashracks cleaning
- ice/debris accumulation
- lubricant levels in the autogreasers
- oil levels in oil coolers
- oil levels in hydraulic pumps
- check for oil leaks
- ensure sump pump is operational
- electrical components
- vandalism.

Daily checks on the site will be completed remotely in normal operating conditions, but under frazil ice conditions the daily checks will be carried out by site visit.
7.3.2 **Operating Equipment**

Maintenance will be scheduled during low flow when only one turbine would normally be in operation. Either turbine may be operated independently of the other at equal efficiency. This permits either one to be maintained with little power outage.

Annual inspections of the turbines will be performed by dewatering the idle equipment during low flow periods. Dewatering is accomplished by first closing the upstream control gate followed by closure of the tailwater gate. The upstream control gate is operated electrically from inside the control gate building. The downstream gate must be lowered with rented hoisting equipment. Once closed the dewatering valve (8-in. gate valve) on the bottom of the draft tube can be opened to drain the turbine into the sump pit. This procedure should be monitored carefully to ensure the sump pump can handle the volume. Alternatively, a rented 2-in. submersible pump can be placed into the pit to assist the sump pump. Access is gained into the intake to the turbine by the access hatch near the hydraulic pumps in the generation room.

7.3.3 **Lubricating Moving Parts and Oil Level Top Ups**

Each gearbox is lubricated by high temperature grease using an automatic greaser located on each of the west and east walls. The greasers need to be refilled monthly, but should be checked on a weekly basis for grease level. Other parts that require periodic greasing include the generator bearings and the wicket gate assemblies. Generators also have grease fittings that should be greased annually.

7.3.4 **Corrosion Control**

Metal parts in the generation room are exposed to humid conditions that may accelerate corrosion. In order to control corrosion humidistats are connected to the ventilation controls. High humidity will trigger the ventilation system to turn on. Corrosion of metal parts can be reduced by painting and/or application of corrosion deterrent materials.

7.3.5 **Ancillary Equipment**

*Fixed Overhead Lifting Hoist*

The hoist is intended for lifting large components within the generation room. It will be infrequently used, but will need lubrication of moving parts on an annual basis.

*Dewatering Gates both Upstream and Downstream*

Dewatering gates downstream are fabricated of aluminum and should require no maintenance. The seals, however, will degrade with time and may require replacement. They have no installed operation system. To open or close these gates for maintenance the operator must use rented equipment. Upstream dewatering gates are steel with concrete fill. They are each lifted with two electric motors and pulley system. The pulleys and wire ropes must be greased annually. The electric motors are serviced as needed.

*Sump Pump*

The sump pump is controlled with a water level sensor that is also triggered to shut down when oil is detected. Water leaks occur in the turbine pit which is below water elevation. If the sump pump is
shut down due to an oil detection, the operator will have 48 hours to clean up the oil and put the pump back in service before wicket gate position sensors will be damaged.

7.4 Maintenance of Obermeyer Gate Components

7.4.1 Routine Checks
Routine checks of the Obermeyer gate would be performed during low flow periods when the gate can be opened entirely. Water elevation will need to be reduced to 84.0 (0.45 below sill elevation of Obermeyer gate). Flows will need to be passed through the turbines to allow maintenance on the gate system. Two weeks notice would be given to operations personnel for scheduled maintenance on the gates.

Checks will include inspection of the gate seals, checking torque on the hinge clamp bolts, monitoring corrosion of the steel components and reviewing condition of the bladders.

During weekly site visits the Obermeyer gate is to be visually checked for debris accumulation or obstructions, position, and damage. In normal operation these visual checks are performed by visual inspection from the east abutment.

Winter checks will occur daily. The operator will review the condition of the gate with respect to ice accumulation.

7.4.2 Operating Equipment
The Obermeyer gate is operated by a pair of Ingersol Rand screw type compressors and air dryers located in the electrical room. One compressor is capable of operating the gate in isolation. The second compressor and dryer are for redundancy. A logic controller alternates use of the compressor/dryer pair weekly. The compressor has air filters that require replacement or cleaning. These should be checked monthly. Oil in the compressor should also be checked monthly and be replaced after 2000 hours of operation. Dryers contain desiccant that remove moisture from the air. When the descant is exhausted an indicator turns from blue to white. Desiccant must be replaced when the indicator is white.

