

Lower Churchill Management Corporation




Muskrat Falls Dam Related Emergency (Full Supply Construction Phase) –
Emergency Preparedness Plan

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Inter-Departmental / Discipline Approval (where required)

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Controlled Distribution List

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09	Community of Sheshatshiu	Anastasia Qupee Grand Chief	P.O. Box 160 Sheshatshiu, NL A0P 1M0
10	Community of North West River	Ernie McLean Mayor of North West River	P.O. Box 100 North West River, NL A0P 1M0

Revisions

This document will be reviewed annually and updated as required. If there are changes, the revised document will be reissued to the communities and organizations identified in the controlled distribution list.

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ABBREVIATIONS AND ACRONYMS

ADA	Canadian Dam Association
CCOC	Canadian Council of Occupational Chemists
EDC	Emergency Control Centre
EMR	Emergency Response Plan
ERT	Emergency Response Team
F&E M	Fuel and Emergency Response Management
F&E	Fuel Supply
HSE	Health, Safety and Environment
HVDC	High Voltage Direct Current
IC	Internal Control System
LC	Low Current Transformer
MP	Major Project
OH&S	Occupational Health and Safety
PMF	Partial Maximum Flood
W-ERP	Water Emergency Response Plan
ERP	Emergency Response Plan

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1 STATEMENT OF PURPOSE

The Emergency Preparedness Plan (EPP) is a guide to assist communities and external agencies in developing emergency response plans for a dam failure or passage of a major flood at the Muskrat Falls site during the Full Supply construction phase. This EPP includes specific information regarding floodwave arrival and inundation to allow timely reactions to flooding resulting from failure of the Muskrat Falls North Dam, the largest dam at the completed facility. This EPP focuses specifically on the communities of Happy Valley-Goose Bay, Mud Lake, Sheshatshiu, and North West River.

The information contained in this EPP is applicable to the Muskrat Falls headpond (reservoir) at Full Supply El. 39.0 m. Further information on Nalcor’s emergency response procedures is available in the Project Wide-Emergency Response Plan (PW-ERP) (Ref. 3).

2 ABBREVIATIONS AND ACRONYMS

CDA	Canadian Dam Association
CEOC	Corporate Emergency Operations Centre
EOC	Emergency Operations Centre
EPP	Emergency Preparedness Plan
ERT	Emergency Response Team
FES-NL	Fire and Emergency Services-Newfoundland and Labrador
FSL	Full Supply Level
HSSER	Health, Safety, Security, and Emergency Response
HVGB	Happy Valley-Goose Bay
ICS	Incident Command System
LCP	Lower Churchill Project
MF	Muskrat Falls
OHS	Occupational Health and Safety
PMF	Probable Maximum Flood
PW-ERP	Project Wide-Emergency Response Plan
RCMP	Royal Canadian Mounted Police

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3 PROJECT DESCRIPTION

The Muskrat Falls hydroelectric generating facility is an 824 MW generating station under construction on the Churchill River, approximately 290 km downstream of the Churchill Falls hydroelectric generating facility, and approximately 30 km west of Happy Valley-Goose Bay. The permanent facilities will include a 4-unit intake and powerhouse, a 5 bay gated spillway, a roller compacted concrete dam to the north of the powerhouse, and a rockfill dam to the south.

To facilitate construction of the North Dam, two rock groins will divert the Churchill River from its existing alignment through the spillway structure. River diversion is scheduled to start late spring or summer 2016 with construction of the North Dam to begin soon after. The North Dam construction site will be kept in the dry by an upstream cofferdam and an additional downstream cofferdam. The completed upstream cofferdam will make it possible to impound the Muskrat Falls headpond up to elevation 25.0 m in fall 2016.

The completed Muskrat Falls facility is shown in Figure 3-1 below.

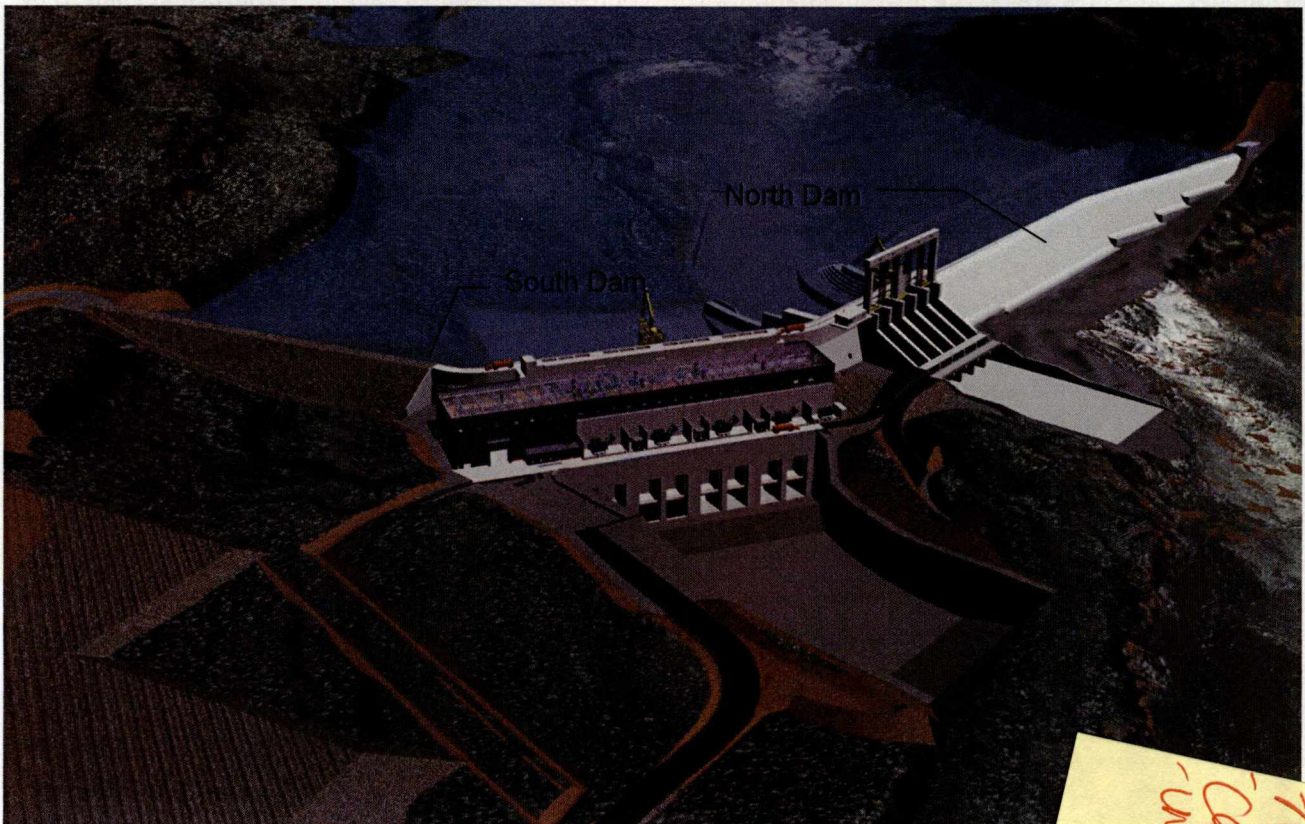


Figure 3-1: Completed Muskrat Falls Facility

*North Spur
- Caribungit
- Infrastructure
CCL meeting*

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3.1 NORTH DAM

The North Dam closes the river channel between the north bank and the Spillway. It is a concrete structure that is approximately 450 m long and 35 m high, with a 330 m long overflow section for spilling water in flood flow situations. Instrumentation installed on the North Dam will be comprised of standpipe piezometers, vibrating wire piezometers, flow weirs, and thermistors. An accelerometer will be installed near the north abutment. The instrumentation will be connected to a datalogger for retrieval and analysis by operational staff.

