Q. [R13-Roads] - Please identify and describe the road to CAT Arm from the standpoint of its construction, use, as well as any problems that have transpired on the road in the last 25 years that would material impact a 10- and 15-year longer life expectation than the 50-year proposed ASL. Further, provide all supporting documents and assumptions associated with the response.

A. The construction, use and maintenance history for the Cat Arm road was recently included in a capital budget project proposal and accompanying report by AMEC Earth & Environmental titled "Slope Stability Assessment Reports" which was part of an application to the Board for approval. This approximately $500,000 project was subsequently approved by the Board in P.U. No. 24(2012). The proposal and report are included as CA-NLH-271 Attachment 1.

CA-NLH-271 Attachment 1 identifies a number of specific issues related to the Cat Arm road. Additionally, this Attachment 1 references the harsh environment to which the Hydro roads are subject. Any expectation of a life estimate beyond the proposed 50 years is clearly not reasonable.

Project Title: Upgrade Access Road

Location: Cat Arm

Category: Generation - Hydraulic

Type: Other

Classification: Normal

Project Description:
Work under this project comprises the completion of slope stabilization work along sections of the access road to the Cat Arm Hydroelectric Generating Station (Cat Arm). The embankment areas requiring attention are contained within a stretch of access road located between 0.5 kilometers and 1.5 kilometers from the powerhouse gate. Work includes:

- Supply and installation of bin walls;
- relocation of existing guiderail;
- removal of debris from existing drainage ditches; and
- supply and installation of class 'A' road topping over the areas affected by the work.

This work scope has been derived based on the site conditions observed during the fall of 2011 and it is expected that further deterioration may occur during the spring and early summer 2012 resulting in additional work. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2012**	**2013**	**Beyond**	**Total**
Material Supply	82.5	0.0	0.0	82.5
Labour	82.1	0.0	0.0	82.1
Consultant	0.0	0.0	0.0	0.0
Contract Work	223.6	0.0	0.0	223.6
Other Direct Costs	9.8	0.0	0.0	9.8
O/H, AFUDC & Escln.	14.5	0.0	0.0	14.5
Contingency	79.6	0.0	0.0	79.6
TOTAL	**492.1**	**0.0**	**0.0**	**492.1**

JUSTIFICATION

This project is justified on the need to provide a safe and reliable access to Hydro's generating facility at Cat Arm.

The Cat Arm Generating plant has a net output of 127 MW with an annual energy production of 710 GWh. The plant produces approximately 14 percent of Hydro's hydroelectric power capacity and comprises 16 percent of the company's hydroelectric energy capability. Year round access, without restriction, is essential to ensure that Hydro can reliably meet the electrical needs of its customers.

The roadway embankment near the powerhouse has been eroding since it was originally constructed in 1984, particularly following freeze and thaw cycles and runoff from coastal rainstorms. A number of recent rainstorms have progressed the erosion to a point whereby the existing guardrail is undermined and imminent failure of the roadway is a real concern (see Figure 1).

Figure 1: Embankment Erosion at Shoulder of Access Road

A slope stability investigation, completed by AMEC Earth & Environmental (AMEC) in June 2011, and a review of the existing site conditions by Hydro staff in October 2011 have confirmed the need for immediate stabilization. A copy of the consultant's slope stability investigation report is contained in Appendix A. Due to the impending winter weather in the region it was recognized that the work could not be safely completed in 2011 and plans were made to submit an application for unbudgeted capital to complete the work in 2012.

The eroded embankment areas require major rehabilitation work to ensure the long term performance and stability of the road. Failure to complete the recommended rehabilitation work will result in continued slope failure and probable road embankment collapse to a point where the road will be impassable or it will be unsafe for Hydro personnel to travel. This would result in loss of access to the powerhouse to address operational or maintenance problems, affecting plant reliability and power supply to Hydro's customers.

While access to the Cat Arm plant can be gained by helicopter, it is very expensive and subject to weather conditions. Access is also available via small boat; however, it is limited due to the absence of proper docking facilities. A permanent safe access road is required for the long-term reliable operation of the Cat Arm Generating Station.

Existing System

The Cat Arm Hydroelectric Generating Station contains two generating units, each rated at 67.5 MW, with a maximum production output of 63.5 MW when running simultaneously. Situated on the east side of the Great Northern Peninsula, the Cat Arm Hydroelectric Development was completed in 1984. Access to the plant is via a 25 kilometer gravel road off Route 420 near Jackson's Arm. A 250 meter section of the road, near the powerhouse at Devil Cove, requires rehabilitation work to stabilize the roadway embankments to prevent the washout of the road and maintain access to the plant.

