REPORT NO. 212003/1

MYRA FALLS OLD TAILINGS DISPOSAL FACILITY
2013 DAM SAFETY REVIEW

Submitted to:

Nyrstar Myra Falls Ltd.
Myra Falls Operations
P.O. Box 8000, Campbell River
British Columbia, Canada V9W 5E2

Prepared by:

Robertson GeoConsultants Inc.
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October 2013

EXECUTIVE SUMMARY

This is the 2013 Dam Safety Report on the Myra Falls Old Tailings Disposal Facility (TDF). The report is prepared by Robertson GeoConsultants (RGC) at the request of Nyrstar Myra Falls Ltd.

The TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur.

The history of the TDF design, construction, and operation is, in brief: the TDF was designed in 1982; construction of starter works done in 1982 to 1984; and the facility was operated until 2011. Construction of a seismic upgrade berm was completed in 2013.

Currently the TDF is not in use for disposal of tailings. The facility is maintained by Nyrstar in terms of the *Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual.* An *Emergency Management Program* is in place.

The *2009 Reclamation and Closure Plan* included details of the proposed closure of the TDF. An application for amendment of Permit M-26, entitled *Nyrstar Myra Falls Tailings Disposal Facility Closure Plan* dated February 2012 was filed with the Chief Inspector of Mines on March 19, 2012 in accordance with Section 10(6) of the Mines Act. Plans for closure of the TDF were approved on July 16, 2013 by the Chief Inspector of Mines in the *Permit Amendment Approving Conceptual TDF Closure Plan*.

A revised site-wide closure plan is being prepared for submission by July 2014. Closure of the TDF will be addressed in the site-wide closure plan on the basis that such work is ongoing closure in support of final closure of the overall site. In support of preparation of the site-wide closure plan, sampling and testing of TDF materials and other material and quantification of facility load and mass balance is in progress.

On the basis of reading reports and on the basis of site observations, this report documents the reasons for the following findings regarding the safety of the TDF:

- The TDF was constructed and operated in accordance with the approved designs and plans.
- The TDF is maintained in accordance with the approved *Operations, Maintenance and Surveillance Manual.*
- An approved emergency response plan is in place as documented in the *Emergency Management Program.*
- In the opinion of the writers of this report, the approved documents represent design, construction, and operation approaches that meet the standards of practice commensurate with a structure of this nature and hazard rating.
- There are no observable conditions that warrant immediate action or response.

- Closure of the TDF as soon as practical is necessary and appropriate. This must be done in accordance with designs currently being formulated. In particular, provision must be made for surface water management, covers, overall stability, seepage control and re-vegetation.

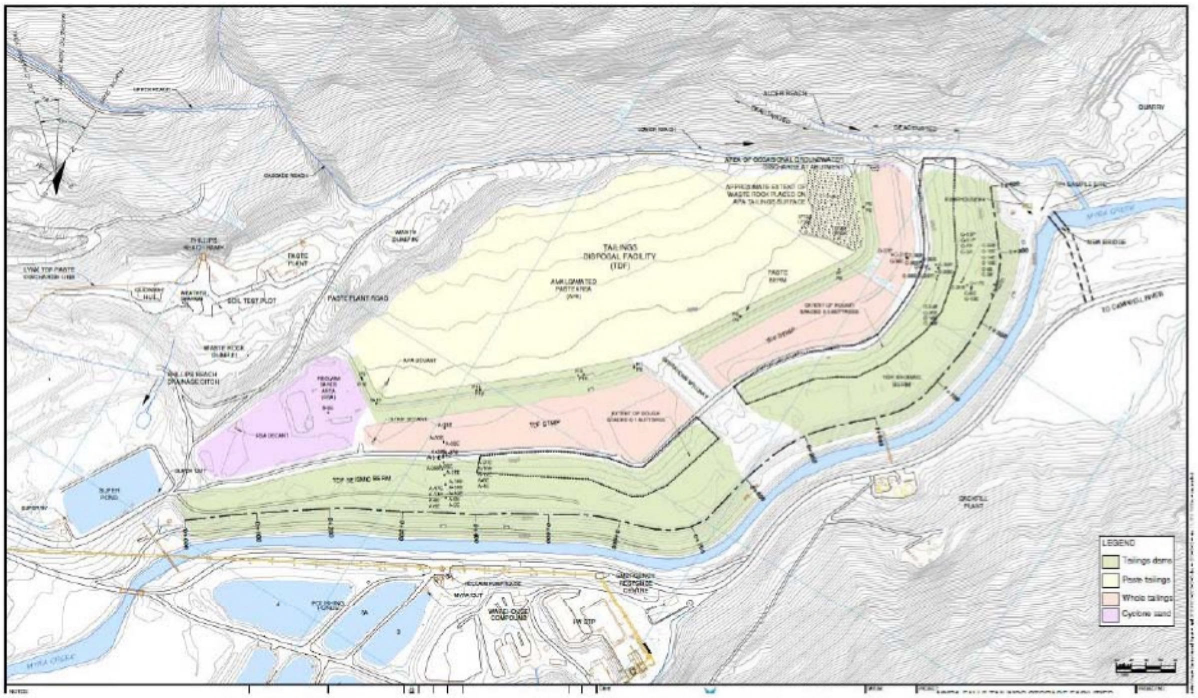

Figure ES1. The general layout of the TDF. The yellow shading denotes the paste tailings surface area; the pink shading denotes the old tailings surface area; the purple shading denotes the reclaim sand area; the green shading denotes sideslopes—the northern one being the paste berm sideslopes and the southern one being the seismic berm sideslopes; Blue shading is Myra Creek.

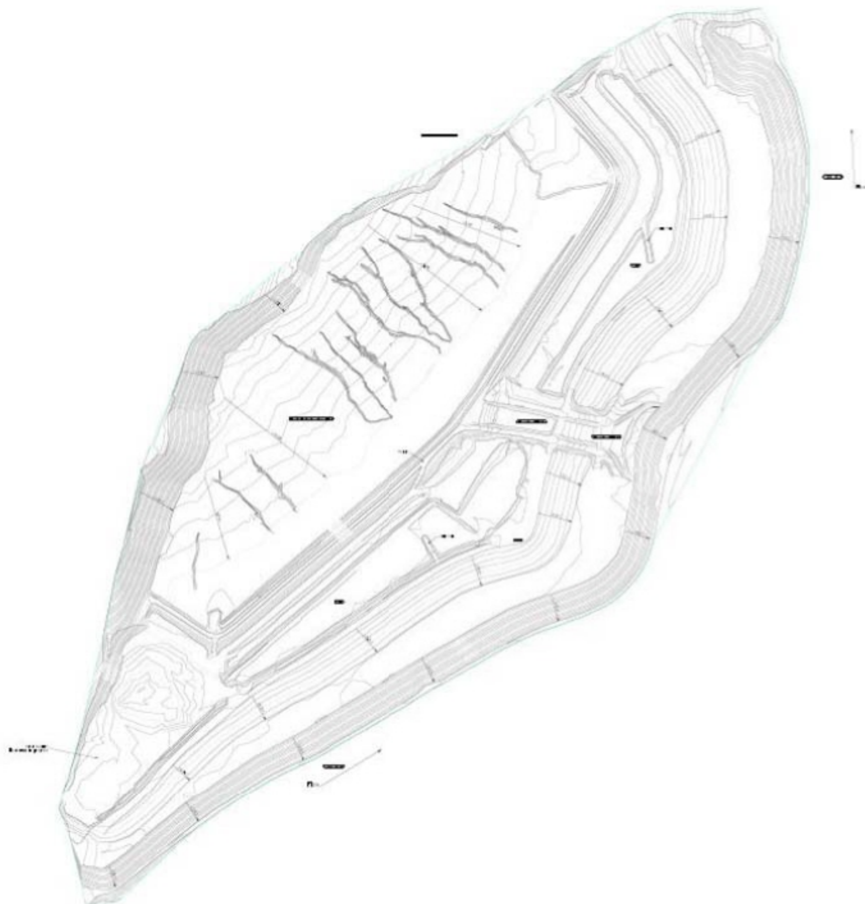

Figure ES-2. A copy of the mid-2013 topographic survey of the Old TDF. While not legible here, the original (large-scale drawing, not included with this report) provides contour elevations, freeboards, and the inclinations of the sideslopes of berms.

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2 FACILITY DESCRIPTION

2.1 GENERAL

This section describes the TDF design, construction and operation up to and including 2012. The descriptions are based on information in the references (Section 7.)

2.2 LOCATION

The TDF is on the Myra Falls Mine which is in Strathcona Provincial Park, Vancouver Island, British Columbia. The mine is in the asserted traditional territories of the We Wai Kai, Wei Wai Kum, K'omoks and Mowachaht/Muchalaht First Nations.

The Myra Falls mine is Mine No. 0800007 as numbered by the B.C. Ministry of Energy and Mines.

2.3 DAM CATEGORY

The TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur. As noted in the Water Act, British Columbia Dam Safety Regulation, Schedule 1, Definitions, a high hazard structure involves the following:

- Population at Risk: Permanent
- Consequences of Failure:
  - Loss of Life: 10 or fewer
  - Environmental and cultural values: Significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat. (b) rare or endangered species, or (c)

- unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.
- Infrastructure and economics: High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.

2.4 HISTORY

The history of the TDF design, construction, and operation is described in the listed references. In brief: the TDF was designed in 1982; construction of starter works done in 1982 to 1984; and the facility was operated until 2011. Construction of a seismic upgrade berm was completed in 2013.

2.5 2012 REPORTS

Reports on work at and the condition of the TDF as of late 2012 include:

- AMEC (2013) *Myra Falls Tailings Storage Facilities 2012 Annual Dam Status Report.*
- AMEC (2013) *Myra Falls Tailings Storage Facilities 2012 Construction Report*.
- Marsland Environmental Associates (2011) *Myra Falls Operations Report on the TDF Under Drain, 2010.*
- Nyrstar (2012) *Annual Environmental Report 2012.*

3 CURRENT STATUS

3.1 General

This section describes the current i.e., 2013, status of the TDF. The descriptions are based on information in the references, discussions with Nyrstar personnel and site observations.

3.2 Current Status

Currently the TDF is not in use for disposal of tailings. The facility is maintained by Nyrstar in terms of the *Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual,* NVI (2010) and the *Emergency Management Program,* Nyrstar (2013).

3.3 TDF Reclamation and Closure Plan

The *2009 Reclamation and Closure Plan* (NVI Mining Ltd. 2009) included details of the proposed closure of the TDF. An application for amendment of Permit M-26, entitled *Nyrstar Myra Fall Tailings Disposal Facility Closure Plan* dated February 2012 was filed with the Chief Inspector of Mines on March 19, 2012 in accordance with Section 10(6) of the Mines Act.

Plans for closure of the TDF were approved in 2013 by the Chief Inspector of Mines (A. Hoffman, 2013) in the *Permit Amendment Approving Conceptual TDF Closure Plan*. The approval conditions include requirements for submission of the following within specified times:

- Detailed Design including technical specifications for construction materials, liner, cover, and surface drainage management.
- Updated slope stability analyses.
- Updated Operation, Maintenance and Surveillance (OMS) Manual.
- As-Built Reports
- Updated Water Balance and Load Balances
- Updated plans for closure of Waste Rock Dump #6 including Waste Rock Dump #6 Cover Investigations and additional groundwater monitoring in the waste rock dump area.
- Surface Drainage Management, Sediments and Erosion Control Plan.

The approval conditions also require:

- That the till cover over the geomembrane be at least 1.3-m thick.
- Execution of inner and outer drain testing, monitoring and maintenance.
- Conduct of a clean fill assessment.
- Revegetation of the facility.

3.4 2013 Characterization

The following characterization work is ongoing at and relevant to the TDF:

- Geochemical sampling and testing to obtain information about the load balance of the TDF and other site facilities.
- Geotechnical and groundwater monitoring to obtain information about tailings properties and groundwater conditions at the TDF and other site facilities.
- Load and mass balance calculations to quantify the TDF and other site facility load and mass balances.

3.5 Site-Wide Closure Plan

The *2009 Reclamation and Closure Plan* (NVI Mining Ltd., 2009) included details of the proposed closure of the site. On the basis of comments and as requested by the regulators, a revised site-wide closure plan is being prepared. This plan will be submitted as required by July 2014.

Closure of the TDF will be addressed in the site-wide closure plan on the basis that such work is ongoing closure in support of final closure of the overall site.

In support of preparation of the site-wide closure plan, sampling and testing of TDF materials and other material and quantification of facility load and mass balance is in progress.

4 2013 OBSERVATIONS

4.1 GENERAL

The following are observations made by RGC during site visits in June, July, and September of 2013. Photographs are included to better document conditions.

4.2 UPGRADIENT DIVERSION

Runoff from upgradient areas is diverted to the east through an upgradient channel, known as the Lynx Diversion Ditch. The channel is of variable dimensions. As described in AMEC (2008), it is estimated that the channel could pass the 1 in 200 year 24-hour storm event rainfall.

In places the concrete lining is affected. The channel is subject to debris inflow and sedimentation accumulation. This channel is the subject of ongoing design evaluations and will likely be removed and replaced as part of closure construction.

In the opinion of the writers of this document, the channel as it is currently is not suitable as a permanent structure or as part of an overall closed facility. We believe the permit conditions and the decision by Nyrstar to replace this channel are correct decisions and courses of action.

Figure 1. The Upgradient Drainage Channel on the north side of the TDF. Note the shotcrete lining on the upgradient side. The light-colored material on the downstream side is gravel that accumulated in the channel and was subsequently removed from the channel.

4.3 Secondary Upgradient Diversion

To the east of the TDF is a steep channel also used to divert upgradient runoff water; this channel is known as the "Alder Reach". This channel was installed pursuant to recommendations in AMEC (2008) that a secondary ditch able to accommodate the 1 in 200 year 24-hour storm event be constructed.

The channel is cut into the hillside. It is unlined. The upslope side is cut steeply into consolidated clays. This cut currently appears to be stable: erosion is occurring and material from upgradient is raveling down into the channel. Debris and other rock accumulate in the channel.

The writers of this report were informed that this channel will be reconstructed as part of closure construction.

In the opinion of the writers of this report, this channel, while it may have played some part in controlling water around the TDF, is not a suitable permanent feature and the decision to reconstruct it as part of TDF closure is the correct decision.

Figure 2. The Secondary Upgradient Channel. Note the steep cut into consolidated clay on the upgradient side. Note also the accumulation of gravels and boulders in the channel.

4.4 Exposed Waste Rock

Waste rock dumps 1 and 6 to the north of the TDF rise at their natural angle of repose above the adjacent tailings surface. Note these rock dumps also underlie the tailings as shown in the Figure 3 below.

These dumps are stable at their natural angle of repose. Some erosion is occurring from the face of the dumps---eroded material moves to the surface of the paste tailings at the toe of the exposed dump faces.

The writers of this report were informed that in accordance with Hoffman (2013) the stability and cover for these dumps are being reevaluated and action will be taken in accordance with plans for the closure of the TDF.

While we are of the opinion that these dumps do not currently constitute a dam safety issue, we concur that as part of closure their stability and covering should be addressed.

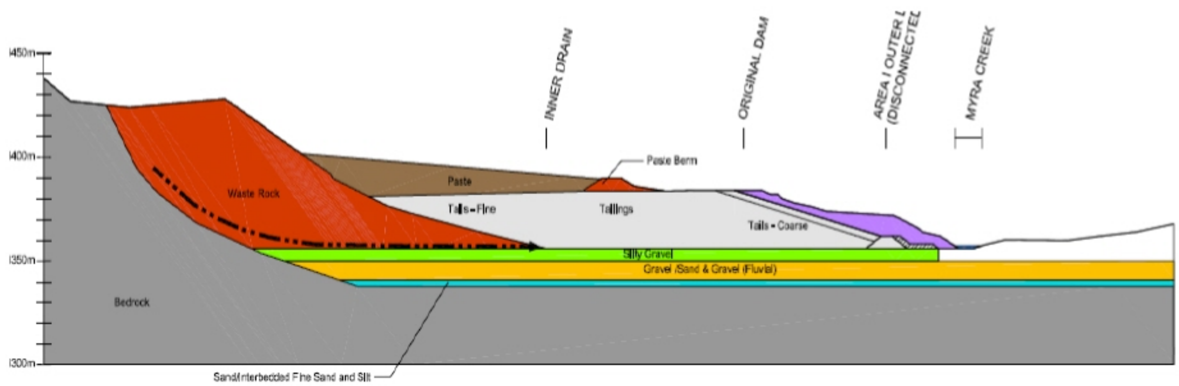


Figure 3. North to south cross section through the TDF. Note the waste rock dumps on the left side of the section. These dumps were initially placed against the hillside. Subsequently the tailings were placed up against these dumps. Note that the (purple) seismic stability berm to the right of the section has now been constructed to full height.