3.2 SOUTH DAM

The South Dam closes the south part of the reservoir between the south bank and the Powerhouse. It is a rockfill embankment dam with a maximum height of approximately 14 m and a length of approximately 200 m. Watertightness of the South Dam is achieved by a till core and a grout curtain embedded in the bedrock foundation. Instrumentation installed on the South Dam is comprised of standpipe piezometers, vibrating wire piezometers, and flow weirs. The instrumentation will be connected to a datalogger for retrieval and analysis by operational staff.

3.3 NORTH SPUR

The North Spur is a deposit of marine and estuarine sediments which naturally provides a partial closure of the Churchill River valley at the Muskrat Falls site. The North Spur is about 1 kilometer long between the rock knoll in the south and the Kettle Lakes in the north. Watertightness of this natural dam will be achieved by a till blanket on the upstream slope and 2 cement bentonite cut-off walls constructed vertically below the ground surface in the upstream and northwest areas of the spur. These features are designed to prevent water inflow from the reservoir and seepage from the surrounding topography from entering the North Spur. Slope stabilization and drainage of seepage in the downstream area will be achieved by granular material embankments and finger drains.

Instrumentation on the North Spur will be comprised of piezometers for measuring porewater pressure, flow weirs for monitoring seepage, and inclinometers for measuring any movement or displacements on the slopes. The instrumentation will be connected to a datalogger for monitoring and analysis by operational staff.

4 EMERGENCY SCENARIOS

This section provides descriptions and potential impacts of various dam breach scenarios. A dam breach can occur during normal flow or flood flow conditions. A breach of a water retaining structure is typically initiated by the following occurrences:

- Water overtopping failure
- Internal erosion failure (called piping)

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An emergency situation can occur as a result of a breach in any of the Muskrat Falls water retaining structures including the South Dam, the North Dam, and the North Spur.

Dam break analysis of the Muskrat Falls North Dam and the North Spur was carried out by Hatch Ltd in 2010 and 2014, respectively. The South Dam was not studied for dam failure because it is proportionately much smaller than the North Dam and North Spur. The downstream flooding resulting from a failure of the South Dam would therefore not produce any governing inputs for developing emergency response procedures. In accordance with the Canadian Dam Association (CDA) Guidelines two scenarios were analyzed: fair weather failure and failure during the PMF. CDA defines a PMF as a hypothetical flood that is considered to be the most severe flood that is “reasonably possible”. Once complete, the Muskrat Falls facility is designed to pass the PMF flow.

A dam failure under PMF or fair weather conditions will result in incremental water level increases along the Churchill River and Goose Bay/Lake Melville as far downstream as North West River and Sheshatshiu. The North Spur Dam Break Study demonstrated that flooding resulting from a loss of the North Spur would be similar to or less severe than flooding resulting from a failure of the North Dam. Therefore, only the results of the North Dam – Dam Break Study are presented in this Emergency Preparedness Plan (EPP).

It should be noted that a natural flood can occur at any time as a result of a storm event. The occurrence of a PMF or other severe event is not dependent on the presence of an upstream dam; such an event can happen regardless of upstream infrastructure. Losses and/or damage may occur under these circumstances. In such a storm event local authorities may initiate emergency response procedures to address the flood situation. The Muskrat Falls dam break analysis for a flood event considers incremental consequences of failure i.e., the incremental downstream damage over and above what would have occurred as a result of the same flood event had the dam not failed.

4.1 FLOODWAVE CHARACTERISTICS

Tables 4-1 and 4-2 summarize the estimated floodwave arrival times, peak water level, time to peak water level, and incremental water depths at key downstream locations for failure of the North Dam under fair weather and PMF conditions, respectively. The incremental increase in water depth is the increase above the natural river level because of the dam failure. Inundation mapping for fair weather and PMF failures is included in Appendices A and B, respectively. Due to the potential for erosion and model limitations, it is recommended that communities delineate evacuation zones beyond the inundation mapping.

Table 4-1: Fair Weather North Dam Failure Floodwave Characteristics

Distance Downstream of MF Dam (km)	Location Description	Breach Flood Arrival Time (hr)	Time to Peak Water Level (hr)	Peak Water Elevation (m)	Incremental Increase in Water Depth (m)
1.5	Downstream of Muskrat Falls Dam	0	3.4	15.4	12.8
18.7	Upstream Blackrock Bridge	0.6	3.8	11.7	10.1
33.6	Happy Valley-Goose Bay	1.4	6.8	6.4	5.7
40.0	Mud Lake	1.7	7.3	5.2	4.7
64.2	North West River/Sheshatshiu	2.5	11.4	0.6	0.2

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Table 4-2: PMF North Dam Failure Floodwave Characteristics

Distance Downstream of MF Dam (km)	Location Description	Breach Flood Arrival Time (hr)	Time to Peak Water Level (hr)	Peak Water Elevation (m)	Incremental Increase in Water Depth (m)
1.5	Downstream of Muskrat Falls Dam	0	3.2	21.1	9.7
18.7	Upstream Blackrock Bridge	0.3	3.4	17.3	9.1
33.6	Happy Valley-Goose Bay	0.8	5.9	8.8	3.4
40.0	Mud Lake	1.2	6.3	7.5	3.3
64.2	North West River/Sheshatshiu	2.0	11.0	0.8	0.2

The transmission line right of way will be inundated in some areas close to Happy Valley-Goose Bay in both fair weather and PMF conditions, and there is potential for damage to the transmission towers and power outages in the downstream communities.

5 EMERGENCY RESPONSE STRUCTURE

The on-site response to a dam related emergency will be managed by the Emergency Operations Centre (EOC) at the Muskrat Falls site and mobilization of additional support will depend on the situation or level of emergency. The PW-ERP provides an overarching structure and framework for emergency response across the Lower Churchill Project. The following sections illustrate the incident command structure that Nalcor-LCP will follow in a dam related emergency, the hierarchy of the EOC’s, and the three emergency levels that have been used to categorize a dam related emergency on the Lower Churchill Project.

5.1 INCIDENT COMMAND SYSTEM

Nalcor-LCP’s response to a dam emergency will follow the Incident Command System (ICS). The ICS is a systematic and commonly used tool for command, control and coordination in an emergency response. The ICS is designed to give standard response and operation procedures to effectively mitigate any problems and potential for miscommunication during the course of an emergency incident. Figure 5-1 shows the Muskrat Falls EOC Activation Flow Chart which follows the ICS structure.

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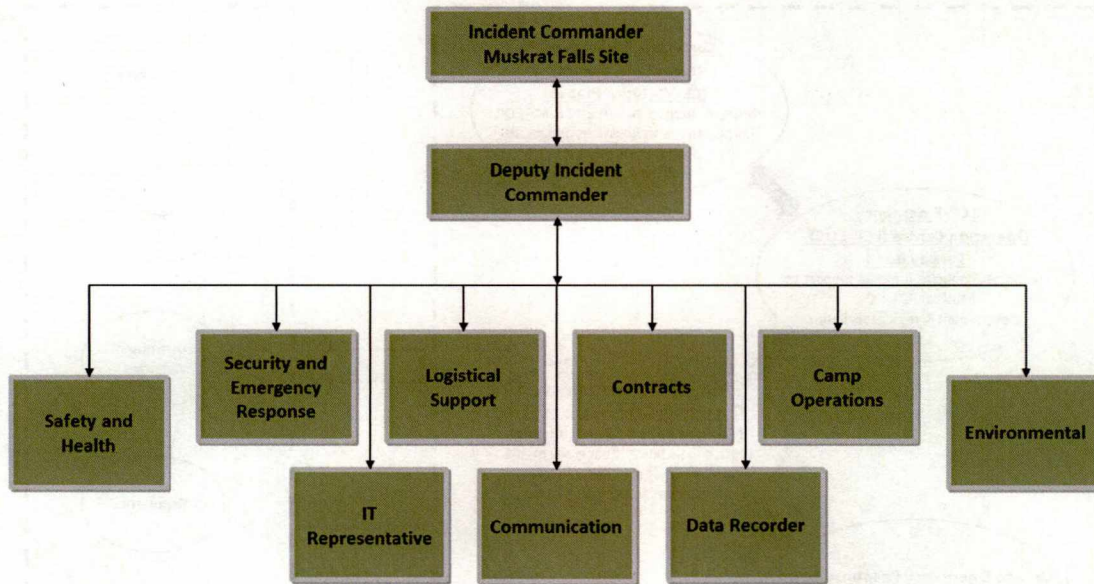


Figure 5-1: Muskrat Falls Site EOC Activation Flow Chart

The Muskrat Falls EOC will function as the central command and control facility responsible for carrying out the strategic management of the dam related emergency. The EOC provides direction to the crews at the dam who are then responsible for the tactical delivery of the response.