Recognizing the need to complete the road renovations in 2012, Hydro submitted an application for Permission to Occupy to Crown Lands in April 9, 2012. Hydro subsequently applied for a Crown Easement to the road lands. This easement form of title has been determined to be appropriate for Hydro's needs as Hydro does not need to exclude others from using the road but it does require the legal right to have secure access over it, to make improvements to the road and to build and maintain structures such as guard rails, bridges and culverts. This is the form of title upon which Hydro holds a significant amount of its distribution and transmission plant. While it is not anticipated that there will be any objections to the Crown easement, the application review process is still ongoing.

<u>Operating Regime</u>

Cat Arm is a critical component of Hydro's available hydraulic resources and is in continuous operation.

Age of Equipment or System

The access road was completed in 1984. It is 28 years old.

Major Work/or Upgrades

Major work and upgrades completed on the Cat Arm Generating Plant Access Road since installation consist of road repairs and slope stabilization. Completed in 2005, this work consisted of the construction of an armour stone, wave barrier at the waterline edge to reestablish a stable road embankment. The repairs were completed in an area adjacent to the section of road required to be upgraded under this proposal. The cost to complete this work was $1,358,300.

Previous upgrades to the access road consisted of bin-wall installation to reinforce failing roadway embankments. This work was completed in 1993 and was constructed at a cost of approximately $50,000 (see Figure 2).

Figure 2: Bin-Wall Installation completed in 1993.

The bin-wall installation has proven to be an effective means of slope stabilization and is consistent with the proposed upgrade to be completed in 2012.

Operating Experience

The road embankment in the area to be upgraded was constructed on an exposed sea cliff, which has experienced significant erosion since its completion in 1984. The erosion has

progressed to a point such that the existing guiderail is undermined, leading to concerns over the potential for imminent failure of the roadway. To maintain public safety, barricades have been placed to prevent vehicular traffic from driving too close to the shoulder of the road (See Figure 3).

Figure 3: Barricades Erected in Vicinity of Undermined Guardrail

Safety Performance

The Cat Arm access road is the only viable access to the powerhouse. This road is used on a daily basis by Hydro's operating staff and at regular intervals by maintenance personnel. The embankment erosion has progressed to point where imminent failure of the road has become a concern as it poses a risk to those who utilize it.

Industry Experience

Industry experience was not considered for this work due to the unique nature of the site and environmental conditions.

Maintenance or Support Arrangements

Routine maintenance of the Cat Arm access road is performed by Hydro personnel. Snow

clearing and road rehabilitation are performed by external contractors with access to more suitable equipment for work of this nature.

Maintenance History

A summary of the maintenance expenditure history for the Cat Arm Hydroelectric Generating Plant Access Road is shown in Table 2.

An independent geotechnical assessment of the roadway embankments was completed in 2008 with a follow-up investigation completed in 2011 to assess changes to the slope condition. Copies of the inspection reports are included in Appendix A.

In 2004, corrective maintenance performed included minor repairs to the section of roadway which then received a major upgrade in 2005. The remaining corrective maintenance costs consist primarily of the clean-up of rock debris from drainage ditches and the relocation of guiderail in the vicinity of embankment erosion areas.

Table 2: Five-Year Maintenance History

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($ 000)
2011	36.1	0.0	36.1
2010	0.0	1.5	1.5
2009	0.0	0.2	0.2
2008	18.0	0.0	18.0
2004	0.0	35.6	35.6

Historical Information

Chronological Listing of Events

Concerns over the stability of roadway embankment proposed to be upgraded were first brought to Hydro's attention in 2008. In response, Hydro acquired the services of AMEC Earth and Environmental (AMEC) to investigate the short term hazards associated with the reported slope erosion. AMEC recommended relocating the guardrail three meters in from the shoulder of the road and then reassessing the condition in the spring 2009. As recommended, follow-up assessments were completed by Hydro's internal engineering

personnel in spring 2009 and 2010. Hydro noted minimal changes in the slope's condition.