The compressors cycle automatically. When pressure in the accumulator reaches 120 psi and is maintained for 1 minute the compressor will shut off. When pressure drops below 80 psi in the accumulator a start is triggered. In the event of a power failure and power is restored the compressor will alarm notifying room occupants that it is powered and may start. It is important for the operator to turn the dryers controls on after a power failure as they do not come back on line automatically.

Servicing the compressors or dryers and logic controller should be performed by technicians. The repair phone contact information for Ingersol Rand is listed on the compressor unit.

The air accumulator has a blow-off valve at the bottom that will drain moisture that may accumulate from time to time. The accumulator should be checked for moisture monthly.

Controls for the gate are located on the PLC control cabinet in the electrical room. They are positioned centrally on the cabinet just below the screen. In manual mode, the gate can be lowered or inflated by rotating and holding a spring-loaded switch to “Inflate” or “Deflate” as required. The switch operates solenoid activated valves in the Obermeyer control cabinet. Alternatively, the
solenoid activated valves can be operated using the PC in the electrical room or by remotely dialling in to the station. It is important for the operator to know that the gate cannot be inflated or deflated by the solenoid activated valves if the pressure in the accumulator drops below 60 psi.

Manual valves can be operated within the Obermeyer control cabinet located in the electrical room. There are two ball valves marked “Inflate” and “Deflate” which may be used for manual operation of the Obermeyer gate. These do not require a certain pressure in the accumulator.

7.4.3 **Lubricating Moving Parts and Oil Level Top Ups**
As discussed in previous section, oil levels should be topped up on a monthly basis on the compressors.

7.4.4 **Corrosion Control**
Mild steel surfaces should be protected by paint or galvalum. Where painted or galvanized surfaces on the interior control equipment become damaged, they should be immediately touched up. Annually, surfaces on the gate subject to corrosion should be inspected during the low flow period. Touch-up paint should be reapplied as needed.

7.4.5 **Ancillary Equipment**
Temperature sensors for the control of the heaters and access panel boxes are exposed to the environment on the gate abutments. These should be inspected weekly for damage from vandalism.

7.5 **Maintenance of Dam Components**
The dam was recently maintained in 2008. The upstream embankment between the control building and the spillway has had new rock protection placed. Immediately east of the control building on the upstream side new rock surfacing was also placed. Downstream side was completely reshaped and topped with new rock.

The entire rock-fill section is in good condition. Within the core there is a sheet-pile cutoff wall and bituthene membrane that forms the water barrier.

7.5.1 **Routine Checks**
At each visit operations staff should check for

- leaks in the dam
- safety issues, fencing, signage
- control gate building for security
- water levels within acceptable range
- sink holes
- faulty or missing equipment
- lighting
- access, road, and stairs.
7.5.2 **Debris Removal**

Debris will collect in the head pond, trash racks and on the Obermeyer gate. This should be raked and temporarily collected on the embankment. Debris must be trucked away and disposed of appropriately.

7.5.3 **Riprap**

High flow events can washout riprap. After every large runoff event, the embankment should be carefully inspected for evidence of slumping or loss of material. If any material loss or slumping is discovered, the operator is to immediately inform the owner.

7.5.4 **Surface Drains and Drainage Systems**

The west spillway wall has drain holes to reduce hydraulic pressure on the wall. The holes south of the Obermeyer gate drain continuously when the water level is held at 87.0 in the head pond. The operator will observe these and inform the owner if any changes are noted.

7.5.5 **Vegetation Control on Embankment Portion of Dam**

The rock-fill section of the dam should be kept clear of vegetation. Vegetation should be removed annually by cutting down to the roots.

7.5.6 **Concrete Repair**

Visual inspections of the concrete are to be completed annually during shut down. Minor cracks or spalls should be patched. Concrete joints should be checked for condition of caulk. Replace caulk as necessary. Major concrete degradation, cracking or loss should be immediately reported to the owner.