The Incident Command System allows the LCP EOC hierarchy and its contractors to effectively respond to any incident in order to avoid a duplication of efforts. Finally, it provides a unified, centrally authorized and fully functional emergency organization.

5.2 EMERGENCY CENTRES

The LCP EOC hierarchy and the responsibilities of each EOC is shown below in Figure 5-2.

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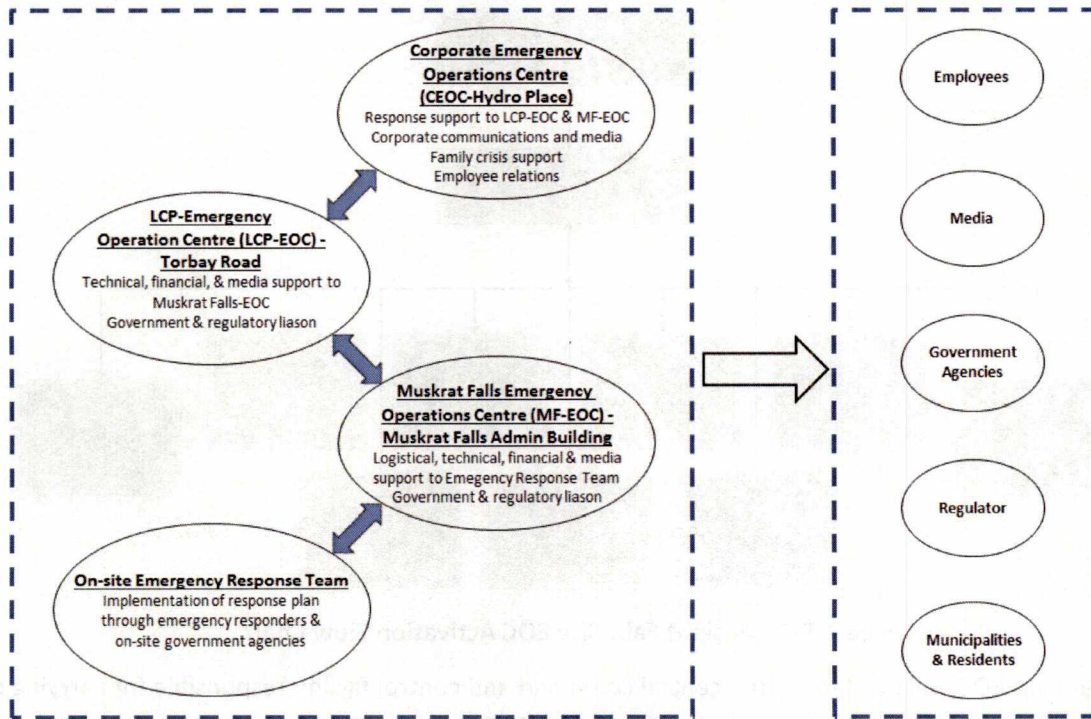


Figure 5-2: Muskrat Falls EOC Hierarchy

The responsibilities of the emergency operations centers are not strictly unique. The MF-EOC, LCP-EOC, and Corporate EOC all support the efforts of the On-site Emergency Response Team (ERT) at various levels depending on where resources are available. The ERT has the sole responsibility of implementing the emergency response plan at the scene of the emergency.

5.3 DAM EMERGENCY LEVELS

Dam related emergencies at the Muskrat Falls construction site will be categorized as follows:

- Level 1 – Dam Alert

A Dam Alert will inform internal staff and management to an abnormal situation at a dam that requires immediate investigation and response. The abnormal situation would not by itself or at that time pose a threat to the integrity of the dam or to the public however it could eventually lead to a dam failure without timely and appropriate response. These situations can be resolved with local resources. A dam alert **will not** initiate an emergency notification to downstream communities. LCP will mobilize personnel to investigate and where possible, resolve the situation. If the situation deteriorates LCP will initiate the EOC, remove personnel from the worksite downstream of the dam, and proceed to a Level 2 or 3 dam emergency as warranted.

The following are some examples of a Level 1 Dam Alert:

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- Damaged or malfunctioning flow control equipment or components causing loss of essential spill capacity.
- A deficiency in a water retaining structure that requires non-critical repair. The intent is that although the deficiency does not pose immediate danger to the function of the dam, it should be addressed as soon as possible to prevent the situation from deteriorating further. Possible deficiencies include settlement, erosion, cracking, leaking or seepage, damaged or missing riprap protection, or unusual instrument readings. There is no immediate threat to the public.
- An unusual flood event that does not immediately threaten dam integrity.
- Facility at maximum discharge capacity or spill capacity is reduced by debris blockage. This situation poses an increased risk for the headpond to rise above safe levels.
- Threat of sabotage. Any communicated threat of sabotage affecting capability for flow control or water retention would require increased security and state of alert.

If the situation is resolved and the situation or facility is verified to be in a safe and stable state then the dam alert is terminated. If the situation still warrants some follow-up investigations or monitoring, it may be downgraded from a Level 1 Dam Alert to a dam related safety concern. This will be decided by the Incident Commander.

- **Level 2 – Dam Emergency**

A Level 2 Dam Emergency is issued when a dam safety condition exists where swift and effective response is required to prevent failure of the dam. This condition will trigger internal and external notifications, emergency procedures, and activation of the EOC. Downstream communities, Royal Canadian Mounted Police (RCMP), and Fire and Emergency Services-Newfoundland and Labrador (FES-NL) will be notified and kept advised of the situation. LCP will carry out response measures to resolve the situation. If the situation or condition deteriorates LCP will proceed to Level 3.

The following are some examples of a Level 2 emergency:

- Damaged or malfunctioning flow control equipment or components causing loss of essential spill capacity where timely and appropriate response is not certain or may be delayed. Delay in restoration will result in the headpond rising above the maximum safe water level.
- A deficiency in a water retaining structure requiring prompt emergency repair (confirmed and coordinated by the Resident Engineer or delegate). Signs of deterioration are evident and pose a significant danger to the function of the dam if not addressed immediately. Examples include increasing and more turbid seepage flows, serious concerns over sinkhole development, continuous deflection or settlement of dam, erosion, instability, cracking, or riprap loss.
- An unusual flood event that causes the headpond to rise above the maximum flood level, or the available spill capacity has been exceeded and may threaten dam integrity. The headpond level is increasing with limited capability for regaining control.
- An act of sabotage or vandalism affecting capability for flow or water retention.

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The Level 2 emergency can be terminated if the situation or facility is verified to be in a safe and stable state. If the situation is stabilized but still considered hazardous, then the emergency is downgraded to Level 1 Dam Alert. This will be decided by the Incident Commander.

- Level 3 – Dam Failure

A Level 3 Dam Failure is issued when a dam failure is not preventable or has occurred. This condition will trigger full internal and external emergency notifications, emergency procedures, and activation of the EOC. Downstream communities, RCMP, and FES-NL will be notified. If the EOC is already activated, then the IC will notify the downstream communities, RCMP, and FES-NL of the changed condition.