Hydro further engaged AMEC in spring of 2011 to complete a follow-up slope stability investigation. Hydro requested that the consultant reassess the access road embankments to determine the further extent of erosion since the 2008 report and, if required, recommend alternatives with cost estimates to complete improvements to the road. During this investigation, AMEC found that the slope's condition had deteriorated significantly during the 2011 spring thaw and recommended that work be undertaken to prevent further deterioration. Hydro Engineering personnel travelled to Cat Arm in October 2011 to confirm the report's findings. Plans were immediately put in place to complete the recommended work under the 2012 unbudgeted capital program.

Similar Work

Similar road upgrade and slope stabilization projects are summarized in Table 3. While the magnitude of the scope for each project varies, the general work requirements are consistent with the work to be performed under this project.

In 2005, major slope stabilization work was completed along a 300 meter section of the Cat Arm access road immediately adjacent to the powerhouse gate. This section was failing due to the effects of erosion. The work consisted of the installation of an armour stone, wave barrier to prevent future erosion, and the placement of rockfill to re-establish a stable road embankment. This has proven to be successful in mitigating the effects of erosion.

The remaining projects, shown in Table 3, consisted of typical road upgrades at other locations. Work under these projects included: the supply and installation of storm culvert; drainage ditch improvements; subgrade improvements; and the supply and installation of granular topping. Table 3 summarizes the work completed over the past five years.

Table 3: Historical Information

Year	Capital Budget ($000)	Actual Expenditures ($000)	Units	Cost per unit ($000)	Comments
2011	998.0	1095.3	-	-	Burnt Dam Access Road Upgrades Phase 2
2007	309.2	288.53	-	-	Burnt Dam Access Road Upgrades Phase 1
2007	674.5	649.7	-	-	Supply and Place Road Topping Upper Salmon Access Road
2005	1,260.0	1,358.3	-	-	Cat Arm Road Repair and Slope Stabilization

Anticipated Useful Life

An asset of this type has a useful life of 30 to 50 years.

Forecast Customer Growth

Customer load growth does not affect this project.

Development of Alternatives

Due to the geographic features of this area, there are no viable alternatives to be considered. Boat or helicopter use on an ongoing basis is unacceptable, for technical as well as economic reasons, considering the importance of this major generating plant. Therefore, an economic analysis is not required to justify this project.

CONCLUSION

The Cat Arm access road embankments have deteriorated to the point that imminent failure has become a real and immediate concern. The road provides the only feasible mode of access to the plant and is travelled daily by plant operating staff and on a regular basis by plant maintenance personnel. The proposed embankment stabilization work must be completed to ensure that safe, reliable access is maintained to the plant.

The effects of erosion on embankment slopes of this nature are greatest in the spring of the year. Higher volumes of water run-off combined with saturated ground conditions resulting from the spring thaw leave sloped embankments vulnerable to washout. Given

the fragile condition of the Cat Arm Access Road embankments there is a real concern that the embankments will be unable to withstand two more spring thaw events. It is, therefore, critical that the proposed slope stabilization measures be implemented in 2012 to ensure that access to the plant is maintained. Future expenditures to address the slope stability issues will be much greater should further major embankment failure occur.

Project Schedule

The anticipated project schedule is shown in Table 4.

Table 4: Project Schedule

Activity		Start Date	End Date
Planning	Project planning and coordination with Operations	July 2012	August 2012
Design	Preparation of Tender Package/Contract Award	July 2012	August 2012
Procurement	Purchase Bin Wall	August 2012	September 2012
Construction	Embankment Stabilization Works	September 2012	September 2012
Closeout	Contract Closeout	-	Oct. 2012

APPENDIX A

AMEC Earth & Environmental Slope Stability Assessment Reports

Report on

Slope Stability Study
Road to Powerhouse
Cat Arm Hydro Development
White Bay, Newfoundland

Prepared for

Newfoundland and Labrador Hydro
500 Columbus Drive
P.O. Box 12400
St. John's, NL A1B 4K7

Prepared by:

AMEC Earth & Environmental
A Division of AMEC Americas Limited
133 Crosbie Road
P.O. Box 13216
St. John's, NL A1B 4A5

TF8310459

March 2009

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
March 2009

amec

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
March 2009

1.0 INTRODUCTION

The report herein presents the results of a slope stability investigation carried out by AMEC Earth & Environmental, a division of AMEC Americas Limited (AMEC), on rock cut and road embankments at select locations along the access road to the Cat Arm powerhouse.

This investigation and report was requested by Newfoundland and Labrador Hydro (Hydro) to examine any short term hazards associated with reported slope erosion and rock falls along a stretch of access road to the Cat Arm powerhouse between 0.5 km to 1.5 km from the powerhouse gate.

