



**Stantec**

**Stantec Consulting Ltd.**  
607 Torbay Road  
St. John's, NL A1A 4Y6  
Tel: (709) 576-1458  
Fax: (709) 576-2126

## **Dam Safety Review Various Former Mine Sites Former Gullbridge Copper Mine, NL**

Prepared for

NL Department of Natural  
Resources  
Mineral Development Division  
3<sup>rd</sup> Floor, 50 Elizabeth Avenue  
PO Box 8700  
St. John's, NL  
A1B 4J6

Final Inspection Report

File No. 121612646

Date: March 2, 2011

## EXECUTIVE SUMMARY

---

Stantec Consulting Ltd. (Stantec) was retained by the Newfoundland and Labrador Department of Natural Resources (NLDNR) in October 2010 to complete a Dam Safety Review at the former Gullbridge Copper Mine, located in central Newfoundland, between the towns of South Brook and Badger, NL.

The guidelines for the Dam Safety Review are provided in the Canadian Dam Association's (CDA) Dam Safety Guidelines (2007). In concordance with the CDA Dam Safety Guidelines, a review of available documents and records was performed, and a site inspection was conducted. The objective of the current review is to identify data gaps for the completion of a detailed Dam Safety Review and provide preliminary/conceptual recommendations for work required to ensure the short and long term stability and performance of the dam and associated infrastructure.

Based on Stantec's site inspection and document review, the former Gullbridge Copper Mine structures are in fair operating condition. However some notable deficiencies were observed and include:

- The slopes and crest of the Gullbridge tailings dam were very densely vegetated along the length of the dam. Vegetation coverage was approximately 50-60% along the crest, 75-90% along the downstream slope, and 30% along the upstream slope. As such, it was difficult to observe and evaluate the condition of the dam shell.
- Ice-jacking and/or shelling was observed at the crest and upstream slope area, and differential elevation was also apparent.
- Some erosion and shallow slope failures were noted where the dam shell material was exposed on the downstream slope. The shallow slope failures are believed to be in the same location as the cracks shown in the DNR photographs recorded June 10, 2010. Since the construction history of the dam is unknown (i.e. if the dam is of rolled-earth cutoff construction, or if there is a rolled-earth core with dumped rock shells (slopes)), it is difficult to determine the cause of the failure shown in the photos. Further, the presence of significant vegetation on the adjacent downstream slope prevented a detailed assessment of the area below these cracks. Given the age of the structure and condition of the remainder of the dam, it is anticipated that these are relatively shallow "sloughing" failures. Further assessment of this area is required once the vegetation is removed.
- Evidence of seepage at the downstream toe was observed at one location, but was difficult to observe elsewhere due to vegetation and the boggy conditions along the downstream toe over most of the dam length.
- Two (2) 900 mm culverts form the discharge outlet for the tailings pond. The culverts bottoms were severely eroded (rusted) on the upstream side. Due to the severe erosion of the culverts, flow through and erosion of the dam structure is occurring underneath the culverts. It is understood that DNR intends on replacing the culverts in the year 2011. Potentially acid generating (PAG) material was also observed in the dam embankment near the outlet upstream.

- Materials washed downstream from a relatively recent failure of the dam at the culvert (outflow) locations were observed and the repair area was also evident. Upon consultation with DNR, it is understood the area was repaired in November 2010, and that these materials are the result of the erosion from this repair and a washout of the original decant structure in 1996.
- A beaver house was observed, located approximately 40-50 yards from the southwest end of the dam. Beaver activity was also observed across the dam.
- Two (2) potential historical discharge locations were observed on the upstream side in the form of a standpipe and old wood frame, and a minor inlet/channel with some timber.

Because historical data on the tailings dam is not available, the extent of the scope of work for the current review is limited to non-invasive, visual assessment of the dam. To complete a full, independent analysis of the long term stability of the tailings dam, a more detailed Dam Safety Review is necessary. This should consist of vegetation removal, a detailed survey of the tailings dam, a geotechnical investigation, a hydrological assessment and geochemical characterization of the tailings. In addition, based only on the information currently available and Stantec's site inspections, priority, short-term work has been recommended to improve stability of the dam and ensure that significant damage or failure does not occur.