Figure 4. The TDF. Looking north from the hillside on the south side of the valley. Note the waste rock dumps are the orange-gray surface just below the trees at the base of the hillside. (See also Figure 5 for more detail.)

Figure 5. The south face of the waste rock dumps rising from the surface of the paste tailings area.

4.5 PASTE TAILINGS SURFACE

At the toe of the waste rocks dumps and extending to the south is the surface of the paste tailings (Figures 3 and 5). This area is sometimes referred to as the Amalgamated Paste Area (APA). The surface slopes gently from north to south. The paste tailings surface is eroded (Figure 6) with eroded material collecting at the south side of the surface up against and adjacent to the paste berm.

Runoff from the surface of the paste tailings generally flows downslope from north to south, and hence towards the west along the upgradient side of the paste berm (Section 4.6). Runoff is removed from the surface via the decant structure at the south-west corner of the upper surface of the paste tailings area (Figures 7-A to 7-C). The decant conveys water to the Super Pond.

No information is available about the capacity of the decant facility or of the ability of the upper surface of the paste tailings area to contain runoff except as noted in AMEC (2008) that the 1 in 200 year, 24-hour design storm should be accommodated.

This surface is to be regraded and covered as part of closure construction (Hoffman, 2013). The writers of this report concur that regrading, covering, and provisions for surface water management in accordance with closure plans should be undertaken.

Figure 6. Erosion of the upper surface of the paste tailings, looking from north to south.

Figure 7-A. The decant location at the south-west corner of the paste tailings area. The sand management area (Section 4.8) is to the west. At the bottom right of the photo are the steeper slopes of the waste rock dump.

Figure 7-B. The Amalgamated Paste Area decant facility as seen from the south-west corner of the area. Note surface water runs east to west in the channel to the right of the photo, then ponds to flow into the area of rock in the middle of which is the decant pipe leading to the Superpond.

Figure 7-C. The inlet to the decant pipe form the Amalgamated Paste Area. Note the wooden top. Water is intended to pass through the square openings in the pipe.

4.6 PASTE BERM

The paste berm retains the upgradient paste tailings and drains to the tailings surface to the south. On the upgradient side of the berm, the top of the berm is between one and two meters higher than the adjacent surface of the paste tailings. The downgradient height of the berm and its inclination varies (Figure 8). Generally there is a steeper (2:1) section about two meters high adjacent to a flatter sloping area falling to the surface of the old tailings.

There is no observed significant erosion or deformation of the berm. This berm will be regraded and covered as part of closure construction. The writers of this report concur that this is necessary and appropriate for closure.

Figure 8. The downgradient side of the paste berm. Note the variable slope inclination leading to the tailings surface on the left side of the photo.

4.7 OLD TAILINGS

To the south and just downgradient of the paste berm is the surface area of the old tailings and upper surface of the seismic berm. This area is sometimes referred to as the Strip Area. .

Surface water runoff from this area generally flows from east to west into the decant facility. (Figure 9).

Figure 9. The Strip Area looking east. Surface water runs in the "channel' to the decant facility, which is seen in the foreground of the photo.

Parts of the surface of this area just downgradient of the paste berm were observed to be wet and soggy. No rain had fallen in the period immediately preceding observations. It is not known if the wet areas are the result of seepage from the paste area, or represent upward seepage associated with possible tailings drainage. The authors of this report are informed that this condition is being evaluated by others as part of the compilation of a new slope stability analysis. We concur that this is necessary and appropriate.

Figure 10-A. The toe of the paste berm looking west. This is the general area where wet and soggy conditions were observed on the flat surface at the toe of the berm.

Figure 10-B A close-up view of the affected surface. Note there was no standing water, simply wet and soggy tailings.

4.8 Top of Seismic Berm

When observed, construction work was in progress to regrade the surface of this area and the top of the recently completed seismic buttress. The area was variously undulating and rough. Incident precipitation would pool in low points or flow to the edge of the seismic berm and hence down the outer face of the berm.

Because of the active regrading of the area, no erosion or cracking (if any) was observed.

The writers of this report were informed that the surface is being regraded prior to covering in accordance with closure plans, and hence provisions for surface water management.

Figure 11. The top surface of the old tailings and seismic buttress. The surface was being regraded to comply with closure requirements.

4.9 Sand Management

Cyclone underflow sand is placed, as part of temporary storage, into the sand management area to the south west of the TDF. The quantity of sand in the area varies as demand for sand for underground backfilling varies and as the use of the sand for construction varies. The ability of the sand area to retain water from upgradient runoff and incident precipitation accordingly varies. The perimeter berms are kept at least one meter above the sand, and in accordance with AMEC (2008) this is considered sufficient to retain the 1 in 200 year, 24-hour storm event. Water passes from the sand area via a dedicated decant to the Super Pond.

The sand area is part of TDF closure area. It will be reclaimed as and when other facilities to stockpile the sand can be established.

Figure 12. General view of the sand area looking from east to west.

4.10 Seismic Berm

The seismic berm was constructed on the south side of the TDF in order to provide for stability of the TDF in the event of large earthquakes. The analysis of the stability of the berm and its design are documented in Klohn Crippen Consultants Ltd. (1999a) and (2004a), and AMEC (2011). The latter presentation notes factors of safety for the TDF for various earthquakes that are consistent with industry standards. The presentation also notes "Even with adequate factor of safety, some liquefaction-related deformation is anticipated in the APA and TDF following the MCE." The calculated deformation under the most extreme seismic loading by the Maximum Credible Earthquake, is that "the berm will horizontally translate about 3 m to 4 m into Myra Creek and the tailings surface at the berm will vertically drop 1.5 m to 2.0 m." This deformation has been calculated using standard procedures and is consistent with similar calculated deformation for other facilities in high seismic areas.

In terms of Hoffman (2013) "Updated slope stability analyses shall be undertaken to complete the detailed closure design for the TDF." In the opinion of the writers of this report, such a course is necessary and appropriate.

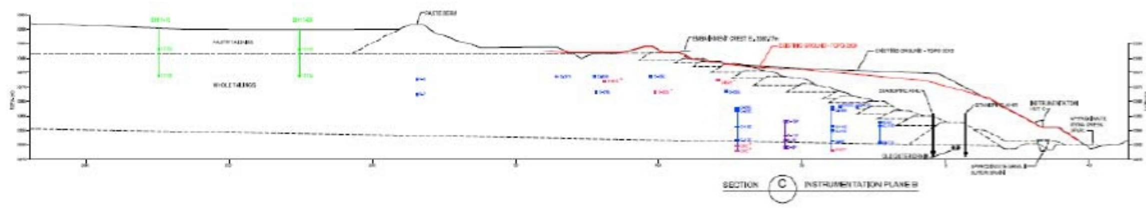


Figure 13. Cross section of the seismic berm (from AMEC, 2011.) Note the seismic berm is to the right of the section and is constructed over the previous outer face of the TDF.

4.11 South Face of TDF

The downstream face of the recently constructed seismic berm is subtended by an access path and Myra Creek. New vegetation has been established on the face of the berm. Minor erosion was observed near the upper crest of the berm.

Figure 14. The outer face of the seismic berm, looking north. Note from left to right: Myra Creek; the toe access road; and the sloping face of the berm with new vegetation.

There is a rock spillway on the south face of the seismic berm. It was constructed to be part of the surface water management system and to serve as an operational spillway. We were informed that adequate filters were not placed between the erosion control rock and the underlying materials at the north end of the spillway; and that accordingly the upper portion of the spillway is to be removed and replaced as part of closure construction.

Figure 15. South face of seismic berm. Note the large boulders that constitute the spillway just to the left of the photo.

4.12 PUMPHOUSE #4

The underdrains of the TDF drain to a sump in the Pumphouse #4 building. Seepage from the underdrains is collected in this sump and returned to the Superpond.

Figure 16. The Pumphouse 4 Building.

5 FINDINGS

On the basis of reading reports (as referenced) and on the basis of site observations (Section 4), RGC makes the following findings regarding the safety of the TDF:

- The TDF was constructed and operated in accordance with the designs and plans.
- The TDF is maintained in accordance with the *Operations, Maintenance and Surveillance Manual*.
- An emergency response plan is in place as documented in the *Emergency Management Program.*
- There are no observable conditions that warrant immediate action or response. Except, as follows and noted in the body of this report:
  - Current surface water management facilities are in a state of construction, redesign, and/or maintenance. They cannot be considered to be in accordance with current best practice. Accordingly they should be upgraded and construction completed as soon as possible.
  - The factors of safety from previous stability analyses appear to be in accordance with industry standards. The deformation in the event of a large earthquake is not insignificant. Accordingly, the stability reports being prepared as part of closure planning should be compiled as soon as practical.
- Closure of the TDF as soon as practical is necessary and appropriate. This must be done in accordance with designs currently being formulated. In particular, provision must be made for surface water management, covers, overall stability, seepage control and revegetation.

6 CLOSURE

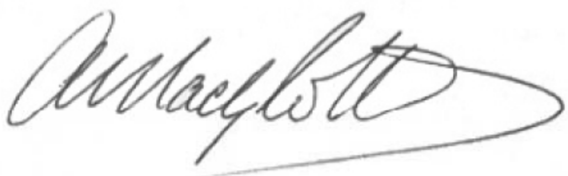
Robertson GeoConsultants Inc. (RGC) is pleased to submit this report entitled Myra Falls Old Tailings Disposal Facility 2013 Dam Safety Review.

This report was prepared by Robertson GeoConsultants Inc. for the use of Nystar Myra Falls, Ltd. .

We trust that the information provided in this report meets your requirements at this time. Should you have any questions or if we can be of further assistance, please do not hesitate to contact the undersigned.

Respectfully Submitted,

ROBERTSON GEOCONSULTANTS INC.



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Principal

J Caldwell. M.Sc.(Eng.)
Civil Engineer

7 REFERENCES

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On the basis of reading reports and on the basis of site observations, this report documents the reasons for the following findings regarding the safety of the TDF:

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- The Lynx TDF is maintained in accordance with the *Operations, Maintenance and Surveillance Manual.*
- An emergency response plan is in place as documented in the *Emergency Management Program.*
- In the opinion of the writers of this report, the approved documents represent design, construction, and operation approaches that meet the standards of practice commensurate with a structure of this nature and hazard rating.
- There are no observable conditions that warrant immediate action or response.

Figure ES-1. *Aerial view of the Myra Falls mine showing the Lynx TDF on the left. The darker gray surface is the top of the tailings; the light gray to the right of the tailings is the embankment dam of rockfill; the brown and gray mottled areas to the upper left of the tailings are the steep slopes of bedrock and the waste rock piles above the Lynx TDF. (From AMEC 2013a)*

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The Myra Falls mine is Mine No. 0800007 as numbered by the B.C. Ministry of Energy and Mines.

2.3 DAM CATEGORY

The TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur. As noted in the Water Act, British Columbia Dam Safety Regulation, Schedule 1, Definitions, a high hazard structure involves the following:

- Population at Risk: Permanent
- Consequences of Failure:
    - Loss of Life: 10 or fewer
    - Environmental and cultural values: Significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat. (b) rare or endangered species, or (c)

unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.

- Infrastructure and economics: High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.

2.4 HISTORY

The history of the TDF design, construction, and operation is described in the references—see in particular AMEC (2008b). In brief:

- The original design of the Lynx TDF was prepared in 2001. The design included backfilling of the worked-out Lynx Open Pit and construction of a rockfill embankment to increase the capacity of the pit for the disposal of paste tailings.
- The Lynx Starter Berm initial construction to El 3385 m was completed in 2006.
- The design was revised in 2008 to account for the presence of old mine workings beneath the pit.
- The Lynx Starter Berm was completed to El. 3389 m in 2011.
- The first raise of the berm to El. 3392 m was done in 2011 and the second raise of the berm to EL. 3396 m was done in 2012.

2.5 2012 REPORTS

Reports on work at and the condition of the Lynx TDF as of late 2012 include:

- AMEC (2013a) *Myra Falls Tailings Storage Facilities 2012 Annual Dam Status Report.*
- AMEC (2013b) *Myra Falls Tailings Storage Facilities 2012 Construction Report*.
- Nyrstar (2012) *Annual Environmental Report 2012.*

Specifically the 2012 Construction Report (AMEC, 2013b) notes the following work undertaken in 2012:

- Dam raise from El. 3392 m to El 3396.1 m, concentrated on the east arm of the dam as the western arm was already near design grade at the beginning of the construction season.
- Construction of a temporary east abutment to tie the east end of the structure into exposed natural ground prior to additional excavation of waste rock from the final alignment.
- Excavation of all material within the Waste Dump #5 (Super Pile) for use in the Lynx TDF alignment.
- Stockpiling of underground mine waste and reclaimed sand within previous Super Pile location for use in construction of the 2013 Lynx TDF dam raise.

2.6 2013 Construction

During 2013, paste tailings deposition continued and the embankment dam was raised to El. 3398.8 m. This is anticipated to provide tailings capacity through 2014.

The zone of cracked embankment as described in AMEC (2013b) was remediated. The report on 2013 construction is being prepared by AMEC.

2.7 Design Criteria

AMEC (2013a) lists these design criteria for the Lynx TDF:

- Flood Storage: Sufficient capacity to store the 1,000-year return period, 24-hour duration storm event.
- Dam Stability: Short-term factor of safety FOS equal to or greater than 1.3; Long-term, steady-state factor of safety equal to or greater than 1.5.
- Earthquake Dam Stability: Acceptable levels of deformation for the Maximum Credible Earthquake. These are noted in AMEC 2013b to be less than 0.6 m during the operational phase.

2.8 Lynx TDF Layout

Figures 1 and 2 show the general layout and cross section of the Lynx TDF. They are reproduced from AMEC (2013b).

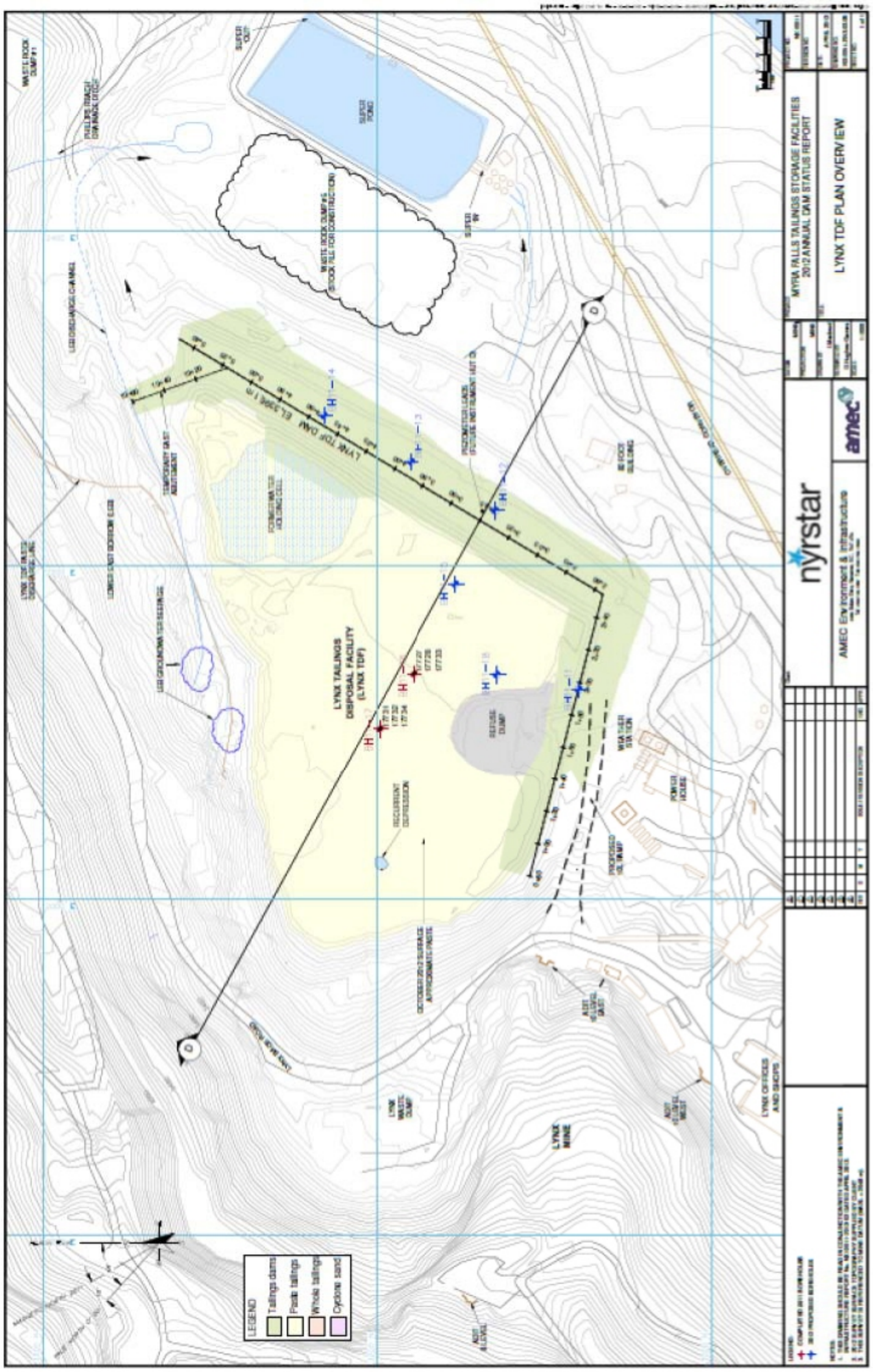


Figure 1. *The Layout of the Lynx TDF. The green shading is the rockfill embankment dam on the downgradient perimeter of the old Lynx open pit. The yellow shading is the top surface of the deposited tailings.*