7.6 **Major Maintenance**

Major maintenance is scheduled to coincide with low water conditions or periods of plant shut down. On the dam structure, this can include major concrete replacement, work on the embankment, gate or lifting equipment overhaul, or water barrier replacement. The hydropower equipment will also require major overhauls on an as-needed basis. Components such as the gearboxes, generators and turbines have specific design lives. Regular maintenance can extend their service lives.

8. **Surveillance and Performance Monitoring**

This section of the manual is intended to deal with the type of instrumentation that may be placed in, on, or adjacent to foundations, abutments, and embankments, or on concrete structures to assess dam stability and potential movements or stresses upon the dam structure. No specific surveillance or monitoring instrumentation of this manner are installed at the McLeod Dam. Surveillance and performance monitoring of the dam components will be undertaken on a regular basis as part of the maintenance procedures identified in Section 7.5. Instrumentation to monitor the operation and performance of the Obermeyer gate is described in Section 7.4. Periodic inspections of the structure to meet provincial dam safety requirements (every 10 years) will be recorded in Appendix F.
9. **Records**

9.1 **Operations Records**

The plant PLC and computer system records all sensor and generation data. These data are kept on file at the plant. Operations are logged in hard copy when completed at the plant. Operations carried out remotely are recorded on the daily log by the operator. Ultimately, all operations are stored at the plant.

9.2 **Maintenance Records**

Routine checks of hydropower and dam components will be undertaken and reported on a weekly basis by the operator. The operator will complete a checklist of equipment and the completed checklist will be kept in a maintenance binder on site. Issues arising will be reported directly to the Water Resources Manager.

Weekly checks will include

- signage
- safety rails or fencing in place
- trashracks cleaning
- ice/debris accumulation
- lubricant levels in the autogreasers
- oil levels in oil coolers
- oil levels in hydraulic pumps
- check for oil leaks
- ensure sump pump is operational
- electrical components
- vandalism.

Daily checks on the site will be completed remotely in normal operating conditions, but under frazil ice conditions the daily checks will be carried out by site visit.

9.3 **Surveillance Records**

No specific surveillance/performance monitoring equipment (related to dam stability) is present at the site. Inspections of dam integrity and maintenance requirements will be undertaken on a routine basis, with those records contained within the maintenance manual. Periodic inspections of the structure to meet provincial dam safety requirements (every 10 years) will be recorded in Appendix F.

9.4 **Unusual Event Records**

Unusual events (hydrologic, seismic, etc) will be recorded on the form provided in Appendix F.
10. Public Safety

10.1 Signage

Signage to warn the public of dangers associated with entry into the head-pond area are located within the parkland along each side of the river, and no entry signage is posted at the powerhouse. Signs are also present warning of dangers in the tailwater area.

A signage location map is included in Appendix D, which also provides visual representations of the signs that are deployed at specific locations (keyed to site map).

10.2 Barriers

A vehicle barrier is in place at the entrance off Cannifton Road to prevent unauthorized vehicle access to the site, and a guardrail barrier is present along the upstream portion of the embankment portion of the dam from the Cannifton Road entrance to the powerhouse building. Handrail barriers are present along both sides of the Obermeyer gate/spillway channel, in front of the trash racks, and along the downstream edge of the powerhouse deck and the intervening space between the powerhouse deck and the east limit of the spillway channel. Handrails are also present along both sides of the walkway between the turbines within the powerhouse. The trash racks would prevent entry into the turbines should a person enter the water in front of the turbine inlets.

10.3 Safety Booms

Ice booms will be left in place year-round. These will prevent inadvertent boating or swimming contact with the Obermeyer gates.

10.4 Restricted Areas

The electrical room, generator room and control gate building are all areas that are restricted to access by lock and key. The entire site is posted ‘no trespassing’ and adequately barriered. Areas downstream of the Obermeyer gate and the draft tubes are signed to discourage access from downstream to each of those dangers.