## Table of Contents

---

<b>1.0 INTRODUCTION .....</b>	<b>1</b>
<b>2.0 BACKGROUND .....</b>	<b>1</b>
<b>3.0 DAM SAFETY REVIEW .....</b>	<b>2</b>
3.1 Review of Documents and Records .....	2
3.2 Site Inspection .....	2

---

<b>4.0 DOCUMENT REVIEW .....</b>	<b>2</b>
<b>5.0 OBSERVATIONS AND DISCUSSION .....</b>	<b>3</b>
5.1 Observations .....	3

---

<b>6.0 RECOMMENDATIONS .....</b>	<b>4</b>
6.1 Detailed Dam Safety Review .....	5
6.1.1 Scope of Work for Detailed Dam Safety Review .....	5
6.1.2 Cost Estimate for Detailed Dam Safety Review .....	5
6.2 Preliminary Recommendations for Dam Repair and Maintenance .....	6
6.2.1 Scope of Work and Priorities for Dam Repair and Maintenance .....	6
6.2.2 Schedule of Work for Dam Repair and Maintenance .....	6
6.2.3 Cost Estimate for Dam Repair and Maintenance .....	6

---

<b>7.0 CLOSURE .....</b>	<b>7</b>
--------------------------	----------

## LIST OF APPENDICES

APPENDIX A	Statement of General Conditions
APPENDIX B	Figure
APPENDIX C	2007 Dam Classification Table
APPENDIX D	UTM Coordinates, Dam Inspection Forms and Site Photos
APPENDIX E	References

## 1.0 INTRODUCTION

---

Stantec Consulting Ltd. (Stantec) was retained by the Newfoundland and Labrador Department of Natural Resources (NLDNR) in October 2010 to complete Dam Safety Reviews at the following historic mine sites: the former Daniel's Harbour Zinc Mine, the former Consolidated Rambler Copper Mine (CRM), the former Whalesback Copper Mine, and the former Gullbridge Copper Mine, all of which are located on the Island of Newfoundland, Newfoundland and Labrador.

As outlined in the Request for Proposals (RFP) issued by NLDNR, it was known that detailed Dam Safety Reviews, as defined by the Canadian Dam Association (CDA), would not be possible at this time due to the lack of design, construction, and operations data available for each site. Therefore, the purpose of the current work was to complete a review of the available literature, conduct a site visit to inspect the current condition of the dams and associated conveyance structures, and to report on the data gaps that would need to be addressed to fully evaluate the physical stability of the dam structures. The RFP also prescribed the need for recommendations and cost estimates to address the data gaps by December 17, 2010 in advance of the final inspection reports. The preliminary recommendations and cost estimates were provided to NLDNR in an Interim Report dated December 17, 2010 and revised December 22, 2010.

The final inspection reports have been prepared separately for each site. The report herein presents the current Dam Safety Review of the former Gullbridge Copper Mine, located in north-central Newfoundland. The Gullbridge site inspection was completed on November 29, 2010 by Stantec personnel.

This report is the first third-party review of the Gullbridge Tailings Dam since mine rehabilitation was initiated. The report provides a summary of the site visit observations and the review of available documentation. It contains all of our findings and recommendations for further work and monitoring of the tailings dam in accordance with the CDA Dam Safety Guidelines (2007).

## 2.0 BACKGROUND

---

The former Gullbridge Copper Mine was a mining and milling facility located in central Newfoundland, between the towns of South Brook and Badger, NL. Gullbridge was first mined in 1967 by First Maritimes mining, and was subsequently sold to K.C. Irving. Approximately 2.8 million tonnes of copper ore were produced from the site. In 1999, rehabilitation work was initiated on the site and included demolition of buildings, sealing all shafts to underground workings and removal of debris and chemicals from the site. At the Gullbridge site, there is one tailings dam, approximately 1050 m, long, 5 m wide and 10 m high with two (2), 900 mm diameter culverts for outflow.

Site and dam location plans are located in Appendix B.

### **3.0 DAM SAFETY REVIEW**

---

As noted above, a detailed Dam Safety Review of the Gullbridge Tailings Dam is not presently feasible based on the available data. The objective of the current review is to identify data gaps for the completion of a detailed Dam Safety Review and provide preliminary/conceptual recommendations for work required to ensure the short and long term stability and performance of the dam and associated infrastructure.

General guidelines for the completion of a Dam Safety Review are provided in the CDA Dam Safety Guidelines (2007). The requirements for the Dam Safety Review depend on the dam classification and condition, which are to be evaluated during the review. The procedures followed for the present inspection and review are summarized in the following sections.

#### **3.1 Review of Documents and Records**

Given that this was the first third party inspection of the former Gullbridge Copper Mine Tailings Dam, previous assessment documents or records are non-existent. Design, construction and operations literature were also unavailable. However, DNR conducted a site visit on June 10, 2010 and provided Stantec with eight (8) photographs from their visit. DNR also conveyed through communications that repairs were made to the outflow culvert area in November 2010, and that materials observed downstream were the result of this repair and a washout of the original decant structure in 1996. DNR also intends on replacing the culverts in 2011.

#### **3.2 Site Inspection**

Mr. James Powell, M.Eng., P.Eng., and Ms. Maureen Matthew, M.Sc., of Stantec Consulting Ltd. conducted the site inspection component of the current Dam Safety Review on November 29, 2010. The site inspection consisted of a detailed walk-over of the Gullbridge Tailings Dam and associated decant structure. During the investigation, photographs were taken and UTM coordinates were acquired by handheld GPS unit (accuracy of +/- 5 m) at pertinent locations across the site.