The following are some examples of a Level 3 emergency:

- Dam overtopping is not preventable or occurring.
- A deficiency or condition of Level 2 emergency is deteriorating at an accelerated rate (e.g. leakage flow is increasing and more turbid, continuous deflection or settlement of a dam, sinkhole growing) and is initiating a dam failure.
- Failure of a dam has occurred.
- An act of sabotage or vandalism that causes a dam failure or an irreparable failure condition.

The emergency can be terminated if the situation or facility is verified to be in a safe and stable state. This will be decided by the Incident Commander.

5.4 EMERGENCY NOTIFICATIONS

The decision to declare a dam related emergency is the responsibility of the Resident Engineer and the Site Manager. After verifying and classifying a dam safety emergency, LCP will initiate appropriate emergency response procedures. Notifications will be initiated as depicted in Figures 5.3-5.5. LCP will focus their attention primarily on any repairs, measures, or operations as needed to mitigate the emergency condition. This could include engaging line management and engineering support, and/or activating the EOC, as appropriate. The level of emergency response depends on the severity and urgency of the emergency and the capability of the responders.

Internal and external notifications will be initiated at the site according to the notification charts. The charts illustrate who is to be notified, the recommended order of notification, and who is responsible for the notification. If any individual responsible for making further notifications cannot be reached, **the initiating caller is responsible for making these further notifications**. All communications to the media will be through Nalcor Corporate Communications. In the event of a significant natural flow that does not necessarily threaten dam

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integrity a public advisory will be issued by Nalcor Corporate Communications. Descriptions of the types of emergency response and notifications by LCP are provided below for each emergency level.

Local authorities will activate their respective emergency plans in coordination with the fire department(s) and the local communities/municipal governments.

5.4.1 Level 1 – Dam Alert Notification Procedure

A Level 1 dam alert is not considered to pose an immediate threat to the dam integrity. The Resident Engineer will activate appropriate internal notification to report a potential deficiency or condition or a change in operating mode, and engage local or corporate resources to enable a timely response.

External notification may be limited depending on if there is any potential threat to the public. LCP will respond to a Level 1 event primarily with local staff. Assistance may be provided from other Nalcor resources and local emergency services. A Level 1 Dam Alert would usually not warrant activating the EOC. The following are examples of possible response activities for various Level 1 conditions or incidents:

- For a situation where some part of the flow control equipment or components are damaged or malfunction causing a loss of essential spill capacity and where timely and appropriate response is readily available, LCP will attempt to maintain flow control through alternate means and repair or restore the affected equipment. If timely response is not possible, the emergency will be elevated to Level 2.
- For a non-critical deficiency in a water retention structure, the Resident Engineer will initiate appropriate repair strategies. The situation may warrant an increased degree of monitoring, lowering the reservoir, a heightened state of alert, and/or further analysis. Again, the condition is not immediately threatening to the structure integrity.
- In the case of an unusual flood event, LCP will operate the spillway according to standard operating procedures prepared for such events. If the facility is at maximum discharge capacity, there will be a heightened level of alert with staff and equipment on standby to respond to potential issues that may affect discharge capacity (e.g. debris blockage, equipment outage, etc.).
- For a threat of sabotage, staff will notify the RCMP and LCP will activate appropriate security measures. This may include heightened security and/or contacting the RCMP to provide additional security at site.

Figure 5-3 shows the notification flow chart for a Level 1 Dam Alert event.

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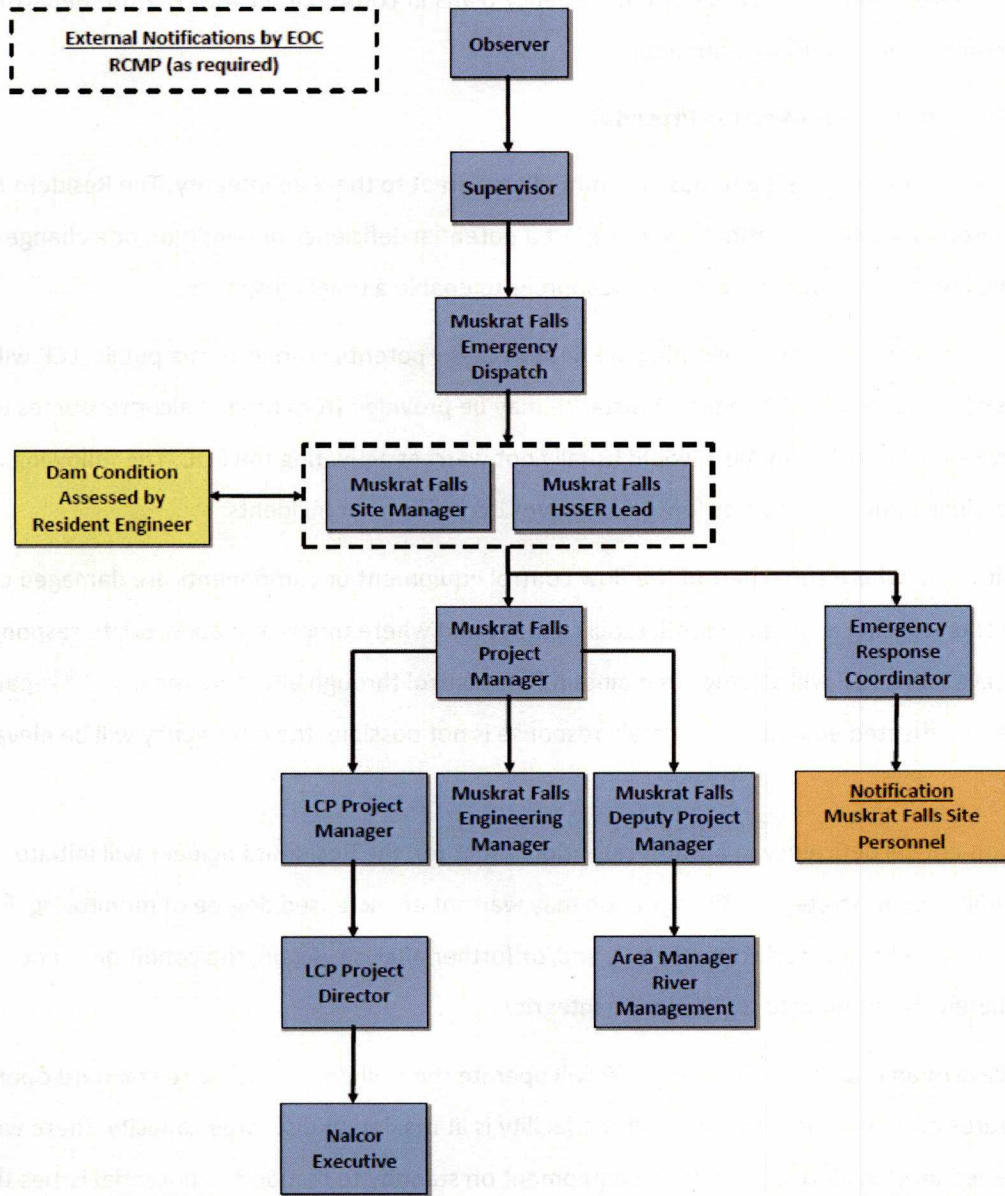


Figure 5-3: Level 1 – Dam Alert Notification Chart

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5.4.2 Level 2 – Dam Emergency Notification Procedure

If a condition is classified as a Level 2 Dam Emergency, the Resident Engineer would initiate internal notifications using the notification chart and the Site Manager (or delegate) would issue a “Level 2 Dam Emergency Advisory” to the communities, RCMP, and FES-NL. The advisory identifies the nature of the emergency and LCP’s response. The Site Manager or designate will act as the EOC IC and if required, will activate the EOC at Muskrat Falls by calling together the EOC support team. The IC will maintain open communication with communities, RCMP, and FES-NL via the EOC until the emergency is resolved. The following are examples of possible response activities for various Level 2 emergencies.