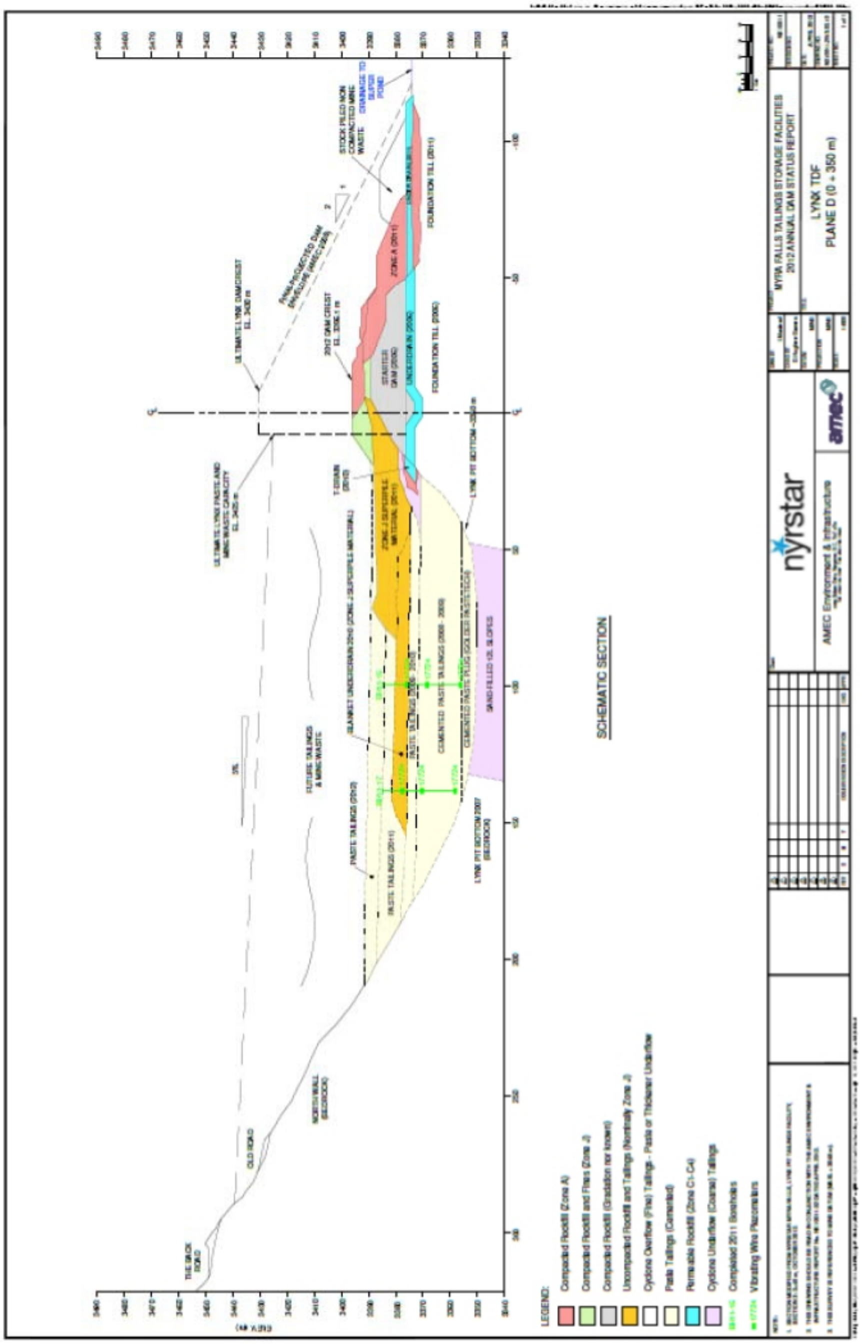


Figure 2. *Cross section through the Lynx TDF tailings and embankment dam. Only the upper surface of the tailings, the Zone J Fines, and the outer face of the Zone A rockfill are visible in practice. It is not possible to observe the various cemented tailings, Zone J Superpile material, or the underdrain.*

3 2013 OBSERVATIONS

3.1 GENERAL

The following are observations made by RGC during site visits in June, July, and September of 2013. Photographs are included to better document conditions.

3.2 CURRENT STATUS

Currently the TDF is in use for disposal of paste tailings. The facility is maintained by Nyrstar in terms of the *Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual,* NVI (2010) and the *Emergency Management Program,* Nyrstar (2013).

3.3 EMBANKMENT DAM

When observed in June 2013, there was extensive cracking along the downstream crest (Figure 3).

Figure 3. *Cracking along the downstream crest of the embankment as observed in June 2013. The cracked zone was, reportedly, removed and replaced as part of 2013 embankment raising.*

When observed in September 2013, raising of the embankment dam had just been completed. The authors of this report were informed that the zone of cracking was removed and replaced as part of the embankment raising. No cracking of the embankment was observed (Figures 4 and 5).

Construction was done under the management of Myra Falls staff by the contractor, Upland Excavating Ltd. Engineering oversight was provided by AMEC who are also the engineers of record for the design of the raise.

***Figure 4**. Looking west to east along the downstream crest of the embankment dam in September 2013. To the left of the crest line is the top of the embankment, which is a compacted surface of waste rock. To the right of the crest line is the downstream face of the embankment which is also compacted waste rock.*

Figure 5. *The access road along the toe of the embankment. To the bottom left of the picture is the inclined downstream face of the embankment. Above, and to the right of the access road are various material stockpiles and other facilities that will be removed to make way for the embankment as, in the future, additional embankment raising is undertaken.*

3.4 ONGOING STUDIES

At the time of writing this report, work is in progress to define the groundwater and geochemical conditions of the Myra Falls site and of the Lynx TDF.

3.5 FILTER ZONE

The top surface of the upstream filter zone was observed (Figure 6). The material is finer than the rockfill and in appearance suitable for its design purpose—controlling migration of tailings into the voids of the embankment rockfill. On the upstream side of the filter zone is either paste tailings or sand (Figures 7 and 8).

Figure 6. *Looking west to east along the upstream crest of the embankment. To the left is the compacted finer-grained material of the filter zone; to the right is the top surface of the compacted waste rock.*

Figure 7. *Looking west to east along the upstream crest of the embankment. To the left is the surface of the tailings*

Figure 8. *Looking east to west along the upstream crest of the embankment. Sand is deposited from the pipe in order to control the beach and hence to push standing water back and away from the embankment.*

3.6 TAILINGS SURFACE

The topography of the tailings surface is controlled by the discharges into the area, including the paste tailings line, the sand line, and overflow from the Super Pond dredging (Figures 9 and 10).

***Figure 9**. Looking from the crest of the embankment to the north-east across the surface of the tailings. In the foreground is sand, and behind this is the wet upper surface of tailings. Rising from the surface of the tailings are the natural bedrock slopes and waste rock dumps above the Lynx TDF.*

***Figure 10**. Looking from the crest of the embankment to the northwest across the surface of the tailings. Rising from the surface of the tailings are the natural bedrock slopes and waste rock dumps above the Lynx TDF*

3.7 Refuse

Mine refuse is deposited into the tailings (Figure 11). In essence as the tailings surface rises, the tailings surround and encapsulate the individual refuse items.

Figure 11. *The truck has just dumped refuse at the right-hand end of the road that slopes down to the tailings surface. Note also the significant difference in elevation shown here between the top of the tailings and the crest of the embankment.*

3.8 Freeboard

Because of the recent raising of the embankment there is significant freeboard (Figure 11). As of August 29, 2013 the reported elevation of the tailings surface against the embankment was 3393.2 m and the elevation of the embankment crest was 3398.8 m. This freeboard (5.6 m) will reduce as tailings are deposited and the surface of the tailings rises. The design operating freeboard is such that there is sufficient volume to retain 78,000 m^3 of precipitation and runoff plus an additional 0.5 m provision for wind and wave action (AMEC 2008b).

3.9 Bedrock Seepage

Towards the east end of the north side of the Lynx TDF, there is seepage from the bedrock (Figure 12). The seepage is directed to a channel formed on the north side by the bedrock and on the south side by piled-up waste rock (Figures 13 and 14).

We were informed that a rock-filled drain will be constructed to collect the bedrock seepage and direct it east where it will exit the Lynx TDF embankment.

***Figure 12**. Seepage from joints in the bedrock on the north side of the Lynx TDF. Flow quantities vary in response to precipitation. The zone of bedrock seepage is relatively large and extends some meters up the slope.*

***Figure 13.** The channel to the east end of the north side of the Lynx TDF. The channel is formed of the bedrock and piled-up waste rock, Seepage is collected in the channel and flows east.*

***Figure 14**. Looking west along the access road on the south side of the channel.*

3.10 Upgradient Diversion

Upgradient diversion of surface waters is partially achieved by the roads and channels upgradient of the Lynx TDF in the area to the north of the facility (Figure 15).

***Figure 15**. The slopes upgradient and to the north of the Lynx TDF. Some interception and diversion of runoff is achieved via the roads and channels of this area.*

3.11 FOUNDATION DRAINAGE SYSTEM

There are drains beneath the starter dam (Figure 2). Water from the drains is reported to seep to the shotcrete lined ditch at the upstream end of the water treatment system (Figure 16). We could not observe this as the elevation of the discharge is approximately 0.6 m beneath the rockfill cover.

Figure 16. *The area downstream of the embankment where tailings bleed water may report via an underdrain at the base of the starter dam.*

3.12 Pool Water Control

Supernatant water on the surface of the tailings is removed, as required, by pumps (Figure 17).

Figure 17. *A pump used to remove supernatant water from the surface of the tailings.*

4 FINDINGS

On the basis of reading reports (as referenced) and on the basis of site observations (Section 3), RGC makes the following findings regarding the safety of the TDF:

- The Lynx TDF is being constructed and operated in accordance with the designs and plans.
- Construction and operation of the Lynx TDF will continue for many years hence. This may be done in accordance with the designs and plans.
- The Lynx TDF is maintained in accordance with the *Operations, Maintenance and Surveillance Manual.*
- An emergency response plan is in place as documented in the *Emergency Management Program.*
- There are no observable conditions that warrant immediate action or response.
- There are no observable conditions that give rise to a concern about risk or component malfunction.
- In the opinion of the writers of this report, the approved documents represent design, construction, and operation approaches that meet the standards of practice commensurate with a structure of this nature and hazard rating.

5 CLOSURE

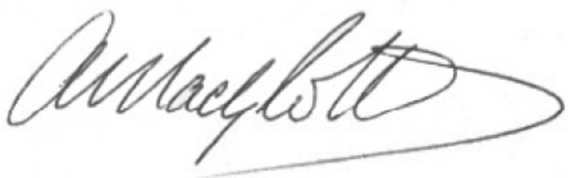
Robertson GeoConsultants Inc. (RGC) is pleased to submit this report entitled Myra Falls Lynx Tailings Disposal Facility 2013 Dam Safety Review.

This report was prepared by Robertson GeoConsultants Inc. for the use of Nystar Myra Falls, Ltd. .

We trust that the information provided in this report meets your requirements at this time. Should you have any questions or if we can be of further assistance, please do not hesitate to contact the undersigned.

Respectfully Submitted,

ROBERTSON GEOCONSULTANTS INC.



Andrew Robertson, P. Eng. PhD.
Principal

J Caldwell. M.Sc.(Eng.)
Civil Engineer

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REPORT NO. 212003/1

MYRA FALLS OLD TAILINGS DISPOSAL FACILITY
2013 DAM SAFETY REVIEW

Rev 1

Submitted to:

Nyrstar Myra Falls Ltd.
Myra Falls Operations
P.O. Box 8000, Campbell River
British Columbia, Canada V9W 5E2

Prepared by:

Robertson GeoConsultants Inc.
Consulting Engineers and Scientists for the Mining Industry
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February 2014

EXECUTIVE SUMMARY

This is the 2013 Dam Safety Report on the Myra Falls Old Tailings Disposal Facility (TDF). The report is prepared by Robertson GeoConsultants (RGC) at the request of Nyrstar Myra Falls Ltd.

The TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur.

The history of the TDF design, construction, and operation is, in brief: the TDF was designed in 1982; construction of starter works done in 1982 to 1984; and the facility was operated until 2011. Construction of a seismic upgrade berm was completed in 2013.

Currently the TDF is not in use for disposal of tailings. The facility is maintained by Nyrstar in terms of the *TDF, Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual*. An *Emergency Management Program* is in place.

The *2009 Reclamation and Closure Plan* included details of the proposed closure of the TDF. An application for amendment of Permit M-26, entitled *Nyrstar Myra Falls Tailings Disposal Facility Closure Plan* dated February 2012 was filed with the Chief Inspector of Mines on March 19, 2012 in accordance with Section 10(6) of the Mines Act. Plans for closure of the TDF were approved on July 16, 2013 by the Chief Inspector of Mines in the *Permit Amendment Approving Conceptual TDF Closure Plan*.

A revised site-wide closure plan is being prepared for submission by July 2014. Closure of the TDF will be addressed in the site-wide closure plan on the basis that such work is ongoing closure in support of final closure of the overall site. In support of preparation of the site-wide closure plan, geotechnical and geochemical sampling and testing of TDF materials (tailings and waste rock) and quantification of facility contaminant load and mass balance is in progress.

On the basis of reading reports and on the basis of site observations, this report documents the reasons for the following findings regarding the safety of the TDF:

- The TDF was constructed and operated in accordance with the approved designs and plans.
- The TDF is maintained in accordance with the approved *Operations, Maintenance and Surveillance Manual.*
- An approved emergency response plan is in place as documented in the *Emergency Management Program.*
- In the opinion of the writers of this report, the approved documents represent design, construction, and operation approaches that meet the standards of good practice commensurate with a structure of this nature and hazard rating.
- There are no observable conditions that warrant immediate action or response.

- Closure of the TDF as soon as practical is necessary and appropriate. This must be done in accordance with designs currently being formulated. In particular, provision must be made for surface water management, covers, overall stability, seepage control and re-vegetation.
- We do not believe, however, that is would be correct to say that the Old TDF is "reasonably safe" or that it conforms to established dam safety management practices. As noted in this report, we believe that the closure works are needed to bring the Old TDF into a condition where it may be considered to be reasonably safe. Pending completion of closure works, there are risks that we do not consider it reasonable to tolerate.

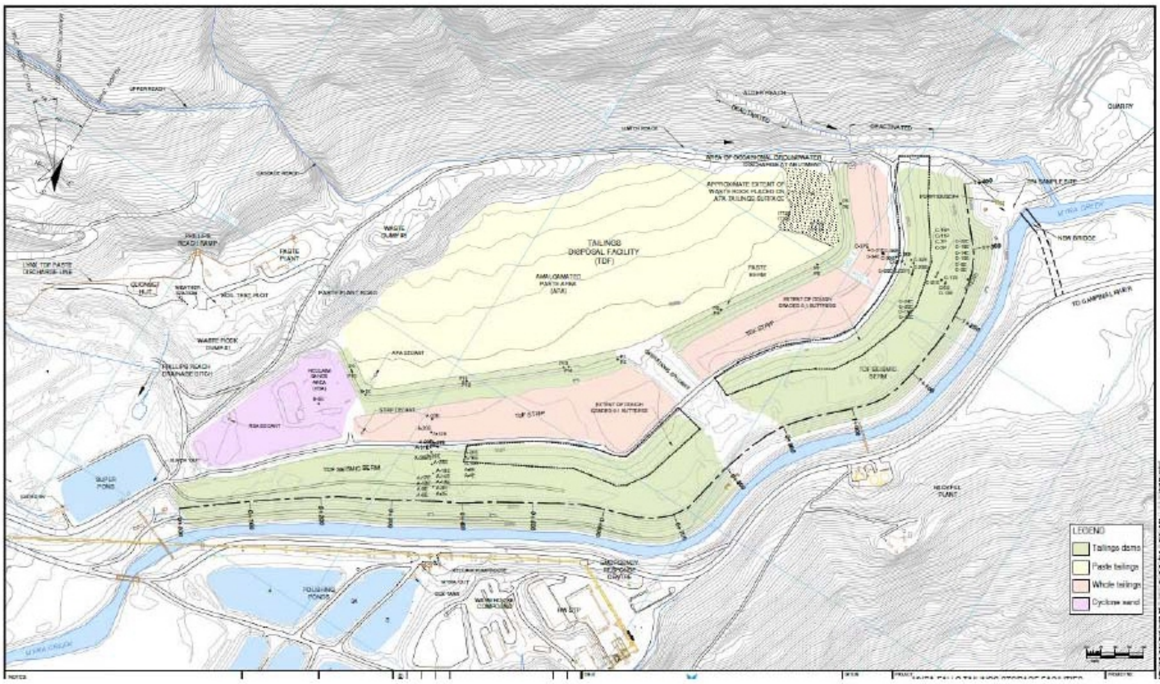

Figure ES1. The general layout of the TDF. The yellow shading denotes the paste tailings surface area; the pink shading denotes the old slurry tailings surface area; the purple shading denotes the reclaim sand area (RSA); the green shading denotes sideslopes—the northern one being the paste berm sideslopes and the southern one being the seismic berm sideslopes; Blue shading is Myra Creek.