The results of the inspection are summarized in Section 5.0 of this report. UTM coordinates, inspection reports, and photographs taken during the inspection are provided in Appendix D. A full suite of photographs will be provided on CD-Rom with the final report.

### **4.0 DOCUMENT REVIEW**

---

In accordance with CDA Dam Safety Guidelines (2007), a classification scheme has been developed that is used to provide guidance in the standard of care expected of dam owners. This classification scheme was revised from the previous CDA Dam Safety Guidelines (1999).

The classification of a dam is based on several consequence criteria including potential loss of life, economic losses, environmental losses, cultural losses, and incremental and total consequences. Based on these criteria, the tailings dam at the former Gullbridge Copper Mine is classified as a “low consequence” structure. It should be noted that South Brook is approximately 450 m west of this dam, and this water course is assumed to be fish habitat. Given the flat, boggy terrain, with some forested areas between the dam and South Brook, it is not anticipated that even a large scale dam failure would result in the movement of significant tailings materials to South Brook. Further, there was no visual evidence (staining, etc. associated with acidic discharge) that the water held by the dam was of such poor quality that an adverse environmental impact would occur if a large scale discharge resulted from a dam failure. The results of the full dam safety review should address the potential for tailings or potentially poor quality drainage of reaching South Brook. The 2007 classification scheme is attached for reference in Appendix C.

As noted in Section 3.1, previous assessment documents or records were unavailable for review. The photographs provided by DNR to Stantec of their June 10, 2010 site visit show a crack/settlement/failure at the crest of the downstream slope towards the south end of the dam.

## **5.0 OBSERVATIONS AND DISCUSSION**

---

Based on Stantec’s limited site inspection and photograph review, the former Gullbridge Copper Mine structures are in fair operating condition. There is dense vegetation cover which hampered the visual assessment of the dam; however minor evidence of instability and seepage was visible in locations that were not covered by vegetation. The bottoms of the outlet culverts are severely eroded and causing erosion of the dam structure to occur. Photographs of the observations are presented in Appendix B.

### **5.1 Observations**

The observations made during the November 29<sup>th</sup>, 2010 site inspection by Stantec may be summarized as follows:

- The slopes and crest of the Gullbridge tailings dam were very densely vegetated along the length of the dam. Vegetation coverage was approximately 50-60% along the crest (Photo GB-1), 75-90% along the downstream slope, and 30% along the upstream slope. As such, it was difficult to observe and evaluate the condition of the dam shell.
- Ice-jacking and/or shelling was observed at the crest and upstream slope area (Photo GB-10), and differential elevation was also apparent (Photo GB-2).
- Some erosion and shallow slope failures were noted where the dam shell material was exposed on the downstream slope (Photos GB-4 and 6). The shallow slope failures are believed to be in the same location as the cracks shown in the DNR photographs recorded June 10, 2010 (Photo GB-5). Since the construction history of the dam is unknown (i.e. if the dam is of rolled-earth cutoff construction, or if there is a rolled-earth core with dumped rock shells (slopes)), it is difficult to determine the cause of the failure (failure in Photo GB-6 / longitudinal crack in Photo GB-5) shown in the photos noted above. Further, the presence of significant vegetation on the adjacent downstream

slope prevented a detailed assessment of the area below these cracks. Given the age of the structure and condition of the remainder of the dam, it is anticipated that these are relatively shallow “sloughing” failures. Further assessment of this area is required once the vegetation is removed.

- Evidence of seepage at the downstream toe was observed at one location (Photos GB-7 and 8), but was difficult to observe elsewhere due to vegetation and the boggy conditions along the downstream toe over most of the dam length.
- Two (2) 900 mm culverts form the discharge outlet for the tailings pond. The culverts bottoms were severely eroded (rusted) on the upstream side. Due to the severe erosion of the culverts, flow through and erosion of the dam structure is occurring underneath the culverts. It is understood that DNR intends on replacing the culverts in the year 2011. Potentially acid generating (PAG) material was also observed in the dam embankment near the outlet upstream (Photo GB-11).
- Materials washed downstream from a relatively recent failure of the dam at the culvert (outflow) locations were observed and the repair area was also evident. Upon consultation with DNR, it is understood the area was repaired in November 2010, and that these materials are the result of the erosion from this repair and a washout of the original decant structure in 1996.
- A beaver house was observed, located approximately 40-50 yards from the southwest end of the dam. Beaver activity was also observed across the dam.
- Two (2) potential historical discharge locations were observed on the upstream side in the form of a standpipe and old wood frame, and a minor inlet/channel with some timber.

## 6.0 RECOMMENDATIONS

---

Recommendations are provided below for work required to complete a detailed Dam Safety Review as well as preliminary recommendations for dam repair and maintenance to ensure the short-term stability of the dam and related infrastructure. The recommendations for dam repair and maintenance were previously provided to NLDNR on December 17, 2010 (revised December 22, 2010).