- For a situation where some part of the flow control equipment or components are damaged or malfunctioning and where timely and appropriate response is not certain or may be delayed, LCP will attempt to take appropriate actions as deemed safe to regain flow control (essential spill capacity) and mitigate damages.
- For a deficiency in a water retention structure that requires prompt emergency repair, the EOC IC will ensure that such repairs are carried out with appropriate engineering support and that the spillway is operated so as to reduce the risk for a failure situation to develop.
- For an act of sabotage or vandalism, all site staff must report such acts to the Site Manager and HSSER Lead who will activate appropriate security measures. Engineering staff will attempt to address any damages provided it is safe to do so.

Figure 5-4 shows the notification flow chart for a Level 2 Dam Emergency event.

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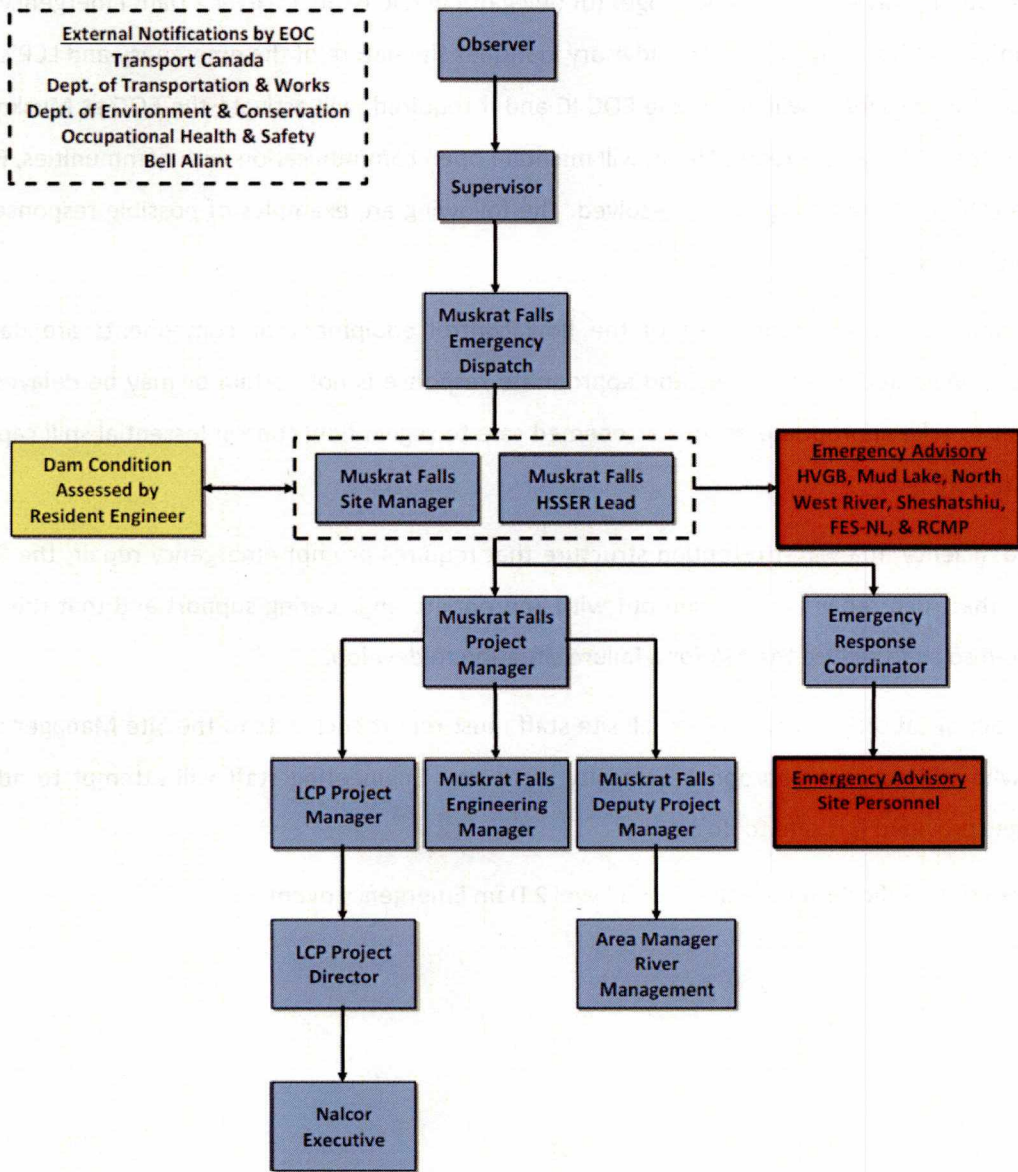


Figure 5-4: Level 2 – Dam Emergency Notification Chart

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5.4.3 Level 3 – Dam Failure Notification Procedure

When a dam failure is not preventable or has been confirmed, the Resident Engineer would initiate internal notifications and the Site Manager or the EOC IC (if the EOC has already been activated) will be responsible for notifying the communities, RCMP, and FES-NL. The notifications and activations of the EOC would occur as described in the response to a Level 2 Dam Safety Emergency. The notification will identify the emergency as a “Level 3 Dam Failure Emergency” and include pertinent information such as the structure that has been affected, when the failure occurred (or is expected to occur), and identify the appropriate references to emergency descriptions and inundation maps. After initiating appropriate notification, site staff will also carry out or continue to carry out emergency repair or operations to mitigate the consequences of failure, considering safety of staff and emergency crews. A Project Wide Emergency Response Plan provides LCP staff with further details of key actions to be taken in the event of a dam failure. The following are examples of possible response activities for various Level 3 emergencies.

- For a situation where repairs are not resolving the deficiency and where the condition is deteriorating at an accelerated rate, where dam failure is imminent, or where there is a high probability of a dam failure, staff or contractors will only attempt to continue repairs or operations as deemed safe. The Site Manager or delegate will have established the EOC at Muskrat Falls. LCP will continue to monitor the situation and provide frequent updates to the communities, RCMP, and FES-NL.
- If it is discovered that a dam failure is already in progress or has already occurred LCP will, along with full notification, ensure the safety of the site staff and crews and where possible and safe, carry out any activities to mitigate the consequences of failure and monitor the situation. This includes activating the EOC (if not already done) and engaging engineering support.

Figure 5-5 shows the notification flow chart for a Level 3 Dam Failure event.

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MFA-PT-MD-0000-EN-PL-0003-01	B1	19