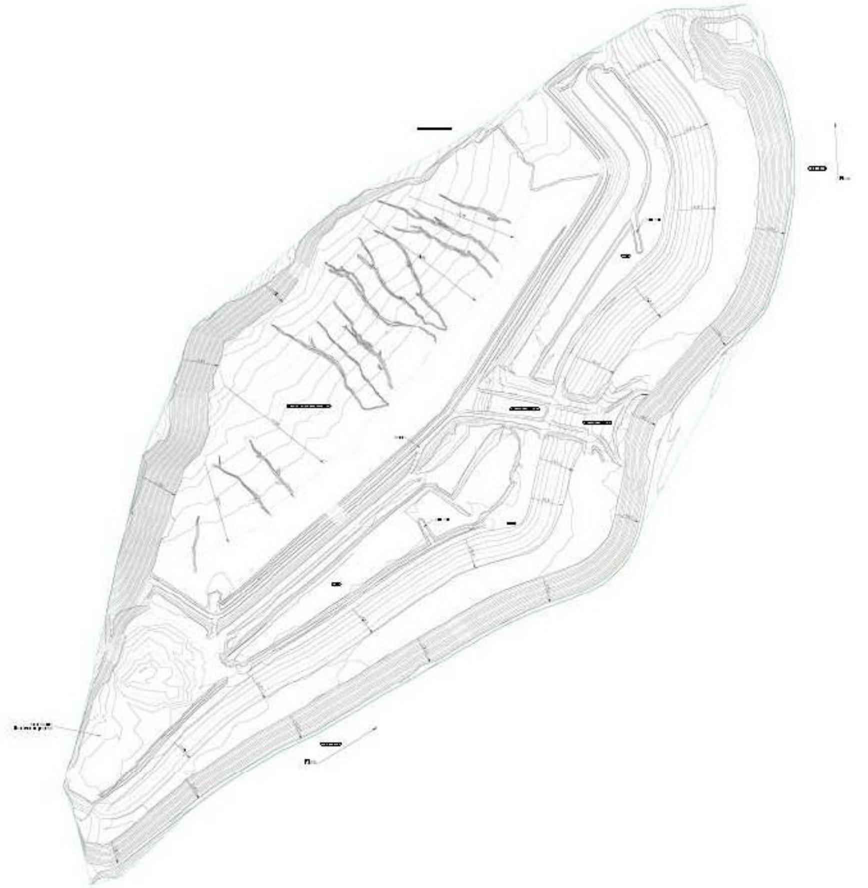

Figure ES-2. A copy of the mid-2013 topographic survey of the Old TDF. While not legible here, the original (large-scale drawing, not included with this report) provides contour elevations, freeboards, and the inclinations of the sideslopes of berms.

REPORT NO. 212003/1

MYRA FALLS OLD TAILINGS DISPOSAL FACILITY
2013 DAM SAFETY REVIEW

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MYRA FALLS OLD TAILINGS DISPOSAL FACILITY

2013 DAM SAFETY REVIEW

1 INTRODUCTION

This is the 2013 Dam Safety Report on the Myra Falls Old Tailings Disposal Facility (TDF). The report is prepared by Robertson GeoConsultants (RGC) at the request of Ivor McWilliams, Environmental Manager, on behalf of Paul Laframboise, Mill and Surface Manager, both of Nyrstar Myra Falls Ltd.

2 FACILITY DESCRIPTION

2.1 GENERAL

This section describes the TDF design, construction and operation up to and including 2012. The descriptions are based on information in the references.

2.2 LOCATION

The TDF is on the Myra Falls Mine which is in Strathcona Provincial Park, Vancouver Island, British Columbia. The mine is in the asserted traditional territories of the We Wai Kai, Wei Wai Kum, K'omoks and Mowachaht/Muchalaht First Nations.

The Myra Falls Mine is Mine No. 0800007 as numbered by the B.C. Ministry of Energy and Mines.

2.3 HISTORY

The history of the TDF design, construction, and operation is described in the listed references. In brief: the TDF was designed in 1982; construction of starter works done in 1982 to 1984; and the facility was operated until 2011. Construction of a seismic upgrade berm was completed in 2013.

2.4 DAM CATEGORY

The TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur. As noted in the Water Act, British Columbia Dam Safety Regulation, Schedule 1, Definitions, a high hazard structure involves the following:

- Population at Risk: Permanent

- Consequences of Failure:
  - Loss of Life: 10 or fewer
  - Environmental and cultural values: Significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat. (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.
  - Infrastructure and economics: High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.

Classification as a high hazard structure is considered reasonable and appropriate. In practice there is no permanent population at risk; only mine workers or visitors to the mine site might be affected. It is certainly true that fewer than ten people could loose their lives in the event of a catastrophic failure. There could be significant impact on fish habitat in Myra Creek and Buttle Lake. Only the local road to the mine and recreational areas around the mine would be affected. Depending on the nature of the failure, tailings could be washed down Myra Creek to Buttle Lake.

The Canadian Dam Association dam classification categories are essentially similar to those noted above for the British Columbia Dam Safety Regulations. Except that the Canadian Dam Association refers to "restoration or compensation in kind highly possible."

Both classification systems envisage what may be called a total failure of the dam, as could occur for a water-retaining reservoir, namely a breach of the retaining embankment and flow of all water from the reservoir to the receiving environment. In practice the Old TDF is unlikely to undergo so total a failure. Even in the event of major storms or earthquakes it is reasonable to envisage some breach of the perimeter slopes and possibly some egress of some of the tailings to Myra Creek and hence to Buttle Lake. But it is most unlikely that even major storms or earthquakes could result in immediate or even short-term loss of all tailings from the facility to Buttle Lake. On this see the Section 7 on risk assessment.

It could be argued that a lower category, namely significant consequence classification may be appropriate. Reasons include: the low potential for multiple loss of life in the event of failure; no significant loss or deterioration of habitat, species, or sites of cultural significance; and low economic losses affecting limited infrastructure etc. In particular, if one considers reasonable failure modes such as breach of the perimeter slopes due to rain, or significant earthquake-induced deformation, it could be argued that only limited release of tailings could occur. If this perspective prevailed a lower category could well be justified.

It would not be reasonable to assign a higher dam failure consequences classification to the facility. There is no permanent population at risk. It is hard to conceive how one hundred people could loose their lives. There would not be very high economic losses affecting important infrastructure, public transport, commercial facilities, or severe damage to residential areas.

In conclusions on the topic of dam safety category, it is considered reasonable and prudent to retain the high hazard classification. This is conservative, and focusses one's attention on the fact that this is a significant structure that merits attention.

2.5 Design Criteria

The following are the design criteria for the Old TDF as noted in the *TDF Operation, Maintenance and Surveillance Manual* Nyrstar (2010)

Aspect	Criteria
Flood storage and freeboard (during operations)	Sufficient capacity to store the 200-year return period, 24-hour duration storm in flow event, assuming the Lynx Diversion Ditch is not breached. An emergency spillway at STA 0+ 800 m would be utilized during an event in excess of the 200 year flood and/or if the Lynx Diversion Ditch is overtopped. The spillway is designed to handle the 1000 year return period, 24-hour storm event under the assumption that Diversion Ditch is overtopped during such an event.
Flood storage and freeboard (closure)	The operational spillway will also function as the closure spillway, however a clean cap will be required as part of the closure plan. The upper portion of spillway will need to be rebuilt at that time.
Dam stability (static loading conditions)	Defined as factor of safety (FoS) derived from limit equilibrium stability analysis. Governing criteria as follows - Short term, end-of-construction conditions (with construction-induced pore pressures within the core of the dam): FoS $\geq$ 1.3. Long term, steady state (closure) conditions: FoS $\geq$ 1.5. Design is governed by short term or temporary conditions, meaning that over the long term FoS values in excess of 1.5 are projected.
Dam stability (design earthquake loading conditions)	Design earthquake for both operations and closure phases is the Maximum Design Earthquake (MDE) equal to 50% of the Maximum Credible Earthquake (MCE) peak horizontal ground acceleration (PGA) and the full moment magnitude. The MDE is estimated to have the following characteristics - Moment Magnitude = M 7.5 and

	Peak Horizontal Ground Acceleration (PGA) = 0.30 g Design FoS for post-seismic conditions FoS $\geq$ 1.1.

AMEC (2013c) notes the following design criteria for the Old TDF:

> The seismic upgrade was designed by Klohn Crippen to increase the resistance of the TDF against a catastrophic post-seismic flowslide failure of the liquefied tailings embankment into Myra Creek. The design criteria established in the Klohn Crippen 1999 original design were in accordance with the 1999 Canadian Dam Association guidelines. The seismic design criteria for the upgrade consisted of the Operating Basis Earthquake during mine operation, consisting of a 475 year return period earthquake having a peak ground acceleration (PGA) of 0.20 g; and [for closure] the Maximum Design Earthquake (MDE), consisting of the greater of a 1,000 year return period earthquake or 50% of the Maximum Credible Earthquake (MCE). The MDE was set at a PGA of 0.30 g. For hydraulic structures, the corresponding design criteria consisted of the 200 year return period peak flow for operating structures and the 1,000 year return period peak flow for closure structures.

AMEC (2013c) also notes:

> AMEC concludes that the TDF Seismic Upgrade project is complete and satisfies its design intent with respect to the slope stability factor of safety given a MDE with a PGA of 0.30 g. The TDF has a minimum calculated post-seismic global factor of safety of 1.1 and a post-seismic factor of safety of 1.25 for failures passing through the Outer Drain. Correlation of limit equilibrium stability modeling to dynamic finite element modeling predicts an associated toe displacement of the Seismic Upgrade Berm of 3 m or less.

The design criteria for the operating period were, presumably, considered appropriate for a high hazard structure at the time they were adopted. If the structure were still being operated (which it is not) then it is noted that these criteria may be considered insufficient and possibly not in line with current criteria adopted in the industry for similar structures. RGC would have recommended an upgrade of the criteria had the structures still been in operation.

The Old TDF is soon to be closed. As noted above, the criteria for closure works include:

- ***Seismic***: Maximum Design Earthquake (MDE), consisting of the greater of a 1,000 year return-period earthquake or 50% of the Maximum Credible Earthquake (MCE). The MDE was set at a PGA of 0.30 g.
- ***Precipitation***: On the basis of a study updating the site precipitation, AMEC (2012b), the following has been adopted for design of closure surface water management facilities

(O'Kane 2014) "The updated 1 in 1,000 year, 24-hour design rainfall event is 236 mm. Given the rainy season on the mine site also coincides with spring-melt, an additional volume of water should be included in the design storm event to account for snowpack melt. AMEC (2012b) determined the potential snowpack melt to be 17 mm using information contained in MOE (1991). Therefore, the 1 in 1,000 year, 24-hour design storm value used to develop a final design for TDF drainage channels is 253 mm."

Thus we may conclude that current design criteria regarding seismicity and precipitation are inadequate. Closure of the Old TDF to the proposed criteria is necessary and appropriate. This will be discussed further in the *Site-Wide Closure Plan* (to be submitted in July 2014).

2.6 2012 Reports

Reports on work at and the condition of the TDF as of late 2012 include:

- AMEC (2013a) *Myra Falls Tailings Storage Facilities 2012 Annual Dam Status Report.*
- AMEC (2013b) *Myra Falls Tailings Storage Facilities 2012 Construction Report*.
- AMEC (2013c) *Myra Falls TDF Seismic Upgrade Project, Final As-Built Report*. 20 December 2013
- Marsland Environmental Associates (2011) *Myra Falls Operations Report on the TDF Under Drain, 2010*.
- Nyrstar (2012) *Annual Environmental Report 2012.*

3 CURRENT STATUS

3.1 General

This section describes the current i.e., 2013, status of the TDF. The descriptions are based on information in the references, discussions with Nyrstar personnel and site observations.

3.2 Current Status

Currently the TDF is not in use for disposal of tailings. The facility is maintained by Nyrstar in terms of the *TDF, Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual,* Nyrstar (2013b) and the *Emergency Management Program,* Nyrstar (2013a).

3.3 TDF Reclamation and Closure Plan

The *2009 Reclamation and Closure Plan* (NVI Mining Ltd. 2009) included details of the proposed closure of the TDF. An application for amendment of Permit M-26, entitled *Nyrstar Myra Fall Tailings Disposal Facility Closure Plan* dated February 2012 was filed with the Chief Inspector of Mines on March 19, 2012 in accordance with Section 10(6) of the Mines Act.

Plans for closure of the TDF were approved in 2013 by the Chief Inspector of Mines (A. Hoffman, 2013) in the *Permit Amendment Approving Conceptual TDF Closure Plan.* The approval conditions include requirements for submission of the following within specified times:

- Detailed Design including technical specifications for construction materials, liner, cover, and surface drainage management.
- Updated slope stability analyses.
- Updated Operation, Maintenance and Surveillance (OMS) Manual.
- As-Built Reports
- Updated Water Balance and Load Balances
- Updated plans for closure of Waste Rock Dump #6 including Waste Rock Dump #6 Cover Investigations and additional groundwater monitoring in the waste rock dump area.
- Surface Drainage Management, Sediments and Erosion Control Plan.

The approval conditions also require:

- That the till cover over the geomembrane be at least 1.3-m thick.
- Execution of inner and outer drain testing, monitoring and maintenance.
- Conduct of a clean fill assessment.
- Revegetation of the facility.

3.4 2013 Characterization

The following characterization work is ongoing at and relevant to the TDF:

- Geochemical sampling and testing to obtain information about the load balance of the TDF and other site facilities.
- Geotechnical and groundwater monitoring to obtain information about tailings properties and groundwater conditions at the TDF and other site facilities.
- Load and mass balance calculations to quantify the TDF and other site facility load and mass balances.

3.5 Site-Wide Closure Plan

The *2009 Reclamation and Closure Plan* (NVI Mining Ltd., 2009) included details of the proposed closure of the site. On the basis of comments and as requested by the regulators, a revised site-wide closure plan is being prepared. This plan will be submitted as required by July 2014.

Closure of the TDF will be addressed in the site-wide closure plan on the basis that such work is ongoing closure in support of final closure of the overall site.

In support of preparation of the site-wide closure plan, sampling and testing of TDF materials and other material and quantification of facility load and mass balance is in progress.

4 2013 OBSERVATIONS

4.1 GENERAL

The following are observations made by RGC during site visits in June, July, and September of 2013. Prior to and subsequent to the site visits we read the documents listed in the references list. During the site visits, we were accompanied by and interviewed Nyrstar personnel and Old TDF operating staff. We have interviewed Dan Hughes-Games, P. Eng. of AMEC who is the engineer of record for the design and operation of the Old TDF.

4.2 UPGRADIENT DIVERSION

Runoff from upgradient areas is diverted to the east through an upgradient channel, known as the Lynx Diversion Ditch. The channel is of variable dimensions. As described in AMEC (2008), it is estimated that the channel could pass the 1 in 200 year 24-hour storm event rainfall.

In places the concrete lining is affected. The channel is subject to debris inflow and sedimentation accumulation. This channel is the subject of ongoing design evaluations and will likely be removed and replaced as part of closure construction.

In the opinion of the writers of this document, the channel as it is currently is not suitable as a permanent structure or as part of an overall closed facility. We believe the permit conditions and the decision by Nyrstar to replace this channel are correct decisions and courses of action.

Figure 1. The Upgradient Drainage Channel on the north side of the TDF. Note the shotcrete lining on the upgradient side. The light-colored material on the downstream side is gravel that accumulated in the channel and was subsequently removed from the channel.

4.3 SECONDARY UPGRADIENT DIVERSION

To the east of the TDF is a steep channel also used to divert upgradient runoff water; this channel is known as the "Alder Reach". This channel was installed pursuant to recommendations in AMEC (2008) that a secondary ditch able to accommodate the 1 in 200 year 24-hour storm event be constructed.

The channel is cut into the hillside. It is unlined. The upslope side is cut steeply into consolidated clays. This cut currently appears to be stable: erosion is occurring and material from upgradient is raveling down into the channel. Debris and other rock accumulate in the channel.