As discussed with NLDNR personnel on December 10, 2010, under the CDA Dam Safety Guidelines (2007), the tailings dam inspected may be classified as “low” and therefore a detailed Dam Safety Review may not be required. However, as NLDNR is responsible for the consequences of any dam deterioration or failure and the resulting impacts, and given the current conditions and lack of design and construction data, it is recommended that a detailed Dam Safety Review be carried out to determine the physical stability of the dam structure. Note that if the current physical condition of the dam is not improved, or at least maintained, the condition of the structure will continue to deteriorate due to weathering (erosion, channeling, ice-jacking, shelling, etc.) eventually progressing to failure of the structure.

The cost estimates to complete the recommended work components, presented below, are based on our knowledge and experience of work in these areas, discussions with local contractors, and assume the work may be completed in separate contracts. Further, the cost

estimates assume that NLDNR will tender and manage these contracts and no costing for a third party project manager has been carried.

## 6.1 Detailed Dam Safety Review

As outlined in the CDA Dam Safety Guidelines (2007), the scope of a Dam Safety Review may vary depending on the classification of the structure. The important aspect of the review is to demonstrate that the dam is safe and maintained in a safe condition. The level of detail of the review may change based on previous assessments, the complexity of the dam, availability and continuity of surveillance data, dam performance and age, and the need for public protection during the life of the dam. Because historical data on the tailings dam is not available, the extent of the scope of work for the current review is limited to non-invasive, visual assessment of the dam. To complete a full, independent analysis of the long term stability of the tailings dam, a more detailed assessment is necessary to evaluate the internal composition/structure of the dam and to review the relevant design data such as hydrology and geochemistry of the tailings area.

### 6.1.1 Scope of Work for Detailed Dam Safety Review

To complete a detailed Dam Safety Review at the former Gullbridge Copper Mine site, the following work is recommended:

- Vegetation removal across the entire dam crest and slopes;
- A detailed survey of tailings dam with bathymetric survey of upstream tailings pond;
- A geotechnical investigation (with select borehole installations such as monitoring wells and piezometers);
- A hydrological assessment; and
- Geochemical characterization of tailings.

### 6.1.2 Cost Estimate for Detailed Dam Safety Review

For the recommended Dam Safety Review components the following cost estimates are provided:

Vegetation Removal	\$25,000
Detailed Survey and Bathymetry	\$15,000
Geotechnical Investigation	\$65,000
Borehole Installations	\$10,000
Hydrological Assessment	\$7,500
Characterization of Tailings	\$10,000
<u>Dam Safety Review</u>	<u>\$20,000</u>
<b>TOTAL</b>	<b>\$152,500</b>

The arrangement, timing, and other industry related factors may impact the actual cost to complete this work, and it is therefore recommended that a contingency of 20% be carried for budgeting purposes.

For geotechnical work, the conditions encountered during the investigations may impact the final requirements for the investigation and should be supervised by experienced geotechnical personnel to ensure that the work is conducted with a full understanding of the data required.

## **6.2 Preliminary Recommendations for Dam Repair and Maintenance**

The site work described below is recommended to improve the stability of the dam based only on the information currently available and Stantec's site inspection. These recommendations, and their assigned priorities, should be confirmed via the completion of the detailed Dam Safety Review. Depending on the schedule to complete the various work required to complete the detailed Dam Safety Review, the following priority, short-term work, should be completed to ensure that significant damage or failure of the dam structure does not occur.

### **6.2.1 Scope of Work and Priorities for Dam Repair and Maintenance**

It is understood that DNR plans on replacing the culverts in the year 2011. However, depending on the timing of this replacement, in the interim, the priority for this dam should be to verify the spillway/culvert sizing (hydrology assessment) and ensure that it is properly sized for the appropriate design high water event. The spillway/culvert should be repaired and armoured, including armoring of the upstream side of the dam to approximately 10 m each side of the spillway.

Secondary priority should be to improve the stability of this dam. This should include grading and armoring of the upstream slopes of the dam. In addition, inspection of the failure/crack on the downstream slope of the dam to determine its extent, and stabilization of this slope should be considered using a toe berm and armoring of the slope. These activities would also require that the thick vegetation on the dam be removed and the slope surfaces regraded during this operation.

### **6.2.2 Schedule of Work for Dam Repair and Maintenance**

Rising water levels and high velocity discharge are the most likely causes of damage or failure of the dam structure. It is recommended that the hydrology/hydraulics assessment of the spillway/culvert structures be completed as soon as possible, and the spillway/culvert structures be sized and reinforced to accommodate the appropriate design flows. Vegetation removal should also be prioritized for this dam, and a supplementary dam inspection performed once these materials are removed. The remaining stability work should be prioritized based on the overall schedule to complete the detailed Dam Safety Review work.