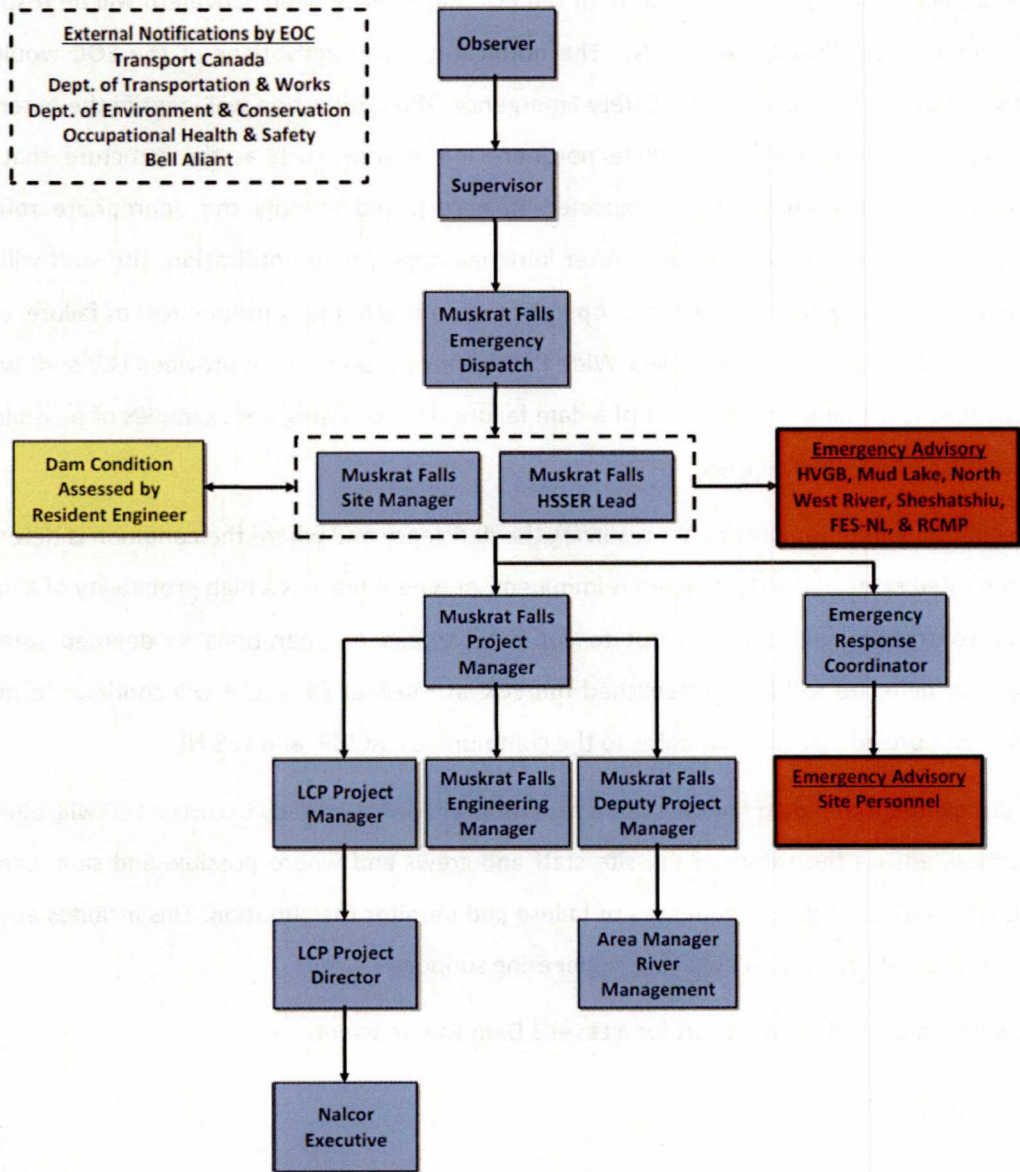


Figure 5-5: Level 3 – Dam Failure Notification Chart

Muskrat Falls Dam Related Emergency (Full Supply Construction Phase) – Emergency Preparedness Plan		
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6 EMERGENCY CONTACTS

Table 6-1: Lower Churchill Project Emergency Contacts

PROJECT PERSONNEL	PHONE NUMBER
Muskrat Falls – Incident Commander	1-709-730-8493
Muskrat Falls – Deputy Incident Commander	1-709-730-8327

Table 6-2: External Agency Emergency Contacts

EMERGENCY AGENCY	PHONE NUMBER
Province-wide 911	9-1-1
Labrador Health Centre	1-709-897-2000
HVGB Ambulance	1-709-896-2100
RCMP - HVGB	1-709-896-3383
HVGB Fire Department	1-709-896-2222
Fire and Emergency Services - HVGB	1-709-896-7957
Fire and Emergency Services - NL	1-709-729-3703

Table 6-3: Community Emergency Contacts

Emergency Contact	Phone Number
HVGB – Town Manager	1-709-896-8222(W) 1-709-899-7380 (C)
	Alternate 1-709-896-3321
HVGB – Community Constable	1-709-896-3933(W) 1-709-897-7011(C)
Sheshatshiu – Grand Chief Anastasia Qupee	1-709-497-8522
North West River – Mayor Ernie McLean	1-709-497-8533
North West River – Fire Department	1-709-497-2222
North West River – Fire Chief Dan Michelin Jr.	1-709-899-1394
Mud Lake – Vyann Kirby	1-709-896-3147(H) 1-709-897-4175(C)