The writers of this report were informed that this channel will be reconstructed as part of closure construction.

In the opinion of the writers of this report, this channel, while it may have played some part in controlling water around the TDF, is not a suitable permanent feature and the decision to reconstruct it as part of TDF closure is the correct decision.

Figure 2. The Secondary Upgradient Channel. Note the steep cut into consolidated clay on the upgradient side. Note also the accumulation of gravels and boulders in the channel.

4.4 EXPOSED WASTE ROCK

Waste rock dumps 1 and 6 to the north of the TDF rise at their natural angle of repose above the adjacent tailings surface. Note these rock dumps also underlie the tailings as shown in the Figure 3 below.

These dumps are stable at their natural angle of repose. Some erosion is occurring from the face of the dumps---eroded material moves to the surface of the paste tailings at the toe of the exposed dump faces.

The writers of this report were informed that in accordance with Hoffman (2013) the stability and cover for these dumps are being reevaluated and action will be taken in accordance with plans for the closure of the TDF.

While we are of the opinion that these dumps do not currently constitute a dam safety issue, we concur that as part of closure their stability and covering should be addressed.

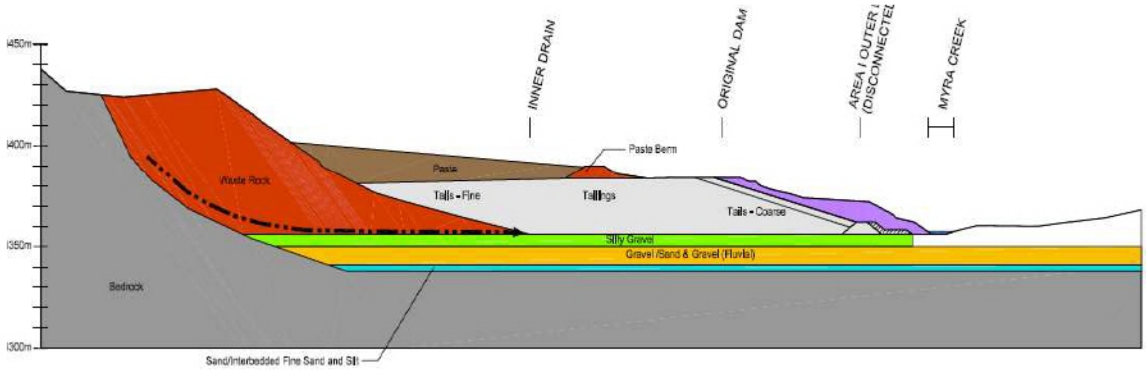

Figure 3. North to south cross section through the TDF. Note the waste rock dumps on the left side of the section. These dumps were initially placed against the hillside. Subsequently the tailings were placed up against these dumps. Note that the (purple) seismic stability berm to the right of the section has now been constructed to full height.

Figure 4. The TDF. Looking north from the hillside on the south side of the valley. Note the waste rock dumps are the orange-gray surface just below the trees at the base of the hillside. (See also Figure 5 for more detail.)

Figure 5. The south face of the waste rock dumps rising from the surface of the paste tailings area.

4.5 PASTE TAILINGS SURFACE

At the toe of the waste rocks dumps and extending to the south is the surface of the paste tailings (Figures 3 and 5). This area is sometimes referred to as the Amalgamated Paste Area (APA). The surface slopes gently from north to south. The paste tailings surface is eroded (Figure 6) with eroded material collecting at the south side of the surface up against and adjacent to the paste berm.

Runoff from the surface of the paste tailings generally flows downslope from north to south, and hence towards the west along the upgradient side of the paste berm (Section 4.6). Runoff is removed from the surface via the decant structure at the south-west corner of the upper surface of the paste tailings area (Figures 7-A to 7-C). The decant pipe conveys water to the Super Pond which is located at the upstream end of the site's water treatment system.

No information is available about the capacity of the decant facility or of the ability of the upper surface of the paste tailings area to contain runoff except as noted in AMEC (2008) that the 1 in 200 year, 24-hour design storm should be accommodated.

This surface is to be regraded and covered as part of closure construction (Hoffman, 2013). The writers of this report concur that regrading, covering, and provisions for surface water management in accordance with closure plans should be undertaken.

Figure 6. Erosion of the upper surface of the paste tailings, looking from north to south.

Figure 7-A. Looking southwest from the top of waste dump #6. The decant location at the south-west corner of the paste tailings area. The sand management area (Section 4.8) is to the west. At the bottom right of the photo are the steeper slopes of the waste rock dump.

Figure 7-B. Looking east along the paste berm. The Amalgamated Paste Area decant facility as seen from the south-west corner of the area. Note surface water runs east to west in the channel to the right of the photo, then ponds to flow into the area of rock in the middle of which is the decant pipe leading to the Super Pond which is located at the upstream end of the site's water treatment system.

Figure 7-C. The inlet to the decant pipe from the Amalgamated Paste Area. Note the wooden top. Water is intended to pass through the square openings in the pipe.

4.6 PASTE BERM

The paste berm retains the upgradient paste tailings and drains to the tailings surface to the south. On the upgradient side of the berm, the top of the berm is between one and two meters higher than the adjacent surface of the paste tailings. The downgradient height of the berm and its inclination varies (Figure 8). Generally there is a steeper (2:1) section about two meters high adjacent to a flatter sloping area falling to the surface of the old tailings.

There is no observed significant erosion or deformation of the berm. This berm will be regraded and covered as part of closure construction. The writers of this report concur that this is necessary and appropriate for closure.

Figure 8. Looking southwest along the paste berm from the east end of the paste berm area. The downgradient side of the paste berm. Note the variable slope inclination leading to the tailings surface on the left side of the photo.

4.7 OLD TAILINGS

To the south and just downgradient of the paste berm is the surface area of the old tailings and upper surface of the seismic berm. This area is sometimes referred to as the Strip Area.

Surface water runoff from this area generally flows from east to west into the decant facility. (Figure 9).

Figure 9. The Strip Area looking east. Surface water runs in the "channel' to the decant facility, which is seen in the foreground of the photo.

Parts of the surface of this area just downgradient of the paste berm were observed to be wet and soggy. No rain had fallen in the period immediately preceding observations. It is not known if the wet areas are the result of seepage from the paste area, or represent upward seepage associated with possible tailings drainage. The authors of this report are informed that this condition is being evaluated by others as part of the compilation of a new slope stability analysis. We concur that this is necessary and appropriate.

Figure 10-A. The toe of the paste berm looking west. This is the general area where wet and soggy conditions were observed on the flat surface at the toe of the berm.

Figure 10-B A close-up view of the affected surface. Note there was no standing water, simply wet and soggy tailings.

4.8 Top of Seismic Berm

When observed, construction work was in progress to regrade the surface of this area and the top of the recently completed seismic buttress. The area was variously undulating and rough. Incident precipitation would pool in low points or flow to the edge of the seismic berm and hence down the outer face of the berm.

Because of the active regrading of the area, no erosion or cracking (if any) was observed.

The writers of this report were informed that the surface is being regraded prior to covering in accordance with closure plans, and hence provisions for surface water management.

Figure 11. The top surface of the old tailings and seismic buttress. The surface was being regraded to comply with closure requirements.

4.9 Sand Management

Cyclone underflow sand is placed, as part of temporary storage, into the sand management area to the south west of the TDF. The quantity of sand in the area varies as demand for sand for underground backfilling varies and as the use of the sand for construction varies. The ability of the sand area to retain water from upgradient runoff and incident precipitation accordingly varies. The perimeter berms are kept at least one meter above the sand, and in accordance with AMEC (2008) this is considered sufficient to retain the 1 in 200 year, 24-hour storm event. Water passes from the sand area via a dedicated decant to the Super Pond.

The sand area is part of TDF closure area. It will be reclaimed as and when other facilities to stockpile the sand can be established.

Figure 12. General view of the sand area looking from east to west.

4.10 SEISMIC BERM

The seismic berm was constructed on the south side of the TDF in order to provide for stability of the TDF in the event of large earthquakes. The analysis of the stability of the berm and its design are documented in Klohn Crippen Consultants Ltd. (1999a) and (2004a), and AMEC (2011). The latter presentation notes factors of safety for the TDF for various earthquakes that are consistent with industry standards. The presentation also notes "Even with adequate factor of safety, some liquefaction-related deformation is anticipated in the APA and TDF following the MCE." The calculated deformation under the most extreme seismic loading by the Maximum Credible Earthquake, is that "the berm will horizontally translate about 3 m to 4 m into Myra Creek and the tailings surface at the berm will vertically drop 1.5 m to 2.0 m." This deformation has been calculated using standard procedures and is consistent with similar calculated deformation for other facilities in high seismic areas.

In terms of Hoffman (2013) "Updated slope stability analyses shall be undertaken to complete the detailed closure design for the TDF." AMEC (2013c) is the report written in response to this request. As noted in the introduction to AMEC (2013c):

> The objective of this as-built report is to provide detailed documentation of the final configuration of the TDF Seismic Upgrade Project and to confirm that it has been built in general conformance to the design and specifications and achieves its design intent. In order to arrive at this conclusion, AMEC first undertook a comprehensive desktop study including

> the compilation of information from existing design and construction reports relating to the TDF Seismic Upgrade Project contained in both the Nyrstar and AMEC project libraries. Approximately 50 report documents that were published between 1984 and the present were considered by AMEC and the references to these documents are summarized in Section 7.0. Thirty-three of the reports had been authored by Klohn Crippen between 1998 and 2006. Twelve additional reports had been authored by AMEC between 2006 and 2012. Other documents included several reports by Knight and Piesold Ltd. from the 1980s and a SWECO International report from 2002.

The report concludes:

> AMEC concludes that the TDF Seismic Upgrade project is complete and satisfies its design intent with respect to the slope stability factor of safety given a MDE with a PGA of 0.30 g. The TDF has a minimum calculated post-seismic global factor of safety of 1.1 and a post-seismic factor of safety of 1.25 for failures passing through the Outer Drain. Correlation of limit equilibrium stability modeling to dynamic finite element modeling predicts an associated toe displacement of the Seismic Upgrade Berm of 3 m or less. This conclusion was reached based on:
>
> - Desktop study of existing engineering design reports by others, including limit-equilibrium and finite-element stability modeling by Klohn Crippen;
> - Supplementary/confirmatory limit-equilibrium stability analyses carried out by AMEC;
> - Documentation of construction activities by others;
> - Construction observations performed by AMEC; and,
> - Review of the final survey data provided by McElhanney.

In our opinion, these conclusions as based on the documents reviewed, are reasonable and acceptable.

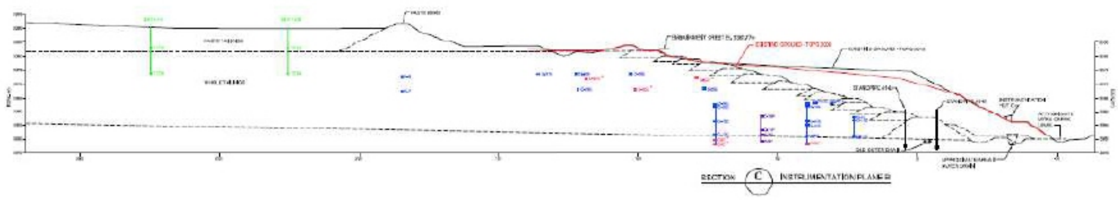

Figure 13. Cross section of the seismic berm (from AMEC, 2011.) Note the seismic berm is to the right of the section and is constructed over the previous outer face of the TDF.

4.11 SOUTH FACE OF TDF

The downstream face of the recently constructed seismic berm is subtended by an access road/path and Myra Creek. New vegetation has been established on the face of the berm. Minor erosion was observed near the upper crest of the berm.

Figure 14. The outer face of the seismic berm, looking north. Note from left to right: Myra Creek; the toe access road; and the sloping face of the berm with new vegetation.

There is a rock spillway on the south face of the seismic berm. It was constructed to be part of the surface water management system and to serve as an operational spillway. We were informed that adequate filters were not placed between the erosion control rock and the underlying materials at the north end of the spillway; and that accordingly the upper portion of the spillway is to be removed and replaced as part of closure construction.

Figure 15. Looking east along the south face of the seismic berm. Note the large boulders (just beyond the concrete blocks) that constitute the spillway just to the left of the photo.

4.12 PUMPHOUSE #4

The underdrains of the TDF drain to a sump in the Pumphouse #4 building. Seepage from the underdrains is collected in this sump and returned to the Super Pond.

Figure 16. The Pumphouse #4 Building.

4.13 PIEZOMETERS

We were informed that there are piezometers in the tailings. The following explanation of their readings and the interpretation thereof was obtained from Dan Hughes-Smith, P.Eng. of AMEC who is the engineer of record for the facility:

> Threshold levels were established by AMEC in 2007 (by previous staff), based on 2D limit equilibrium analysis. The details are on page 28 of the 2007 Annual Report (dated 17 April 2008).
>
> Threshold 1 is the average of the maximum for that horizontal section of tailings. For example all of the instruments on Plane A near the base of the tailings have the same threshold 1. While this takes into account the overall vertical seepage pattern in the tailings, it does not take into account proximity to the toe, and it stands to reason that instruments further from the toe will have higher readings compared to the threshold.
>
> In general we've found that threshold 1 exceedance are not especially useful in predicting or monitoring any behavior. A few piezometers have been above threshold 1 for all-time. A better comparison may be the "average value of the group" to the maximum of the "historical average values for the group", or perhaps a different division of piezometers than what's been established, but we have carried the existing system for consistency.
>
> Threshold 2 is the maximum for a given piezometer. This is of more pertinent concern. Of those which show exceedances:
>
> - A-6E – one anomalously high reading, nearly 2 m higher than the preceding and following day, is considered a likely data error.
> - P3 – this piezometer does not show the same trends as the other paste berm piezometers, and seems unrelated to climatic influences (it was generally very flat year round, varying only between about 3372.5-3372.8). Our interpretation is that this instrument has most likely malfunctioned.
> - P10 – this piezometer exceeds previous maximums by no more than 0.2 m at several points during the year, but mimics the overall trends of the other piezometers in its group. This piezometer is located near the RSA and the slightly higher than previous maximum water level is likely due to high operational water levels in the reclaim sand area (RSA) and discharge of backfill sand on the beach near the piezometer. Unfortunately its nested pair (P9) has not been functional since 2007.
>
> On a year to year basis, we review the piezometer data in each area to check that the trends are consistent with previous behavior, weather trends, and that there are no anomalous behaviors developing. As far as the thresholds go, Threshold II is the only one we give much merit to. Threshold III exceedances are all but unheard of (and to date have all shown to be invariably the result of bad data), and by definition Threshold II must also be exceeded.

This explanation appears to be reasonable on the basis of our observations and reading of the reference documents.

5 OPERATIONS, MAINTENANCE, AND SURVEILLANCE

Old TDF operations, maintenance, and surveillance are undertaken in terms of the *Operations, Maintenance and Surveillance Manual, TDF, Lynx TDF & Water Treatment Facilities* (OSM) (Nyrstar 2013b). This is an update of the 2010 Manual of the same name. The 2013 update is being prepared for distribution to the regulators.

The Chief Inspector of Mines (A. Hoffman, 2013) in the *Permit Amendment Approving Conceptual TDF Closure Plan*, includes in the approval conditions the requirement that an updated OSM Manual be prepared once closure works are completed.

In our opinion, the 2013 OSM Manual is comprehensive and appropriate for the dam classification. Considering site-specific conditions, we believe the 2013 OSM manual is in accord with the CDA guidelines and Mining Association of Canada guidelines for an OMS Manual.

6 EMERGENCY MANAGEMENT PROGRAM

Response to an emergency at the Old TDF is governed by the *Emergency Management Program* (Nyrstar 2013). This document includes an emergency response plan.

In our opinion the emergency management program and the emergency response plan are appropriate for safeguarding site workers, underground workers, the public, and the environment.

On the basis of discussions with Ivor McWilliams of Nyrstar we were informed as follows regarding "testing of the EPP and ERP."

> We don't do specific emergency "dry-runs" for the tailings facilities. However, we did have a real life one in 2006 and mobilized contractors, site personnel, equipment etc. and generally responded very well to the threat of surface water inundation onto the TDF surface. Also we continually have monthly SERT (Surface Emergency Response Team) training sessions for volunteer site personnel. Also, 2006 made everyone here very cognizant of tailings emergencies, so for what that counts for, people are mentally tuned into this threat.

This appears to be reasonable. We would recommend that future SERT training sessions specifically consider responses to the risk-related events discussed in Section 7.

The *TDF Emergency Preparednes Plan* (NVI, 2007) is referenced in the *Emergency Management Plan*. At the time this document was prepared it was relevant and appropriate. It is now out-of-date and not reflective of the current status of the Old TDF or of issues relating to emergency preparedness. It is not clear, at this time, how the plan integrates with or supports the *Emergency Management Plan.* It is accordingly recommended that the documents governing emergency preparedness and emergency management be update, simplified, and collated into one readily available document.