### **6.2.3 Cost Estimate for Dam Repair and Maintenance**

The costs presented for dam repair and maintenance are order-of-magnitude, as per NLDNR's scope of work, and as such the appropriate contingency for this estimate is difficult to assess. Stantec contacted local contractors to provide a reasonable level of accuracy with respect to equipment and materials. Based on the available costing information and the current project information available, these estimates may be considered to require 25 – 35% contingency.

For the dam repair and stabilization components, the following order-of-magnitude cost estimates are provided:

Dam Spillway Assessment and Repair	\$20,000
Dam U/S Armour	\$65,000
Dam D/S Armour and Toe	\$150,000
<b>TOTAL</b>	<b>\$235,000</b>

## 7.0 CLOSURE

---

This inspection report has been prepared for the sole benefit of the Newfoundland and Labrador Department of Natural Resources and their agents, and may not be used by any third party without the express written consent of Stantec and the client. Any use which a third party makes of this report is the responsibility of such third party.

Use of this report is subject to the Statement of General Conditions provided as an Attachment. It is the responsibility of NLDNR, who is identified as “the Client” within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following: use of the report; basis of the report; standard of care; interpretation of site conditions; varying or unexpected site conditions; and planning, design or construction.

**Stantec**

DAM SAFETY REVIEW  
FORMER GULLBRIDGE COPPER MINE

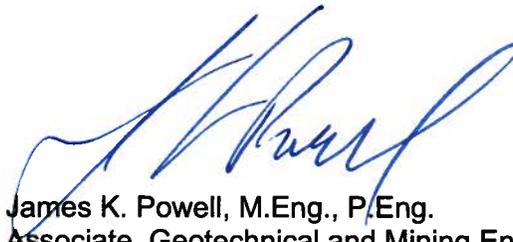
We trust this information meets your present requirements. Should any additional information be required, please do not hesitate to contact our office at your convenience.

Respectfully submitted,

**STANTEC CONSULTING LTD.**



Amy Copeland, P.Eng.  
Mining and Geotechnical Engineering



James K. Powell, M.Eng., P.Eng.  
Associate, Geotechnical and Mining Engineering

PROVINCE OF NEWFOUNDLAND AND LABRADOR	
	<b>PERMIT HOLDER</b>
	This Permit Allows
<b>STANTEC CONSULTING LTD.</b>	
To practice Professional Engineering in Newfoundland and Labrador. Permit No. as issued by PEG <u>50291</u> which is valid for the year <u>2011</u>	



# **APPENDIX A**

## Statement of General Conditions

## STATEMENT OF GENERAL CONDITIONS

**USE OF THIS REPORT:** This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

**BASIS OF THE REPORT:** The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

**STANDARD OF CARE:** Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

**INTERPRETATION OF SITE CONDITIONS:** Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

**VARYING OR UNEXPECTED CONDITIONS:** Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

**PLANNING, DESIGN, OR CONSTRUCTION:** Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

# APPENDIX B

Figure



NOTE: 1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES. 2. IMAGERY PROVIDED BY NEWFOUNDLAND AND LABRADOR DEPARTMENT OF ENVIRONMENT AND CONSERVATION.

CLIENT:	<b>NEWFOUNDLAND AND LABRADOR DEPARTMENT OF NATURAL RESOURCES</b>		SCALE: <b>1:4000</b>	DATE: <b>JAN 28, 2011</b>
PROJECT TITLE:	<b>DAM SAFETY REVIEW VARIOUS FORMER MINE SITES</b>		DRAWN BY: <b>AF</b>	CHECKED BY: <i>ACE</i>
DRAWING TITLE:	<b>FORMER GULLBRIDGE COPPER MINE SITE OVERVIEW</b>		EDITED BY:	REV. No. <b>0</b>
			DRAWING No.: <b>121612646-GE-GB-01</b>	
			MAP FILE: <b>Gullbridge.MXD</b>	



# **APPENDIX C**

## 2007 Dam Classification Table

Table 2-1: Dam Classification

Dam class	Population at risk [note 1]	Incremental losses		
		Loss of life [note 2]	Environmental and cultural values	Infrastructure and economics
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	Significant loss or deterioration of <i>important</i> fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very high	Permanent	100 or fewer	Significant loss or deterioration of <i>critical</i> fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of <i>critical</i> fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

**Note 1. Definitions for population at risk:**

**None**—There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

**Temporary**—People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

**Permanent**—The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

**Note 2. Implications for loss of life:**

**Unspecified**—The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

# **APPENDIX D**

UTM Coordinates

Dam Inspection Forms and Site Photos





**CDA GENERAL INSPECTION FORM**



**Stantec**

**Site:** Former Gullbridge Copper Mine

**Project Number:** 121612646

**Date:** 11/29/2010

Are Supplemental Forms Attached?