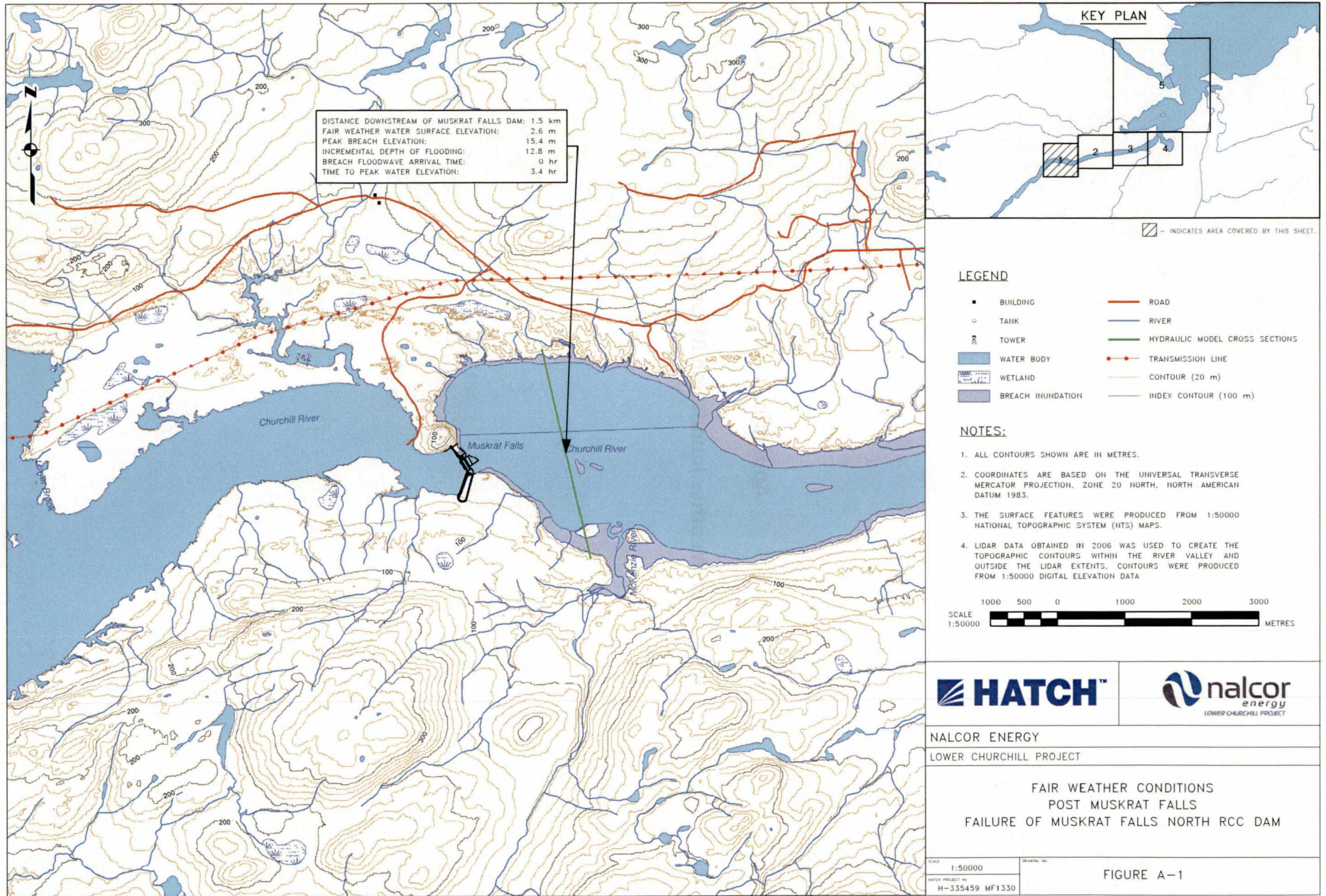
Muskrat Falls Dam Related Emergency (Full Supply Construction Phase) – Emergency Preparedness Plan		
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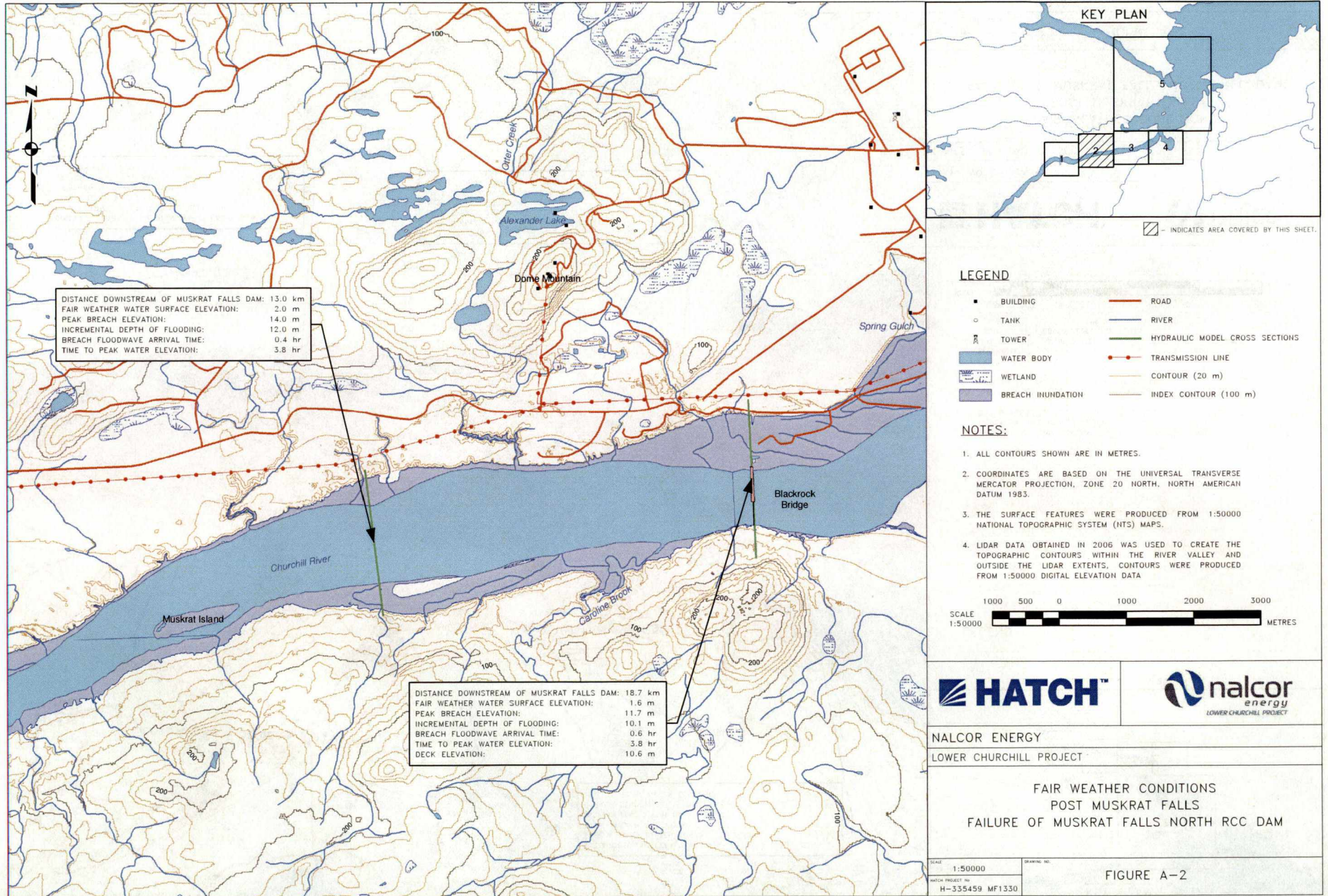
7 REFERENCES

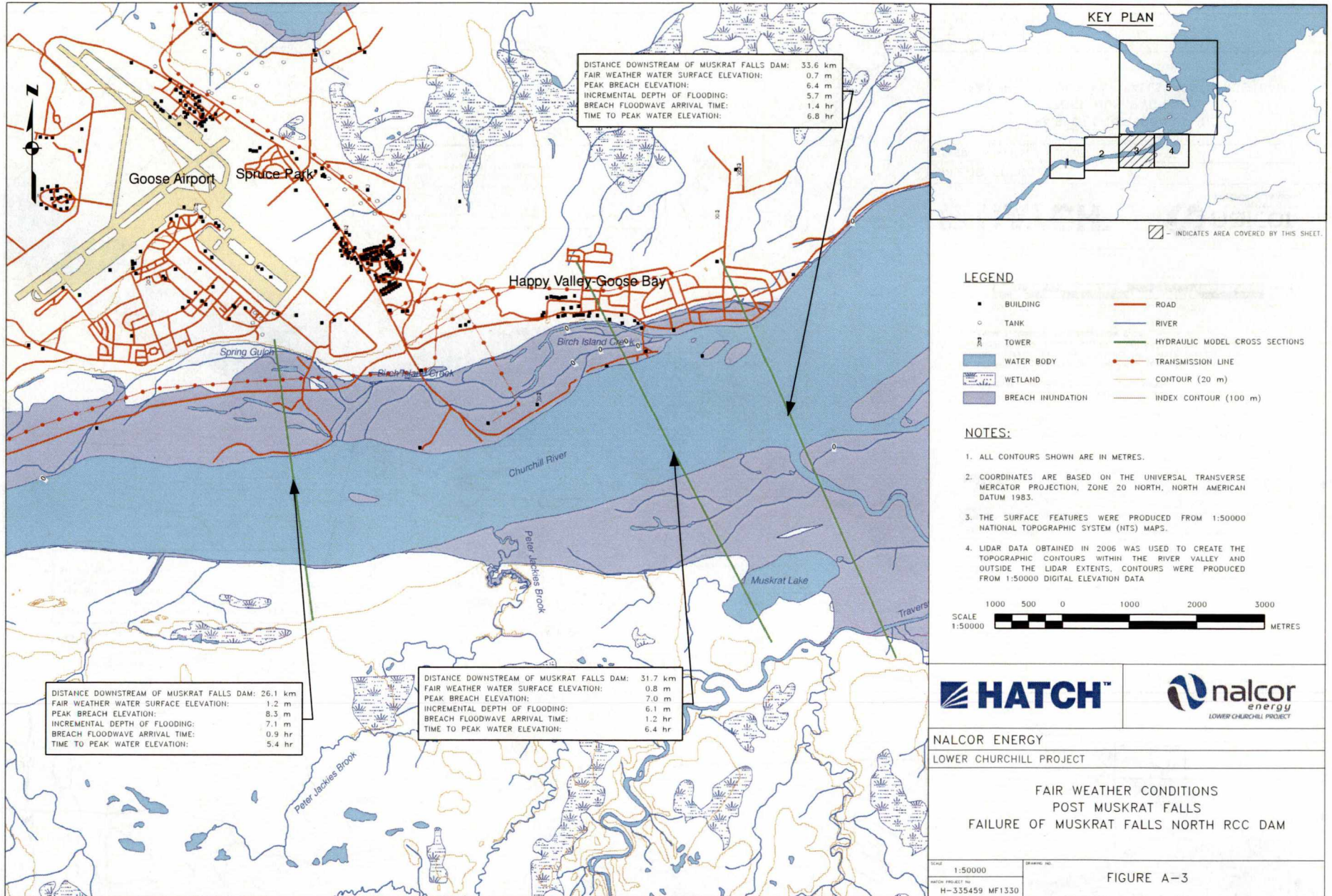
1. Canadian Dam Association (2007). Dam Safety Guidelines – Section 4 Emergency Preparedness
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3. Lower Churchill Management Corporation (2015). LCP Project-Wide Emergency Response Plan, Nalcor Doc. No. LCP-PT-MD-0000-HS-PL-0004-01