7 RISKS PENDING CLOSURE

The risks to which the current Old TDF was subjected during operation and is currently subjected are described in Nystar (2013a). These risks will continue to be relevant pending closure of the Old TDF.

As noted in the *Environmental Emergency Response Plans* that is a part of Nyrstar 2013a, the following are the primary risks:

Storms, Heavy Precipitation, and/or Floods. Events larger than those for which current surface water management facilities are designed (see Section 2.5) could result in overflow of water onto the top surface of the Old TDF. Such water along with incident precipitation could lead to an overwhelming of the outlet decant facilities and hence overtopping of perimeter embankments. Overtopping could induce erosion and the passage of contaminated liquid and/or solids to Myra Creek and possibly on to Buttle Lake.

Terrain Hazards, Mudslides, and Avalanches. While it is considered that significant landslide of materials from the hillside north of the TDF is unlikely, there is a risk that a landslide could occur. A landslide might block surface water management facilities and extend out and over the top surface of the Old TDF. If cleaning of the water management facilities were delayed, it is possible that water that would otherwise flow in the channel could flow instead to the top of the TDF. Provided the quantity of overflow were less than the capacity of the decant facilities from the cells of the top deck, no overflow of perimeter embankments is likely. Conversely if the inflow exceeded the capacity of the decant facilities, perimeter overflow is possible, with results similar to those noted above for storms.

Earthquake. The Old TDF is not designed, nor will it be closed, to deal with the probable maximum earthquake. Now, in the event of delayed closure, and even after closure there is a risk of an earthquake larger than the design earthquake (see Section 2.5). The design earthquake is estimated to possibly cause up to four meters of toe movement towards Myra Creek. Earthquakes larger than the design earthquake could induce larger movement of the toe and perimeter slopes. In addition, earthquakes could damage surface water management facilities and induce landsliding from the adjacent hillside on to the Old TDF.

Decant Facilities. Decant facilities currently, and will continue pending closure, convey water from the cells of the Old TDF to the Super Pond. Breaking or clogging of the decant facilities could result in overflow of excess water from the cells or could lead to discharge of excess tailings to the Super Pond.

Underdrains. Seepage of contaminated groundwater beneath the Old TDF is currently and will continue until and after closure to be collected by the underdrain system. In the event of blocking, clogging, or damage of the drains by an earthquake, groundwater seepage may not be collected, but would instead emerge at the surface and proceed to Myra Creek. The result could be increased loads to the creek pending installation of new dewatering wells.

Some but not all of these risks may be eliminated or ameliorated by closure. For example construction of new surface water management facilities and elimination of the decant facilities will result in reduction of risk. The risks associated with precipitation and earthquakes in excess of design criteria will remain even after closure.

While we cannot comment on the reasonableness of the risk tolerance inherent in the design criteria, we do urge that closure proceed in accordance with current plans as a practical way to manage, reduce, eliminate, or ameliorate the risks discussed in this section.

8 FINDINGS

On the basis of reading reports (as referenced), site observations (Section 4), and review of instrument and operating performance data, RGC makes the following findings regarding the safety of the TDF:

- The TDF was constructed and operated in accordance with the designs and plans.
- The TDF is maintained in accordance with the *Operations, Maintenance and Surveillance Manual.*
- An emergency response plan is in place as documented in the *Emergency Management Program.*
- There are no observable conditions that warrant immediate action or response. Except, as follows and noted in the body of this report:
  - Current surface water management facilities are in a state of construction, redesign, and/or maintenance. They are not be considered to be in accordance with current best practice. Accordingly they should be upgraded and construction completed as soon as possible.
  - The factors of safety from previous stability analyses appear to be in accordance with industry standards. The deformation in the event of a large earthquake is not insignificant. Accordingly, the stability reports being prepared as part of closure planning should be compiled as soon as practical.
- Closure of the TDF as soon as practical is necessary and appropriate. This must be done in accordance with designs currently being formulated. In particular, provision must be made for surface water management, covers, overall stability, seepage control and revegetation.

APEG (2013) requires a finding that the dam is or is not "reasonably safe." The term is intended to mean that the *dam owner* has implemented all *dam* safety management measures which conform to those norms that are considered by the *Regulatory Authority* and the engineering profession to reasonably reflect established engineering and *dam* safety management practices.

In our opinion as noted above, Nyrstar has implemented management measures which conform to the norms required by the regulatory authority and which reasonably reflect some engineering management practices.

We do not believe, however, that is would be correct to say that the Old TDF is "reasonably safe" or that it conforms to established dam safety management practices. As noted in this report, we believe that the closure works are needed to bring the Old TDF into a condition where it may be considered to be reasonably safe. Pending completion of closure works, there are risks that we do not consider it reasonable to tolerate.

In accordance with APEG (2013) attached to this report is the required certification.

9 RECOMMENDATIONS

On the basis of the findings above, we recommend as follows:

- Continue maintenance and surveillance of the Old TDF in accordance with approved plans and procedures.
- Continue to be prepared for an emergency and response to an emergency in terms of approved plans and procedures.
- Update and simplify documents dealing with emergency preparedness and emergency management.
- Expedite closure planning and construction of approved closure works.
- Undertake annual dam safety inspections (the next should be in about September of 2014.)

10 CLOSURE

Robertson GeoConsultants Inc. (RGC) is pleased to submit this report entitled Myra Falls Old Tailings Disposal Facility 2013 Dam Safety Review.

This report was prepared by Robertson GeoConsultants Inc. for the use of Nystar Myra Falls, Ltd. .

We trust that the information provided in this report meets your requirements at this time. Should you have any questions or if we can be of further assistance, please do not hesitate to contact the undersigned.

Respectfully Submitted,

ROBERTSON GEOCONSULTANTS INC.

PROFESSIONAL
PROVINCE OF
A. M. ROBERTSON
BRITISH COLUMBIA

License # 11634

Andrew Robertson, P. Eng. PhD.
Principal

J Caldwell, M.Sc.(Eng.)
Civil Engineer

11 REFERENCES

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APPENDIX C: *DAM SAFETY REVIEW ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Guidelines for Legislated Dam Safety Reviews in British Columbia*, July 2013 ("*APEGBC Guidelines*") and is to be provided for *dam safety review reports* for the purposes of the *British Columbia Dam Safety Regulation*, B.C. Reg. 44/2000 as amended. Italicized words are defined in the *APEGBC Guidelines*.

To: The *Owner* Date: 26 FEB 2014

NYRSTAR MYRA FALLS LTD
Name MYRA FALLS OPERATIONS
P.O. BOX 8000, CAMPBELL RIVER, BC
Address CANADA V9W 5E2

With reference to the *British Columbia Dam Safety Regulation*, B.C. Reg. 44/2000 as amended.

For the *dam*:

UTM Location): UTM ZONE 10, 312900 5494400 (Crest of OER @ Spill...
Located at (Description): MYRA FALLS MINE, STRATHCONA PARK
Name of *dam* or description: OLD TDF
Dam function: RETAIN TAILINGS
Owned by: NYRSTAR MYRA FALLS LTD

(the "*Dam*")

Current *Dam classification* is:

Check one

- ☐ Low
- ☐ Significant
- ☑ High
- ☐ Very High
- ☐ Extreme

The undersigned hereby gives assurance that he/she is a *Professional Engineer* and a *Qualified Professional*.

I have signed, sealed and dated the attached *dam safety review report* on the *Dam* in accordance with the *APEGBC* Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items (see Guideline Section 3.2):

✓ 1. Collected and reviewed available and relevant background information, documentation and data

✓ 2. Understood the current *classification* for the *dam*, including performance expectations

✓ 3. Undertaken an initial facility review

12

DAM SAFETY REVIEW ASSURANCE STATEMENT

✓ 4. Reviewed and assessed the *dam* safety management obligations and procedures

✓ 5. Reviewed the condition of the *dam*, reservoir and relevant upstream and downstream portions of the river

✓ 6. Interviewed operations and maintenance personnel

✓ 7. Reviewed available maintenance records, the Operations, Maintenance and Surveillance (OMS) Manual and the Emergency Preparedness Plan

✓ 8. Confirmed proper functioning of flow control equipment

✓ 9. After the above, reassess the consequence *classification*, including the identification of required *dam* safety criteria

✓ 10. Carried out a *dam safety analysis* based on the *classification* in 9. above

✓ 11. Evaluated facility performance

✓ 12. Identified, characterized and determined the severity of deficiencies in the safe operation of the *Dam* and non-conformances in *dam* safety management system

✓ 13. Recommended and prioritized actions to be taken in relation to deficiencies and non-conformances

✓ 14. Prepared a *dam safety review report* for submittal to the *Regulatory Authority* by the *Owner* and reviewed the report with the *Owner*.

Based on my *dam safety review*, the current *dam classification* is:

Check one

- ✓ Appropriate
- □ Should be reviewed and amended

I undertook the following type of *dam safety review*:

Check one

- □ Audit
- ✓ Comprehensive
- □ Detailed design-based multi-disciplinary
- □ Comprehensive, detailed design and performance

I hereby give my assurance that, based on the attached *dam safety review report*, at this point in time:

Check one

- □ The *Dam* is reasonably safe in that the *dam safety review* did not reveal any unsafe or unacceptable conditions in relation to the design, construction, maintenance and operation of the *Dam* as set out in the attached *dam safety review report*

- □ The *Dam* is reasonably safe but the *dam safety review* did reveal non-conformances with the *Dam Safety Regulations* as set out in section(s) ____ of the attached *dam safety review report*.

□ The *Dam* is reasonably safe but the *dam safety review* did reveal deficiencies and non-conformances as set out in section(s) ____ of the attached *dam safety review report.*

☑ The *dam* is not safe in that the *dam safety review* did reveal deficiencies and/or non-conformances which require urgent action as set out in section(s) 8 of the attached *dam safety review report.*

ANDREW ROBERTSON
Name

26 FEB 2014
Date

[signature]
Signature

580 HORNBY ST, SUITE 900
Address

VANCOUVER BC V6C 3B6

(Affix Professional Seal here)

778 331 5060
Telephone

If the *Qualified Professional* is a member of a firm, complete the following:

I am a member of the firm ROBERTSON GEOCONSULTANTS. (Print name of firm)
and I sign this letter on behalf of the firm.

REPORT NO. 212003/2

MYRA FALLS LYNX TAILINGS DISPOSAL FACILITY

2013 DAM SAFETY REVIEW

Rev 1

Submitted to:

Nyrstar Myra Falls Ltd.
Myra Falls Operations
P.O. Box 8000, Campbell River
British Columbia, Canada V9W 5E2

Prepared by:

Robertson GeoConsultants Inc.
Consulting Engineers and Scientists for the Mining Industry
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February 2014

EXECUTIVE SUMMARY

This is the 2013 Dam Safety Report on the Myra Falls Lynx Tailings Disposal Facility (TDF). The report is prepared by Robertson GeoConsultants (RGC) at the request of Nyrstar Myra Falls Ltd.

The Lynx TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur.

Currently the Lynx TDF is in use for disposal of paste tailings. The facility is operated and maintained by Nyrstar in terms of the *TDF, Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual.* An *Emergency Management Program* is in place.

A revised site-wide closure plan is being prepared for submission by July 2014. Closure of the Lynx TDF will be addressed in the site-wide closure plan on the basis that such work is ongoing closure in support of final closure of the overall site.

On the basis of reading reports and on the basis of site observations, this report documents the reasons for the following findings regarding the safety of the TDF:

- The Lynx TDF was constructed and operated in accordance with the approved designs and plans.
- The Lynx TDF is maintained in accordance with the *Operations, Maintenance and Surveillance Manual.*
- An emergency response plan is in place as documented in the *Emergency Management Program.*
- In the opinion of the writers of this report, the approved documents represent construction, and operation approaches that meet the standards of practice commensurate with a structure of this nature and hazard rating.

Recent drilling and sampling near the Lynx TDF indicate that foundation conditions may vary from those assumed in the design. It is recommended that the new information be considered and embankment stability analyses updated. Pending confirmation of the fact that the embankment is stable for the recently characterized foundation conditions, it is not possible to make a conclusion as to whether or not the Lynx TDF is “reasonably safe,” and conforms to established dam safety management practices.

Figure ES-1. *Aerial view of the Myra Falls mine showing the Lynx TDF on the left. The darker gray surface is the top of the tailings; the light gray to the right of the tailings is the embankment dam of rockfill; the brown and gray mottled areas to the upper left of the tailings are the steep slopes of bedrock and the waste rock piles above the Lynx TDF. (From AMEC 2013a)*

REPORT NO. 212003/2

MYRA FALLS LYNX TAILINGS DISPOSAL FACILITY

2013 DAM SAFETY REVIEW

Table of Contents

REPORT NO. 212003/1

MYRA FALLS LYNX TAILINGS DISPOSAL FACILITY

2013 DAM SAFETY REVIEW

1 INTRODUCTION

This is the 2013 Dam Safety Report on the Myra Falls Lynx Tailings Disposal Facility (TDF). The report is prepared by Robertson GeoConsultants (RGC) at the request of Ivor McWilliams, Environmental Manager, on behalf of Paul Laframboise, Mill and Surface Manager, both of Nyrstar Myra Falls Ltd.

2 FACILITY DESCRIPTION

2.1 GENERAL

This section describes the TDF design, construction and operation up to and including 2013. The descriptions are based on information in the references.

2.2 LOCATION

The TDF is on the Myra Falls Mine which is in Strathcona Provincial Park, Vancouver Island, British Columbia. The mine is in the asserted traditional territories of the We Wai Kai, Wei Wai Kum, K'omoks and Mowachaht/Muchalaht First Nations.

The Myra Falls Mine is Mine No. 0800007 as numbered by the B.C. Ministry of Energy and Mines. It is at UTM Zone 10, UTM Zone 10, 311850 5494680 (roughly the centre of the south arm)

2.3 DAM CATEGORY

The TDF is considered to be a high hazard structure based upon the economic and environmental impacts and the potential loss of life should a failure occur. As noted in the Water Act, British Columbia Dam Safety Regulation, Schedule 1, Definitions, a high hazard structure involves the following:

- Population at Risk: Permanent
- Consequences of Failure:
  - Loss of Life: 10 or fewer
  - Environmental and cultural values: Significant loss or deterioration of: (a) important fisheries habitat or important wildlife habitat; (b) rare or endangered species; or (c)

unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.

- Infrastructure and economics: High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.

Classification as a high hazard structure is considered reasonable and appropriate. In practice there is no permanent population at risk; only mine workers or visitors to the mine site might be affected. It is certainly true that fewer than ten people could loose their lives in the event of a catastrophic failure. There could be significant impact on fish habitat in Myra Creek and Buttle Lake. Only the local road to the mine and recreational areas around the mine would be affected. Depending on the nature of the failure, tailings could be washed down Myra Creek to Buttle Lake.

The Canadian Dam Association dam classification categories are essentially similar to those noted above for the British Columbia Dam Safety Regulations. Except that the Canadian Dam Association refers to "restoration or compensation in kind highly possible."

Both classification systems envisage what may be called a total failure of the dam, as could occur for a water-retaining reservoir, namely a breach of the retaining embankment and flow of all water from the reservoir to the receiving environment. In practice the Lynx TDF is unlikely to undergo so total a failure. Even in the event of major storms or earthquakes it is difficult to envisage breach of the perimeter slopes or egress of tailings to Myra Creek and hence to Buttle Lake. It is unlikely that major storms or earthquakes could result in immediate or even short-term loss of all tailings from the facility to Buttle Lake. On this see Section 6 on risk assessment.

It could be argued that a lower category may be appropriate. Reasons include: the low potential for multiple loss of life in the event of failure; the probability that many failure modes might not result in significant loss or deterioration of habitat, species, or sites of cultural significance; and low economic losses affecting limited infrastructure etc. In particular, if one considers reasonable failure modes such as breach of the perimeter slopes due to rain, or significant earthquake-induced deformation, it could be argued that only limited release of tailings could occur. If this perspective prevailed a lower category could well be justified.

It would not be reasonable to assign a higher dam failure consequences classification to the facility. There is no permanent population at risk. It is hard to conceive how one hundred people could loose their lives. There would not be very high economic losses affecting important infrastructure, public transport, commercial facilities, or severe damage to residential areas.

In conclusions on the topic of dam safety category, it is considered reasonable and prudent to retain the high hazard classification. This is conservative, and focusses one's attention on the fact that this is a significant structure that merits attention.

2.4 History

The history of the Lynx TDF design, construction, and operation is described in the references—see in particular AMEC (2008b). In brief:

- The original design of the Lynx TDF was prepared in 2001. The design included backfilling of the worked-out Lynx Open Pit and construction of a rockfill embankment to increase the capacity of the pit for the disposal of paste tailings.
- The Lynx Starter Berm initial construction to El 3385 m was completed in 2006.
- The design was revised in 2008 to account for the presence of old mine workings beneath the pit.
- The Lynx Starter Berm was completed to El. 3389 m in 2011.
- The first raise of the berm to El. 3392 m was done in 2011 and the second raise of the berm to EL. 3396 m was done in 2012.