Form A	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No
Form B	<input type="checkbox"/>	Yes	<input checked="" type="checkbox"/>	No

**General Site and Background Data**

Dam Owner: Newfoundland and Labrador Department of Natural Resources

Design Report	<input type="checkbox"/>	Copy Received	<input type="checkbox"/>	Drawings
	<input type="checkbox"/>	Copy Reviewed	<input type="checkbox"/>	
	<input checked="" type="checkbox"/>	Not Available	<input type="checkbox"/>	
	<input type="checkbox"/>	Design Company	<input type="checkbox"/>	

Previous CDA Inspections	<input type="checkbox"/>	Copy Received
	<input type="checkbox"/>	Copy Reviewed
	<input checked="" type="checkbox"/>	First Inspection
	<input type="checkbox"/>	Not Available
	<input type="checkbox"/>	Inspection Company

Instrumentation	<input type="checkbox"/>	Yes	<input checked="" type="checkbox"/>	No
-----------------	--------------------------	-----	-------------------------------------	----

Instrumentation data	<input type="checkbox"/>	Copy Received
	<input type="checkbox"/>	Copy Reviewed
	<input checked="" type="checkbox"/>	Not Available
	<input type="checkbox"/>	Data Collection by:

Owner's staff available	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No
-------------------------	-------------------------------------	-----	--------------------------	----

Name: Alex Smith / Len Mandville

Position: NLDNR, Mineral Development Division

Accompanying on inspection	<input type="checkbox"/>	Yes	<input checked="" type="checkbox"/>	No
----------------------------	--------------------------	-----	-------------------------------------	----

Pre-inspection meeting held	<input type="checkbox"/>	Yes	<input checked="" type="checkbox"/>	No
-----------------------------	--------------------------	-----	-------------------------------------	----

Post-inspection meeting held	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No
------------------------------	-------------------------------------	-----	--------------------------	----

**CDA GENERAL INSPECTION FORM**

Owner's specific concerns or comments: Lack of design and historical data on the structure.	
Overall stability of the dam and spillway (culvert) with respect to short term failure and long term maintenance.	
Extent of dense vegetation present on the crest and slopes of the dam.	
Crack near dam crest on downstream side of dam indicating possible failure mode.	
Significant metrological events (recent): Hurricane Igor - September 21, 2010, though not a significant impact in this area of the province.	
Change in operating conditions:	
Operating, Maintenance, and Surveillance (OMS) Manual:	
<input type="checkbox"/> Copy Received	
<input type="checkbox"/> Copy Reviewed	
<input checked="" type="checkbox"/> Not Available	
<input type="checkbox"/> Prepared by:	_____
Owner's inspection reports:	
<input checked="" type="checkbox"/> Copy Received	June 10, 2010 Photographs only.
<input type="checkbox"/> Copy Reviewed	
<input type="checkbox"/> Not Available	
<input type="checkbox"/> Inspection by:	_____
Special Conditions:	

**DAM INSPECTION REPORT  
FIELD INSPECTION FORM A**



**Stantec**

Site: Former Gullbridge Copper Mine

Project Number: 121612646

Date: 11/29/2010

Dam Owner : Newfoundland and Labrador Department of Natural Resources

All parts of this inspection form should be completed. Adverse conditions should be described and location stated. Additional information and relevant photographs should be attached.

Inspector's Name: J.Powell / M. Matthew Report No.: \_\_\_\_\_ Inspection Date: 11/29/2010  
Stantec Consulting Ltd. (MM/DD/YEAR)

**DAM INFORMATION :**

Identification: Former Gullbridge Copper Mine Crest Elevation: Not taken Head Pond Elevation: Not taken  
Tailings Dam

**DAM INSPECTION :**

**Earth Dam Structure**

**A) Crest**

cracking	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
settlement	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
erosion	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
other movement	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
crest vegetation	<input type="checkbox"/>	none	<input checked="" type="checkbox"/>	Moderate grass and alder growth on crest, approximately 50-60%

**B) Downstream Slope and Toe Area**

erosion	<input type="checkbox"/>	none	<input checked="" type="checkbox"/>	Some minor evidence of erosion, increased due to moose travel paths
settlement	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
bulging	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
sloughing	<input type="checkbox"/>	none	<input checked="" type="checkbox"/>	Evidence of shallow failure at one location, see comments section for description
slope protection	<input checked="" type="checkbox"/>	good	<input type="checkbox"/>	_____
slope vegetation	<input type="checkbox"/>	none	<input checked="" type="checkbox"/>	Major alder, birch and fir growth on downstream slope, approximately 75-90%
animal burrows	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	_____
seepage	<input type="checkbox"/>	none	<input checked="" type="checkbox"/>	location 1: <b>See Note Below-Left.</b>

**Entire toe area is a bog and saturated.  
Seepage may not be visible due to downstream bog and frozen conditions.**

rate:  damp  trickle  steady \_\_\_\_\_ (L/s)  
 clarity:  clear  muddy  
 water sample taken:  yes  no