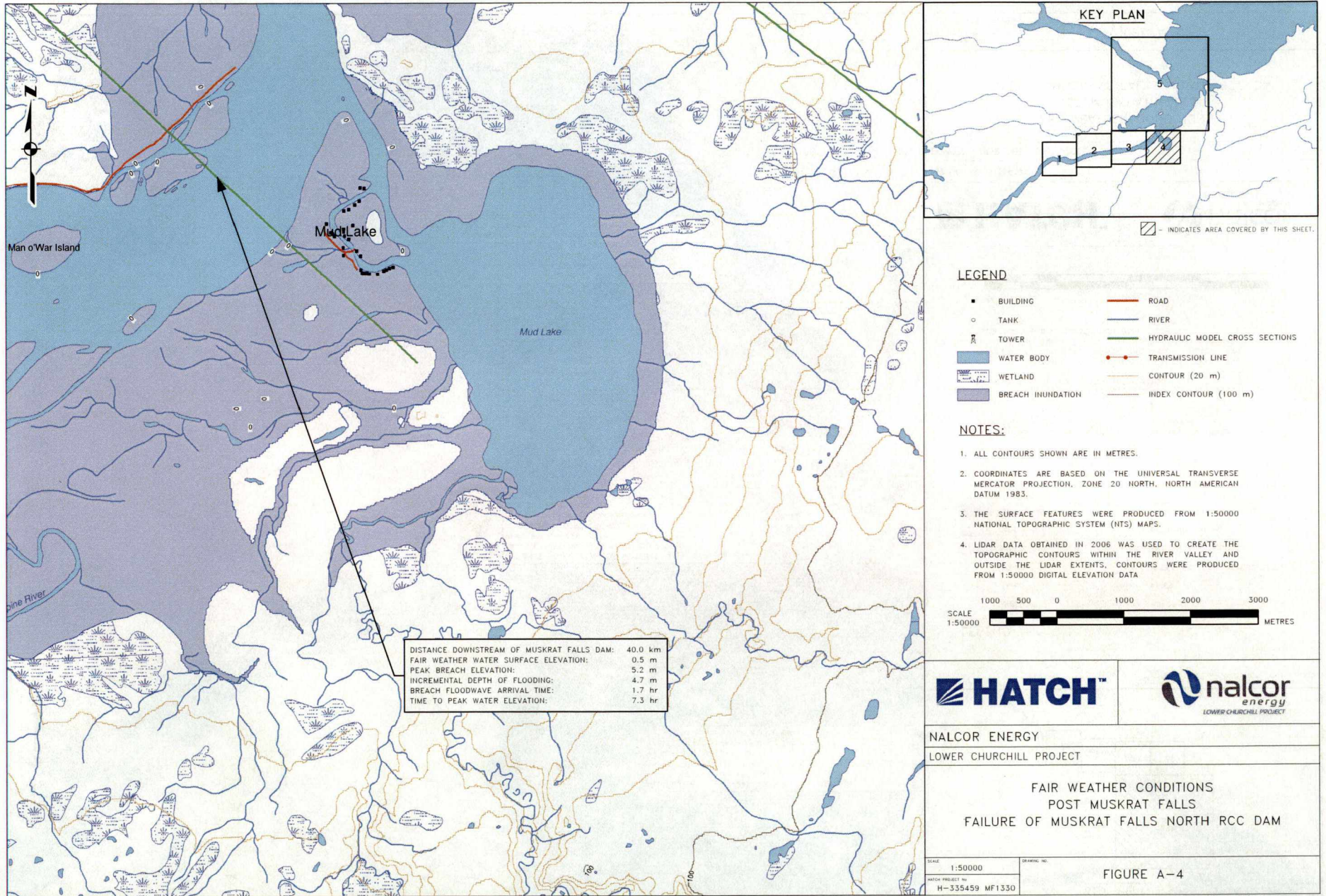
Appendix A

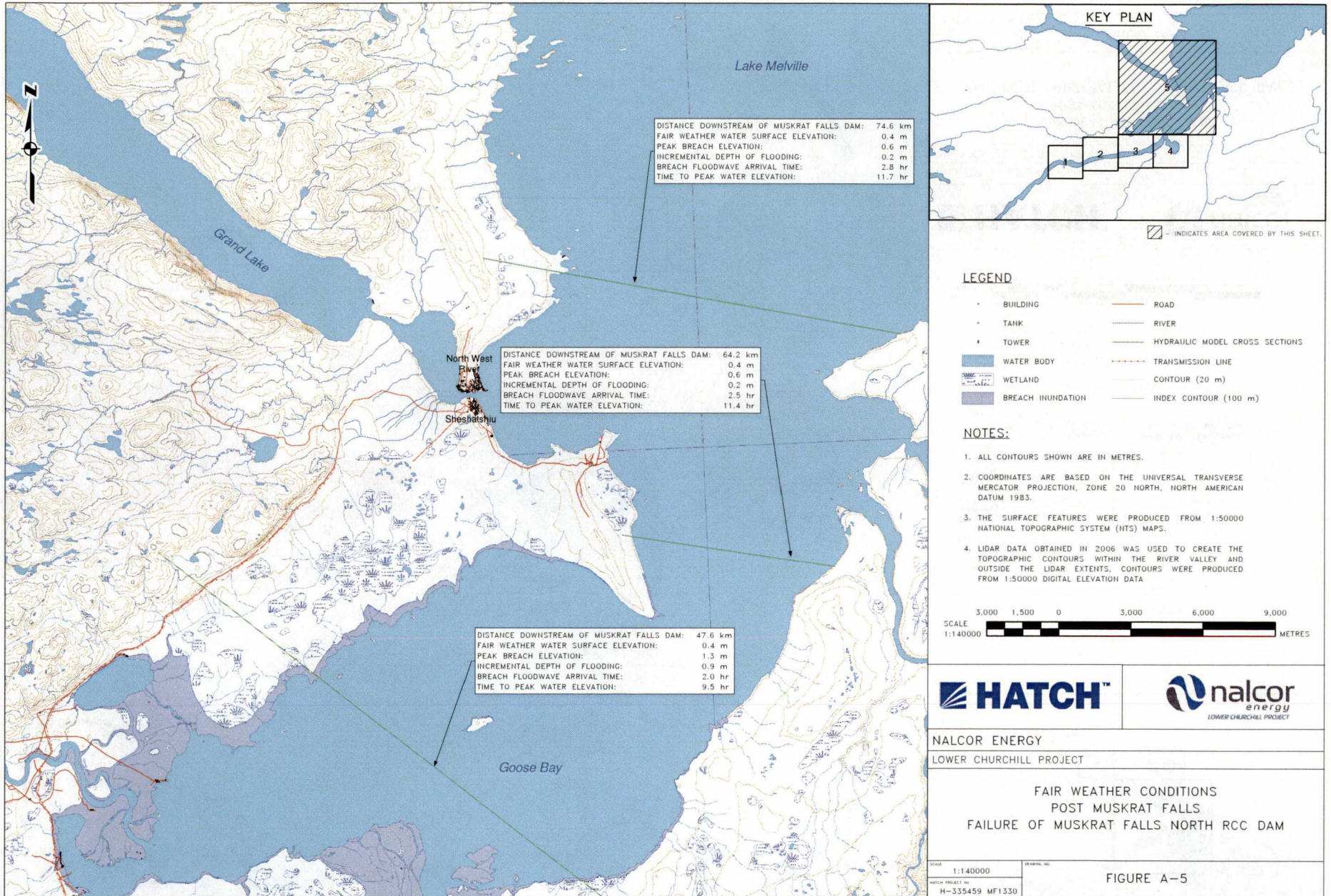
Fair Weather Inundation Mapping











Appendix B

PMF Inundation Mapping