The purpose of the investigation was to identify areas of concern with respect to potential hazards from falling rock along the rock cuts and over-steeping of the road embankment due to erosion and undermining along the shoreline of Devil Cove.

The road was originally constructed in the early 1980's along a high cliff seashore to access the Cat Arm Hydro Development's power house in Devil Cove. This initial construction involved blast and fill operations, with much of the fill being fine to medium grain blast rock fill with some large armor sized stones. Falling rocks from the rock cuts on the hill-ward side of the road have been a concern since the road's construction and the erosion of the embankment in areas where it forms the shoreline has also been ongoing since construction.

A number of remedial measures have been undertaken since the initial construction, which include removing fallen rocks from the ditches and roadway, construction of bin walls in areas where the embankment has become over steepened and realignment of the guide rail to prevent travel near the eroding edge. A 300 m section of the embankment was reconstructed in 2005 and not included in this report (reported under separate cover).

2.0 SCOPE OF WORK

AMEC's work included a visual site investigation; rock mapping and stereographic analyses; and preparing a factual report addressing the items presented above.

3.0 INVESTIGATION PROCEDURES

Calvin Miles, P.Geo, of AMEC, performed the field work for this investigation on October 1, 2008. This involved the visual observation from the roadway of the rock cut faces and embankment where erosion was a concern from approximately 0.5 km to 1.5 km from the powerhouse compound gate. Where possible, dip and strike angles were taken of the bedrock joints and entered in computer software programs: Dips which plotted a stereonet and Swedge which modeled potential rock fall hazards. In referencing these areas, the existing guide rails were used. Within the study area, three sets of guide rails were encountered. For reporting purposes, each guide rail section will be reported individually.

4.0 RESULTS

4.1 SITE VISIT

For reporting purposes the site investigation was divided into three sections of road with reference to the guide rail sections as installed at the time of the investigation. Stations were referenced with respect to the number of posts from the south end of the guide rail sections. The posts were approximately 3.8 m apart. These sections were further divided into the upper rock cut slope and the lower road embankment slope.

4.1.1 Guide Rail Section 1

The first section investigated was along the stretch of roadway with a seaward guide rail starting at approximately 1.5 km south of the powerhouse compound gate and proceeded north towards the powerhouse.

A number of rock debris falls were identified at the toe of the rock cuts and within the ditch and shoulder of the road. The major areas observed are summarized below:

Table 4.1.1-A – Rock Cut Inspection, Guide Rail Section 1

Location	Quantity	Remarks
Post 0 (South end of guide rail)	22 pieces of rock ranging in size from 2 m^3 to 0.25 m^3.	Area of a fault, rocks most likely originated from a wedge feature formed by the fault and jointing. Fault surface is thin with slickensides and mylonite.
Post 5 to 15	Occasional fallen rock.	Rock face is set back from the road. Half barrels from the original blasting were observed throughout the area.
Post 17	-	Rock debris from possible previous cleanup dumped on embankment shoulder of road.
Post 20 to 21	Occasional fallen rock.	Large boulders observed high up on the slope. Small pieces of debris observed in the ditch and along the shoulder of the road that may have been graded off the road. Ditch in narrow in this area.
Post 30	Occasional fallen rock.	Several boulders in the ditch that appear to have originated from ~15 m height on the slope.
Post 41 to 54	Occasional fallen rock.	Wide ditch in good condition, with occasional small boulders originating from the lower slope.
Post 57	-	Area of gully in bedrock.

Location	Quantity	Remarks
Post 84 (North end of guide rail)	Occasional fallen rock.	Post 84 is the north end of the guide rail. Occasional rock debris observed in the ditch between Section 1 and Section 2 of guide rail.

A visual inspection of the seaward embankment of the roadway identified two areas of particular concern. These areas, along with the existing infrastructure, potential failure mechanisms, and recommendations for temporary increased safety, are presented below:

Table 4.1.1-B – Road Embankment Inspection, Guide Rail Section 1

Location	Existing Infrastructure	Failure Mechanism	Recommendations to Increase Safety in the Area
Post 35 to 39	Bin wall supporting roadway. Bin wall is partially supported on bedrock. Traffic barrier up to keep traffic away from guide rail.	Erosion at toe of slope has caused over steep conditions.	Keep barrier up and reassess in May 2009 by qualified geotechnical personnel.
Post 70 to 73	Bin wall supporting roadway. Bin wall is partially supported on bedrock. Traffic barrier up to keep traffic away from guide rail.	Erosion at toe of slope has caused over steep conditions	Move guide rail in three metres. Reassess in May 2009 by qualified geotechnical personnel.