**location 2:**

rate:  damp  trickle  steady \_\_\_\_\_ (L/s)  
 clarity:  clear  muddy  
 water sample taken:  yes  no

toe vegetation	<input type="checkbox"/>	none	<input type="checkbox"/>	sparse	<input type="checkbox"/>	moderate	<input checked="" type="checkbox"/>	heavy
sand boils	<input checked="" type="checkbox"/>	none	<input type="checkbox"/>	location(s)	<u>Bog Area - Grasses and small evergreen shrubs</u>			

**DAM INSPECTION REPORT  
FIELD INSPECTION FORM A**



Site: Former Gullbridge Copper Mine  
 Project Number: 121612646 Date: 11/29/2010

Dam Identification: Former Gullbridge Copper Mine Tailings Dam

**C) Upstream Slope and Tailings Surface**

erosion	<input checked="" type="checkbox"/> none	<input type="checkbox"/> wave induced	<input type="checkbox"/> surface runoff
		location(s)	
		degree	<input type="checkbox"/> minor <input type="checkbox"/> moderate <input type="checkbox"/> severe
settlement	<input checked="" type="checkbox"/> none	<input type="checkbox"/>	
bulging	<input checked="" type="checkbox"/> none	<input type="checkbox"/>	
sloughing	<input type="checkbox"/> none	<input checked="" type="checkbox"/>	Moderate sloughing (differential elevation) due to shelling or ice-jacking
slope protection	<input checked="" type="checkbox"/> good	<input type="checkbox"/>	
slope vegetation	<input type="checkbox"/> none	<input checked="" type="checkbox"/>	Some grass and alder growth on upstream slope, approximately 30%
animal burrows	<input checked="" type="checkbox"/> none	<input type="checkbox"/>	
whirlpool	<input checked="" type="checkbox"/> none	<input type="checkbox"/>	
sinkholes	<input checked="" type="checkbox"/> none	<input type="checkbox"/>	
tailings surface	<input checked="" type="checkbox"/> water covered	<input type="checkbox"/>	

**SPILLWAY/FLOW CONTROL STRUCTURE INSPECTION**

**Type:** Two 0.9 m steel culverts side by side

<input checked="" type="checkbox"/> spillway	<input type="checkbox"/> water reclaim well
<input type="checkbox"/> decant	<input type="checkbox"/> weir
	<input type="checkbox"/> other _____

Flow:  none  clear  muddy

Rate of discharge: \_\_\_\_\_ (m<sup>3</sup>/hr)  estimated  measured Gauge Reading \_\_\_\_\_

**Conditions Observed:**

<input checked="" type="checkbox"/> good	<input type="checkbox"/> blockage of inlet	<input type="checkbox"/> debris _____	<b>corrective action</b>	<input type="checkbox"/> taken
		<input type="checkbox"/> beaver dam _____		<input type="checkbox"/> to follow
		<input type="checkbox"/> siltation _____		
	<input type="checkbox"/> blockage of outlet	<input type="checkbox"/> debris _____	<b>corrective action</b>	<input type="checkbox"/> taken
		<input type="checkbox"/> beaver dam _____		<input type="checkbox"/> to follow
		<input type="checkbox"/> siltation _____		
	<input type="checkbox"/> erosion	<input type="checkbox"/> channel _____	<b>corrective action</b>	<input type="checkbox"/> taken
		<input type="checkbox"/> side slope _____		<input type="checkbox"/> to follow
		<input type="checkbox"/> at discharge _____		

**Comments:**

Bottoms of culverts rusted. Potentially Acid Generating (PAG) material in dam near outlet upstream.  
 Approximate culvert locations UTM Coordinates\* NAD 27 Zone 21: Easting 559973 and Northing 5450786.

**DAM INSPECTION REPORT  
FIELD INSPECTION FORM A**



**Stantec**

Site: Former Gullbridge Copper Mine

Project Number: 121612646

Date: 11/29/2010

Dam Identification: Former Gullbridge Copper Mine Tailings Dam

**DAM INSTRUMENTATION:** (plot any newly installed instrumentation on relevant plans and cross-sections)

	<u>Operational</u>	<u>Damaged</u>	<u>Measurement Taken</u>
<input checked="" type="checkbox"/> none			
<input type="checkbox"/> piezometers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> monitoring wells	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> survey monuments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**COMMENTS AND RECOMMENDATIONS:**

South abutment (approximate) UTM Coordinates\* NAD 27 Zone 21: Easting 559886 and Northing 5450023

Northeast abutment (approximate) UTM Coordinates\* NAD 27 Zone 21: Easting 560175 and Northing 5450788

\*Note: UTM Coordinates acquired with hand-held GPS at an accuracy of +/- 5 m.

Recommendations provided in the Inspection Report.

- Action Required:                       none                       further monitoring                       immediate remediation  
 Plan or Sketch Attached  
 Photographs Attached                      Photo Nos: Photos GB-1 to GB-12

Reviewer's Name: J. Powell  
Stantec Consulting Ltd.