2.5 2012 Reports

Reports on work at and the condition of the Lynx TDF as of late 2012 include:

- AMEC (2013a) *Myra Falls Tailings Storage Facilities 2012 Annual Dam Status Report.*
- AMEC (2013b) *Myra Falls Tailings Storage Facilities 2012 Construction Report*.
- Nyrstar (2012) *Annual Environmental Report 2012.*

Specifically the 2012 Construction Report (AMEC, 2013b) notes the following work undertaken in 2012:

- Dam raise from El. 3392 m to El 3396.1 m, concentrated on the east arm of the dam as the western arm was already near design grade at the beginning of the construction season.
- Construction of a temporary east abutment to tie the east end of the structure into exposed natural ground prior to additional excavation of waste rock from the final alignment.
- Excavation of all material within the Waste Dump #5 (Super Pile) for use in the Lynx TDF alignment.
- Stockpiling of underground mine waste and reclaimed sand within previous Super Pile location for use in construction of the 2013 Lynx TDF dam raise.
- Implementation of appropriate quality assurance and control measure.

2.6 2013 Construction

During 2013, paste tailings deposition continued and the embankment dam was raised to El. 3398.8 m. This is anticipated to provide tailings capacity through 2014.

The zone of cracked embankment as described in AMEC (2013b) was remediated. The report on 2013 construction is being prepared by AMEC.

2.7 Design Criteria

AMEC (2013a) lists these design criteria for the Lynx TDF:

- Flood Storage: Sufficient capacity to store the 1,000-year return period, 24-hour duration storm event.
- Dam Stability: Short-term factor of safety FOS equal to or greater than 1.3; Long-term, steady-state factor of safety equal to or greater than 1.5.
- Earthquake Dam Stability: Acceptable levels of deformation for the Maximum Credible Earthquake. These are noted in AMEC 2013b to be less than 0.6 m during the operational phase.

These design criteria are considered to be reasonable for a high hazard category structure. In practice, as configured when observed, the reservoir behind the embankment could accommodate runoff from a larger storm. The factors of safety are standard in the industry. And the calculated earthquake-induced deformation of the rockfill embankment is small and in line with criteria generally applied to rockfill dams in high seismic regions.

2.8 Lynx TDF Layout

In practice application of the criteria listed in Section 2.7 resulted in a design that encompasses the following essential features as shown in Figures 1 and 2 which are the general layout and cross section of the Lynx TDF. They are reproduced from AMEC (2013b). Note the following:

- An embankment designed as an initial starter embankment to be raised periodically by the centerline method. The embankment to be raised using waste rock from mine development—the rock fill is variable ranging from a sandy gravel to a gravel.
- An upstream filter zone between the rock fill and the paste tailings.
- Tailings as deposited into the reservoir formed by the old Lynx open pit and the embankment and associated filter zone.
- A drain near the lower part of the topography and more or less near the center of the embankment.

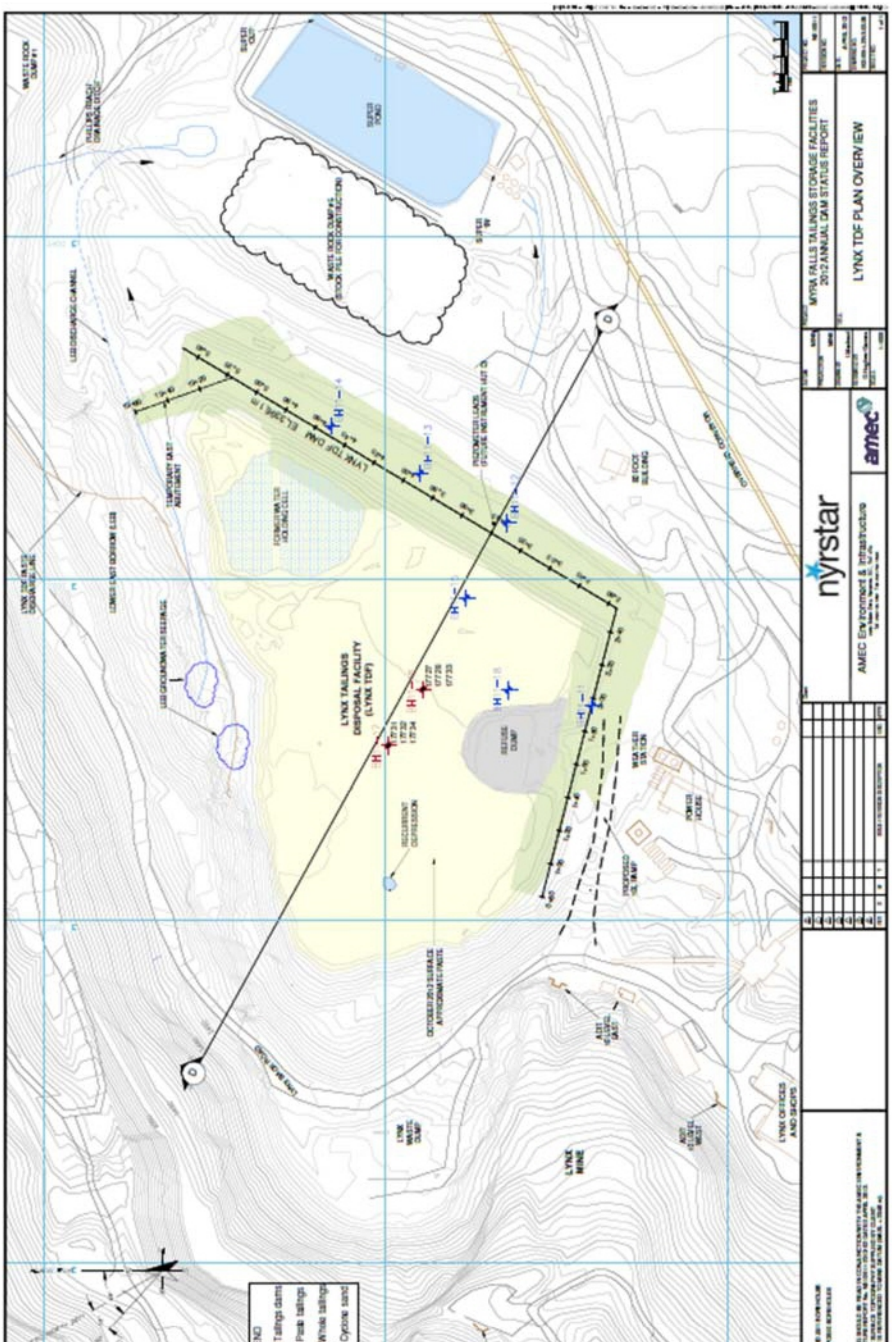

Figure 1. *The Layout of the Lynx TDF. The green shading is the rockfill embankment dam on the downgradient perimeter of the old Lynx open pit. The yellow shading is the top surface of the deposited tailings.*

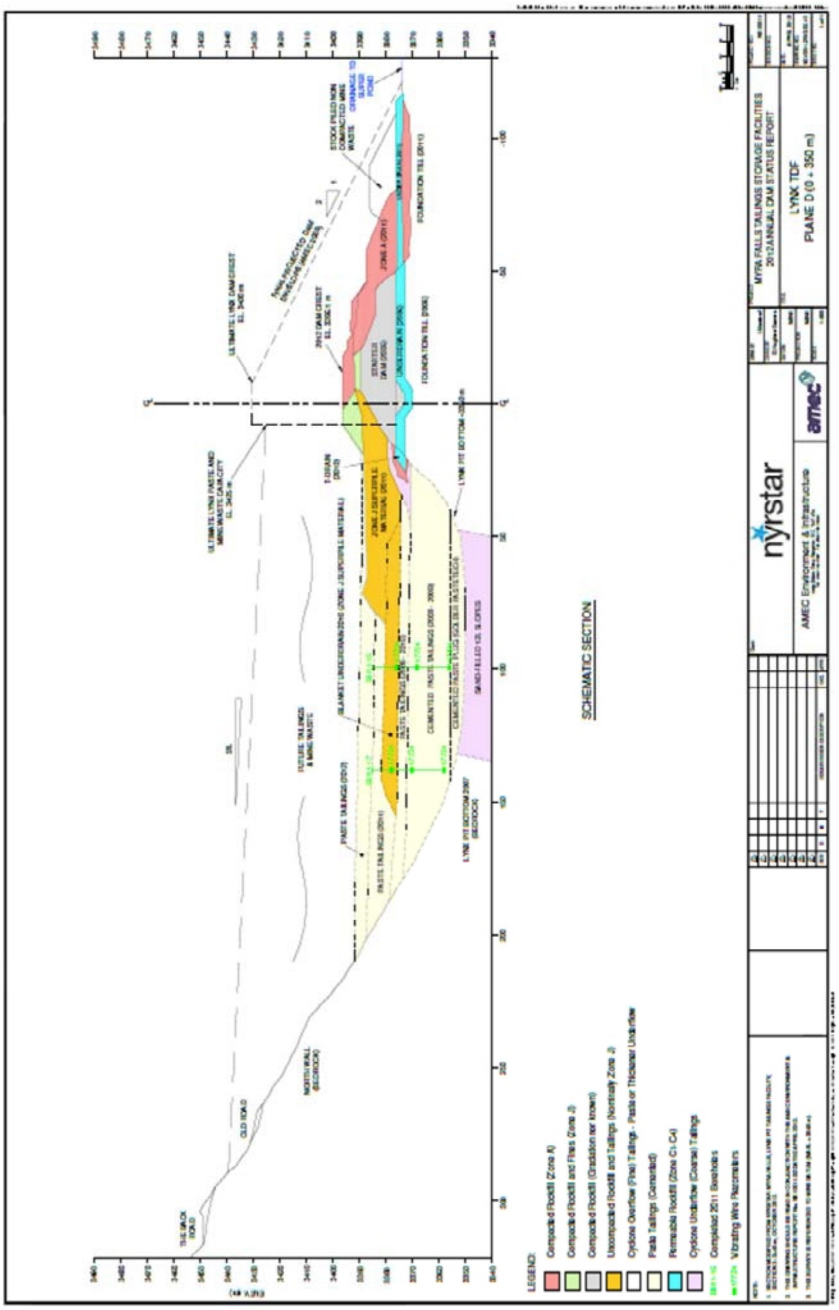

Figure 2. *Cross section through the Lynx TDF tailings and embankment dam. Only the upper surface of the tailings, the Zone J Fines, and the outer face of the Zone A rockfill are visible in practice. It is not possible to observe the various cemented tailings, Zone J Super Pile material, or the underdrain. The blue drainis not continuous beneath the embankment, but is only near the center of the embankment.*

3 2013 OBSERVATIONS

3.1 GENERAL

The following are observations made by RGC during site visits in June, July, and September of 2013. The descriptions are based on information in the references, discussions with Nyrstar personnel and site observations.

3.2 CURRENT STATUS

Currently the Lynx TDF is in use for disposal of paste tailings. The facility is maintained by Nyrstar in terms of the *TDF, Lynx TDF & Water Treatment Facilities, Operations, Maintenance and Surveillance Manual,* Nyrstar (2013b) and the *Emergency Management Program,* Nyrstar (2013a).

3.3 ONGOING STUDIES

At the time of writing this report, work is in progress to define the groundwater and geochemical conditions of the Myra Falls site and of the Lynx TDF. Preliminary results indicate seepage from the facility to groundwater beneath and downgradient of the facility.

3.4 EMBANKMENT DAM

When observed in June 2013, there was extensive cracking along the downstream crest (Figure 3).

Figure 3. *Cracking along the downstream crest of the embankment as observed in June 2013. The cracked zone was, reportedly, removed and replaced as part of 2013 embankment raising.*

When observed in September 2013, raising of the embankment dam had just been completed. The authors of this report were informed that the zone of cracking was removed and replaced as part of the embankment raising. No cracking of the embankment was observed (Figures 4 and 5). Construction was done under the management of Myra Falls staff by the contractor, Upland Excavating Ltd. Engineering oversight was provided by AMEC who are also the engineers of record for the design of the raise. We are informed that the as-built report on this work will be available only after submittal of this report.

***Figure 4**. Looking west to east along the downstream crest of the embankment dam in September 2013. To the left of the crest line is the top of the embankment, which is a compacted surface of waste rock. To the right of the crest line is the downstream face of the embankment which is also compacted waste rock.*

Figure 5. *The access road along the toe of the embankment. To the bottom left of the picture is the inclined downstream face of the embankment. Above, and to the right of the access road are various material stockpiles and other facilities that will be removed to make way for the embankment as, in the future, additional embankment raising is undertaken.*

3.5 FILTER ZONE

The top surface of the upstream filter zone was observed (Figure 6). The material is finer than the rockfill and in appearance suitable for its design purpose—controlling migration of tailings into the voids of the embankment rockfill. On the upstream side of the filter zone is either paste tailings or sand (Figures 7 and 8).

As noted in AMEC (2013b), testing is done to confirm that the gradation of the filter is as designed:

> The construction materials used were evaluated on a regular basis for compliance with design specifications for the various earthworks carried out during the 2012 construction season. Gradation and moisture content tests were performed by AMEC's Nanaimo laboratory for select structural fills. Material was sampled at approximately 3000 m³ intervals for gradation analyses. AMEC field personnel performed weekly site visits to confirm the construction material was placed according to specifications. After very wet weather at the beginning of October, more frequent visits were completed in order to confirm adequate compaction in the face of difficulties handling and compacting wet material.

Figure 6. *Looking west to east along the upstream crest of the embankment. To the left is the compacted finer-grained material of the filter zone; to the right is the top surface of the compacted waste rock.*

Figure 7. *Looking west to east along the upstream crest of the embankment. To the left is the surface of the tailings*

Figure 8. *Looking east to west along the upstream crest of the embankment. Sand is deposited from the pipe in order to control the beach and hence to push standing water back and away from the embankment—a operating procedure that is considered to be good practice.*

3.6 TAILINGS SURFACE

The topography of the tailings surface is controlled by the discharges into the area, including the paste tailings line, the sand line, and overflow from the Super Pond dredging (Figures 9 and 10). The Super Pond is located at the upstream end of the site's water treatment system.

***Figure 9**. Looking from the crest of the embankment to the north-east across the surface of the tailings. In the foreground is sand, and behind this is the wet upper surface of tailings. Rising from the surface of the tailings are the natural bedrock slopes and waste rock dumps above the Lynx TDF.*

***Figure 10**. Looking from the crest of the embankment to the northwest across the surface of the tailings. Rising from the surface of the tailings are the natural bedrock slopes and waste rock dumps above the Lynx TDF*

3.7 REFUSE

Mine refuse is deposited into the tailings (Figure 11). In essence as the tailings surface rises, the tailings surround and encapsulate the individual refuse items.

Figure 11. *The truck has just dumped refuse at the right-hand end of the road that slopes down to the tailings surface. Note also the significant difference in elevation shown here between the top of the tailings and the crest of the embankment.*

3.8 FREEBOARD

Because of the recent raising of the embankment there is significant freeboard (Figure 11). As of August 29, 2013 the reported elevation of the tailings surface against the embankment was 3393.2 m and the elevation of the embankment crest was 3398.8 m. This freeboard (5.6 m) will reduce as tailings are deposited and the surface of the tailings rises. The design operating freeboard is such that there is sufficient volume to retain 78,000 m^3 of precipitation and runoff plus an additional 0.5 m provision for wind and wave action (AMEC 2008b).

3.9 BEDROCK SEEPAGE

Towards the east end of the north side of the Lynx TDF, there is seepage from the bedrock (Figure 12). The seepage is directed to a channel formed on the north side by the bedrock and on the south side by piled-up waste rock (Figures 13 and 14).

We were informed that a rock-filled drain will be constructed to collect the bedrock seepage and direct it east where it will exit the Lynx TDF embankment and be conveyed to the Super Pond.

Figure 12. *Seepage from joints in the bedrock on the north side of the Lynx TDF. Flow quantities vary in response to precipitation. The zone of bedrock seepage is relatively large and extends some meters up the slope.*

Figure 13. *The channel to the east end of the north side of the Lynx TDF. The channel is formed of the bedrock and piled-up waste rock, Seepage is collected in the channel and flows east.*

***Figure 14**. Looking west along the access road on the south side of the channel.*

3.10 UPGRADIENT DIVERSION

Upgradient diversion of surface waters is partially achieved by the roads and channels upgradient of the Lynx TDF in the area to the north of the facility (Figure 15).

***Figure 15**. The slopes upgradient and to the north of the Lynx TDF. Some interception and diversion of runoff is achieved via the roads and channels of this area.*

3.11 EMBANKMENT SEEPAGE

There are drains beneath the starter dam (Figure 2). Water from the drains is reported to seep to the shotcrete lined ditch at the upstream end of the water treatment system (Figure 16). We could not observe this as the elevation of the discharge is approximately 0.6 m beneath the rockfill cover.