Date Reviewed: 1/10/2011  
(MM/DD/YEAR)

**REVIEW COMMENTS:**                       none

See draft inspection report entitled "Dam Safety Review, Various Former Mine Sites, Former Gullbridge Copper Mine, NL" dated January 14, 2011.

CDA FACILITY INSPECTION PHOTOGRAPHIC RECORDS

<b>Site:</b> <b>Former Gullbridge Copper Mine</b>	
<b>Client:</b> Newfoundland and Labrador Department of Natural Resources	<b>Project Number:</b> 121612646
<b>Site Location:</b> Former Gullbridge Copper Mine Tailings Dam	
<b>Dam Owner:</b> Newfoundland and Labrador Department of Natural Resources	
<b>Photographer:</b> Maureen Matthew	<b>Date:</b> 11/29/2010
Photograph GB-1	
Looking N along crest of dam - note heavy vegetation.	
Photograph GB-2	
Looking N along crest and upstream slope - note differential elevation.	

CDA FACILITY INSPECTION PHOTOGRAPHIC RECORDS

<b>Site:</b> <b>Former Gullbridge Copper Mine</b>	
<b>Client:</b> Newfoundland and Labrador Department of Natural Resources	<b>Project Number:</b> 121612646
<b>Site Location:</b> Former Gullbridge Copper Mine Tailings Dam	
<b>Dam Owner:</b> Newfoundland and Labrador Department of Natural Resources	
<b>Photographer:</b> Maureen Matthew	<b>Date:</b> 11/29/2010
<b>Photograph GB-3</b>	
Looking SW along downstream slope at south end - note dense vegetation.	
<b>Photograph GB-4</b>	
Looking W towards downstream slope and tow - note erosion and moose tracks.	

**CDA FACILITY INSPECTION PHOTOGRAPHIC RECORDS**

<b>Site:</b> <b>Former Gullbridge Copper Mine</b>	
<b>Client:</b> Newfoundland and Labrador Department of Natural Resources	<b>Project Number:</b> 121612646
<b>Site Location:</b> Former Gullbridge Copper Mine Tailings Dam	
<b>Dam Owner:</b> Newfoundland and Labrador Department of Natural Resources	
<b>Photographer:</b> Maureen Matthew	<b>Date:</b> 11/29/2010
<p>Photograph GB-5</p> <p>Looking N along downstream slope - note crack / shallow failure (Photo Provided by NLDNR, taken June 10, 2010 - believed to be same location as Photo GB-6).</p>	
<p>Photograph GB-6</p> <p>Looking N along downstream slope - note sloughing.</p>	



CDA FACILITY INSPECTION PHOTOGRAPHIC RECORDS

<b>Site:</b> <b>Former Gullbridge Copper Mine</b>	
<b>Client:</b> Newfoundland and Labrador Department of Natural Resources	<b>Project Number:</b> 121612646
<b>Site Location:</b> Former Gullbridge Copper Mine Tailings Dam	
<b>Dam Owner:</b> Newfoundland and Labrador Department of Natural Resources	
<b>Photographer:</b> Maureen Matthew	<b>Date:</b> 11/29/2010
Photograph GB-9	
Looking N along upstream slope - note extent of vegetation.	
Photograph GB-10	
Looking N along upstream slope at north end.	

CDA FACILITY INSPECTION PHOTOGRAPHIC RECORDS

<b>Site:</b> <b>Former Gullbridge Copper Mine</b>	
<b>Client:</b> Newfoundland and Labrador Department of Natural Resources	<b>Project Number:</b> 121612646
<b>Site Location:</b> Former Gullbridge Copper Mine Tailings Dam	
<b>Dam Owner:</b> Newfoundland and Labrador Department of Natural Resources	
<b>Photographer:</b> Maureen Matthew	<b>Date:</b> 11/29/2010
Photograph GB-11	
Looking N at outlet culverts - note bottoms rusted out and PAG material on upstream slope.	
Photograph GB-12	
Looking NW at outlet culverts on downstream side - note no recent discharge.	

# **APPENDIX E**

## References

## REFERENCES

CDA, 1999. "Dam Safety Guidelines". Published by the Canadian Dam Association. January 1999.

CDA, 2007. "Dam Safety Guidelines". Published by the Canadian Dam Association. 2007.

Newfoundland and Labrador Department of Natural Resources (NLDNR), Mines Branch. June 10, 2010. Eight (8) photographs of site visit conducted by NLDNR.

Newfoundland and Labrador Department of Natural Resources, Mines Branch. 2010. Request for Proposals, Terms of Reference for 2010 Dam Safety Review at the Former Consolidated Rambler Copper Mine, Former Daniel's Harbour Zinc Mine, Former Whalesback Copper Mine, and Former Gullbridge Copper Mine.

Sherard, J., Woodward, R., Gizienski, S. & Clevenger, W. 1963. Earth and Earth-Rock Dams, Engineering Problems of Design and Construction.

Verbal communication with Newfoundland and Labrador Department of Natural Resources.