Figure 16. *The area downstream of the embankment where tailings bleed water may report via an underdrain at the base of the starter dam.*

As noted in Section 3.3, groundwater information indicates downward seepage from the Lynx TDF to the sediments beneath the facility and hence to groundwater beneath and downgradient of the facility. This would indicate that some or all of the seepage through the embankment is downward and not necessarily primarily to the reported drains.

3.12 Pool Water Control

Supernatant water on the surface of the tailings is removed, as required, by pumps (Figure 17).

Figure 17. *A pump used to remove supernatant water from the surface of the tailings.*

4 OPERATIONS, MAINTENANCE, AND SURVEILLANCE

Lynx TDF operations, maintenance, and surveillance are undertaken in terms of the *Operations, Maintenance and Surveillance Manual, TDF, Lynx TDF & Water Treatment Facilities* (OSM) (Nyrstar 2013b). This is an update of the 2010 Manual of the same name. The 2013 update is being prepared for distribution to the regulators.

In our opinion, the 2013 OSM Manual is comprehensive and appropriate for the dam classification. Considering site-specific conditions, we believe the 2013 OSM manual is in accord with the CDA guidelines and Mining Association of Canada guidelines for an OMS Manual.

5 EMERGENCY MANAGEMENT PROGRAM

Response to an emergency at the Lynx TDF is governed by the *Emergency Management Program* (Nyrstar 2013a). This document includes an emergency response plan.

In our opinion the emergency management program and the emergency response plan are appropriate for safeguarding site workers, underground workers, the public, and the environment.

On the basis of discussions with Ivor McWilliams of Nyrstar we were informed as follows regarding "testing of the EPP and ERP."

> We don't do specific emergency "dry-runs" for the tailings facilities. However, we did have a real life one in 2006 and mobilized contractors, site personnel, equipment etc. and generally responded very well to the threat of surface water inundation onto the TDF surface. Also we continually have monthly SERT (Surface Emergency Response Team) training sessions for volunteer site personnel. Also, 2006 made everyone here very cognizant of tailings emergencies, so for what that counts for, people are mentally tuned into this threat.

This appears to be reasonable. We would recommend that future SERT training sessions specifically consider responses to the risk-related events discussed in Section 7.

The *TDF Emergency Preparedness Plan* (NVI, 2007) is referenced in the *Emergency Management Plan*. It is not clear how the plan integrates with or supports the *Emergency Management Plan.* Moreover, the plan addresses only the Old TDF and not the Lynx TDF, although much of the information in the plan may be considered relevant to the Lynx TDF. It is accordingly recommended that the documents governing emergency preparedness and emergency management be update, simplified, and collated into one readily available document.

6 RISKS DURING ONGOING OPERATION

The risks to which the Lynx TDF is subjected during operation are described in Nystar (2013a). As noted in the *Environmental Emergency Response Plans* that is a part of Nyrstar 2013a, the following are the primary risks:

Storms, Heavy Precipitation, and/or Floods. Events larger than those for which current surface water management facilities are designed could result in overflow of water onto the top surface of the Lynx TDF. As currently configured, the consequence would simply be a rise of the pool in the reservoir. Such water would have to be pumped out prior to resumption of tailings deposition.

Terrain Hazards, Mudslides, and Avalanches. It is considered that significant landsliding of natural materials from the hillside north of the Lynx TDF is unlikely—see Klohn (2006) and AMEC (2007).

Waste Rock Dumps Above Reservoir. There is a risk of sliding of one or more of the waste rock dumps above the Lynx TDF into the reservoir of the facility. Such landslides could be triggered by excessive rain and/or earthquakes. A landslide might block or destroy surface water management facilities and extend out and over the top surface of the Lynx TDF. It is conceivable that a significant landslide could expel tailings from the reservoir out and over the embankment. Mitigation of this risk would include relocation of the materials of the waste rocks dumps to a more stable location.

We are informed by personal communication as follows on this issue by AMEC, the engineers of record for the Lynx TDF:

> There have been no comprehensive studies or analysis done to support the stability of the dumps; however, to my [Dan Hughes-Gains] knowledge there are no features indicative of movement, creep, or other deformation that would be expected from a waste pile with a low factor of safety. I would agree that there is "risk" of a landslide, but said risk hasn't been quantified. It might well be that the risk is within acceptable parameters. Surface raveling (particularly during thawing conditions) is the only mode of material transport that we've witnessed. During wet conditions it's not uncommon for massive amounts of water to come from the toe of the dumps above the bedrock surface in the LEB. My interpretation has been that the dumps are relatively permeable compared to the underlying rock and/or basal till materials, and that possibly there are some bedrock sources of water as well. Given these conditions, there are still no indications that the factor of safety is low.

Earthquake. The rockfill embankment of the Lynx TDF is calculated to undergo some deformation (estimated to be less than one meter) in the event of the design earthquake. This calculated deformation is consistent with industry experience for well-constructed, well-compacted rockfill. Earthquake-induced liquefaction of the tailings is not likely to have a significant impact---the substantial rockfill embankment is considered adequate to retain liquefied tailings.

Delivery Lines. There are a number of pipe or delivery lines conveying tailings and materials dredged from the Super Pond to the reservoir of the Lynx TDF. These lines are generally small---it is not considered that rupture of the lines constitutes a significant risk to the operation or integrity of the facility. We believe that they could be shut off in the event of rupture before inducing significant erosion of the rockfill embankment.

7 FOUNDATION CONDITIONS

AMEC (2008b) describes slope stability analyses of the Lynx TDF. As noted in Figure 18, failure surfaces through the tailings and beneath the embankment assume that the foundation materials are a high-strength, cohesionless till.

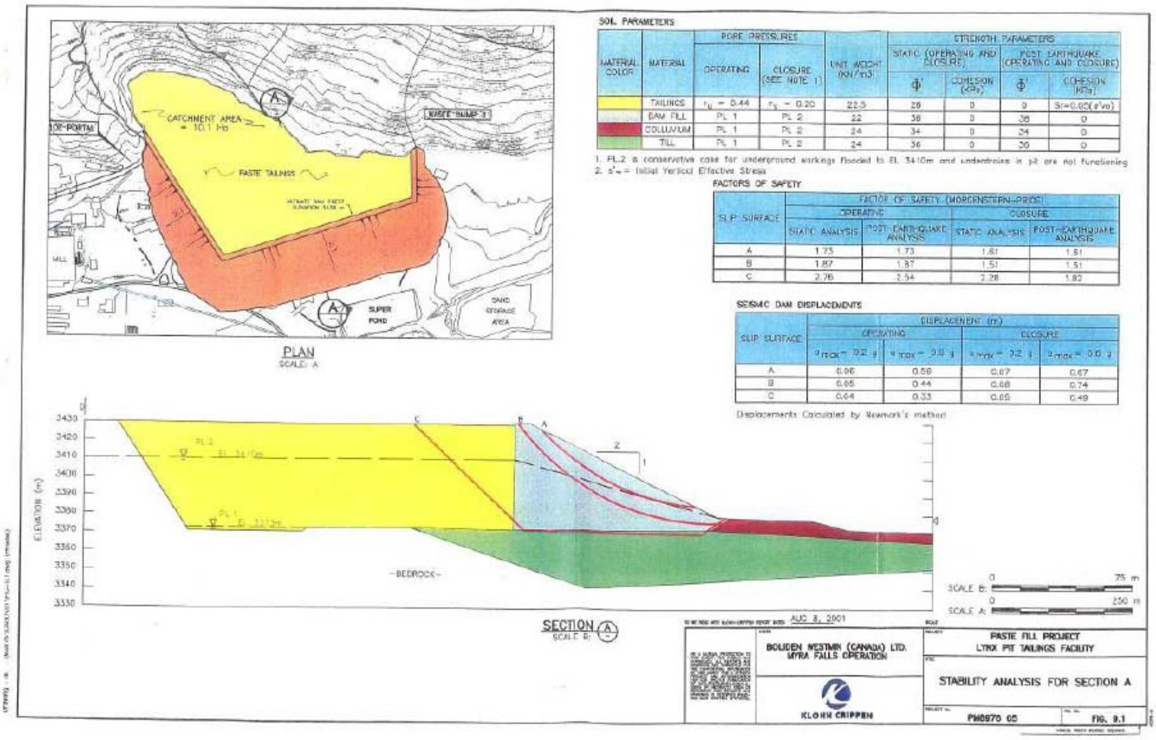

Figure 18. *Static stability analyses for the Lynx TDF. Note the failure surface through the tailings and beneath the rockfill embankment passes through a till of high strength. This figure is the basis of a conclusion that the embankment has an adequate static factor of safety.*

Drilling in 2013 undertaken as part of preparation of the site closure plan and characterization of site groundwater conditions indicates that the foundation materials may differ from those assumed in previous stability analyses. Specifically one borehole (well number MW13-05) indicates that from about 15 to 45 m, the material is as follows:

> *Well Graded Sand with Gravel, (SW), (50% fine to coarse grained: 45% gravel, subrounded, fine to coarse grained; and 5% fines.) Non-plastic; light brownish gray, well graded, no staining, wet, medium dense, 90-95% recovery. Increasing silt with depth to 32 m. 20 cm sand lenses at 32, 34, and 37 m (Alluvium).*

RGC is concerned that these conditions, in particular the possible presence of layers of wet, loose sand, and/or layers the seismic response of which may be dominated by sand, may affect the seismic response of the foundations and possibly impact the stability and performance of the embankment.

It is recommended that the static stability and seismic response of the Lynx TDF rockfill embankment be reassessed in the light of these conditions. It is recognized that additional site characterization may be required to more accurately characterize the seismic response of possible layers of sand or layers the performance of which is dominated by the sand in the foundation.

8 FINDINGS

On the basis of reading reports (as referenced) and on the basis of site observations (Section 3), RGC makes the following findings regarding the safety of the TDF:

- The Lynx TDF is being constructed and operated in accordance with the designs and plans.
- Construction and operation of the Lynx TDF will continue for many years hence. This may be done in accordance with the designs and plans, provided that additional stability analyses confirm embankment stability.
- As-built reports are prepared that document that construction has been completed in accordance with designs and specifications and appropriate standards of quality assurance and control.
- The Lynx TDF is maintained in accordance with the *Operations, Maintenance and Surveillance Manual.*
- An emergency response plan is in place as documented in the *Emergency Management Program.*
- There are no observable conditions that warrant immediate action or response, except that reconsideration of the performance of the waste rock dumps above the facility is warranted.
- There are no observable conditions that give rise to a concern about risk or component malfunction, except the new information about foundation conditions that raises questions regarding embankment seismic stability.

APEG (2013) requires a finding that the dam is or is not "reasonably safe." The term is intended to mean that the *dam owner* has implemented all *dam* safety management measures which conform to those norms that are considered by the *Regulatory Authority* and the engineering profession to reasonably reflect established engineering and *dam* safety management practices.

In our opinion as noted above, Nyrstar has implemented management measures which conform to the norms required by the regulatory authority and which reasonably reflect engineering management practices.

Recent drilling and sampling near the Lynx TDF indicate that foundation conditions may vary from those assumed in the design. It is recommended that the new information be considered and embankment stability analyses updated. Pending confirmation of the fact that the embankment is stable for the recently characterized foundation conditions, it is not possible to make a conclusion as to whether or not the Lynx TDF is "reasonably safe," and conforms to established dam safety management practices.

In accordance with APEG (2013) attached to this report is the required certification.

9 RECOMMENDATIONS

On the basis of the findings above, we recommend as follows:

- Reassess the static stability and seismic response of the Lynx TDF in the light of recent information about foundation conditions.
- Asses the stability and performance of the waste rock dumps above the Lynx TDF.
- Consider relocating the waste rock dumps as soon as is practical.
- Continue maintenance and surveillance of the Lynx TDF in accordance with approved plans and procedures.
- Update and simplify documents dealing with emergency preparedness and emergency management.
- Undertake annual dam safety inspections (the next should be in about September of 2014.)

10 CLOSURE

Robertson GeoConsultants Inc. (RGC) is pleased to submit this report entitled Myra Falls Lynx Tailings Disposal Facility 2013 Dam Safety Review.

This report was prepared by Robertson GeoConsultants Inc. for the use of Nystar Myra Falls, Ltd. .

We trust that the information provided in this report meets your requirements at this time. Should you have any questions or if we can be of further assistance, please do not hesitate to contact the undersigned.

Respectfully Submitted,

ROBERTSON GEOCONSULTANTS INC.

License # 11634

Andrew Robertson, P. Eng. PhD.
Principal

J Caldwell. M.Sc.(Eng.)
Civil Engineer

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APPENDIX C: *DAM SAFETY REVIEW ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Guidelines for Legislated Dam Safety Reviews in British Columbia*, July 2013 ("*APEGBC Guidelines*") and is to be provided for *dam safety review reports* for the purposes of the *British Columbia Dam Safety Regulation*, B.C. Reg. 44/2000 as amended. Italicized words are defined in the *APEGBC Guidelines*.

To: The *Owner* Date: 26 FEB 2014.

NYSTAR MYRA FALLS LTD.

Name

MYRA FALLS OPERATIONS

P.O. BOX 800, CAMPBELL RIVER, BC

Address CANADA, V9W 5E2

With reference to the *British Columbia Dam Safety Regulation*, B.C. Reg. 44/2000 as amended.

For the *dam*:

UTM Location): UTM ZONE 10, 311850 5494680

Located at (Description): MYRA FALLS MINE, STRATHCONA PARK.

Name of *dam* or description: LYNX TDF

Dam function: RETAIN TAILINGS

Owned by: NYRSTAR MYRA FALLS LTD.

(the "*Dam*")

Current *Dam classification* is:

Check one

- ☐ Low
- ☐ Significant
- ☑ High
- ☐ Very High
- ☐ Extreme

The undersigned hereby gives assurance that he/she is a *Professional Engineer* and a *Qualified Professional*.

I have signed, sealed and dated the attached *dam safety review report* on the *Dam* in accordance with the *APEGBC* Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items (see Guideline Section 3.2):

✓ 1. Collected and reviewed available and relevant background information, documentation and data

✓ 2. Understood the current *classification* for the *dam*, including performance expectations

✓ 3. Undertaken an initial facility *review*

✓ 4. Reviewed and assessed the *dam* safety management obligations and procedures

✓ 5. Reviewed the condition of the *dam*, reservoir and relevant upstream and downstream portions of the *river*

✓ 6. Interviewed operations and maintenance personnel

✓ 7. Reviewed available maintenance records, the Operations, Maintenance and Surveillance (OMS) Manual and the Emergency Preparedness Plan

✓ 8. Confirmed proper functioning of flow control equipment

✓ 9. After the above, reassess the consequence *classification*, including the identification of required *dam* safety criteria

✓ 10. Carried out a *dam safety analysis* based on the *classification* in 9. above

✓ 11. Evaluated facility performance

✓ 12. Identified, characterized and determined the severity of deficiencies in the safe operation of the *Dam* and non-conformances in *dam* safety management system

✓ 13. Recommended and prioritized actions to be taken in relation to deficiencies and non-conformances

✓ 14. Prepared a *dam safety review report* for submittal to the *Regulatory Authority* by the *Owner* and reviewed the report with the *Owner*.

Based on my *dam safety review*, the current *dam classification* is:

Check one

- ✓ Appropriate
- ☐ Should be reviewed and amended

I undertook the following type of *dam safety review*:

Check one

- ☐ Audit
- ✓ Comprehensive
- ☐ Detailed design-based multi-disciplinary
- ☐ Comprehensive, detailed design and performance

I hereby give my assurance that, based on the attached *dam safety review report*, at this point in time:

Check one

- ☐ The *Dam* is reasonably safe in that the *dam safety review* did not reveal any unsafe or unacceptable conditions in relation to the design, construction, maintenance and operation of the *Dam* as set out in the attached *dam safety review report*

- ☐ The *Dam* is reasonably safe but the *dam safety review* did reveal non-conformances with the *Dam Safety Regulations* as set out in section(s) ____ of the attached *dam safety review report*.

☐ The *Dam* is reasonably safe but the *dam safety review* did reveal deficiencies and non-conformances as set out in section(s) ____ of the attached *dam safety review report.*

☑ The *dam* is not safe in that the *dam safety review* did reveal deficiencies and/or non-conformances which require urgent action as set out in section(s) 8 of the attached *dam safety review report.*

ANDREW ROBERTSON
Name

Date 26 FEB 2014.

[signature]
Signature

580 HORNBY ST., Suite 900.
Address
VANCOUVER BC. V6C 3B6

(Affix Professional Seal here)

778 3315060
Telephone

If the *Qualified Professional* is a member of a firm, complete the following:

I am a member of the firm ROBERTSON GEOCONSULTANTS. (Print name of firm)
and I sign this letter on behalf of the firm.