The general location of these areas is shown on Drawing 1 in Appendix A, with select photographs presented in Appendix B.

4.1.2 Guide Rail Section 2

The second section investigated was located approximately 60 m north of the first section investigated above. This section was along the stretch of roadway with a seaward guide rail starting at approximately 1.1 km south of the powerhouse compound gate and proceeded north towards the powerhouse.

A number of rock debris falls were identified at the toe of the rock cuts and within the ditch and shoulder of the road. The major areas observed are summarized below.

Table 4.1.2-A – Rock Cut Inspection, Guide Rail Section 2

Location	Quantity	Remarks
Post 16 to 20	Occasional fallen rock.	Slope is highly fractured with some minor debris in the ditch. Bedrock appears to be undercut.
Post 20 to 45	-	Location of a small valley. Possible location for disposal of debris from cleanup operations.
Post 45 (North end of guide rail)	-	Post 45 is the north end of guide rail.

A visual inspection of the seaward embankment of the roadway identified three areas of particular concern. These areas, along with the existing infrastructure, potential failure mechanisms, and recommendations for temporary increased safety, are presented below:

Table 4.1.2-B – Road Embankment Inspection, Guide Rail Section 2

Location	Existing Infrastructure	Failure Mechanism	Recommendations to Increase Safety in the Area
Post 6 to 12	Guide rail only. No bin wall or other support mechanism.	Erosion at toe of slope has caused over steep conditions. Erosion has undermined one of the posts. Bedrock is visible on the slope at three metres below the crest of the slope.	Move guide rail in three metres. Reassess in May 2009 by qualified geotechnical personnel.
Post 16 to 21	Guide rail only. No bin wall or other support mechanism.	Erosion at toe of slope has caused over steep conditions. Erosion has reached one of the posts. Bedrock is visible on the slope at three metres below the crest of the slope.	Move guide rail in three metres. Reassess in May 2009 by qualified geotechnical personnel.
Post 43 to 45	Guide rail only. No bin wall or other support mechanism. Guide rail was previously moved in about 1.5 m.	Erosion at toe of slope has caused over steep conditions.	Move guide rail in three metres. Reassess in May 2009 by qualified geotechnical personnel.

The general location of these areas is shown on Drawing 1 in Appendix A, with select photographs presented in Appendix B.

4.1.3 Guide Rail Section 3

The third section investigated was located approximately 50 m north of the second section investigated above. This section was along the stretch of roadway with a seaward guide rail starting at approximately 0.8 km south of the powerhouse compound gate and proceeded north towards the powerhouse. This guide rail was newly reinstalled in 2005 as part of the 2005 embankment repair in this area.

Some of the fallen debris at the toe of this rock cut was cleaned up during the 2005 embankment repair. The bedrock is generally close jointed in random directions, with minor talus in the ditch. Typically it is cobble and small bounder size rock fragments. Some loose boulder size rock fragments were observed along the rock cut.

Some fallen debris was also observed at the last rock cut to the powerhouse, just north of the guide rail, consisting of a large 1.5 m x 1.5 m x 2 m boulder, and many smaller rock fragments.

Between the south end of this guide rail and 300 m north, the seaward embankment was reconstructed in 2005. This area was also investigated during this site visit and is reported separately. Approximately 50 m to 100 m north of this area, two new erosion gullies were observed along the soil embankment, with an overall slope angle of 40 degrees from horizontal.

4.2 COMPUTER MODELING

The stability of the rock cut is significantly influenced by the structural geology of the rock mass in which the cut was made. To interpret the significance of structural geology on the stability of the rock cut, orientations of naturally occurring breaks in the rock mass called discontinuities (bedding planes, joints, faults, etc.) were plotted on a stereonet (Figure 4.2-A). The stereonet allows the three dimensional orientation data to be represented and analyzed in two dimensions.

All nature discontinuities have variations in their orientations that result in scatter of the pole plots. Figure 4.2-A below, shows a contour plot of the poles. Base on the pole contours, average joint orientations were selected.

The following average orientations were observed and used in stability analysis calculations:

- Approximate rock cut face orientation: Strike 331° Dip 85°
- Set 1: Strike 036°, Dip 81°
- Set 2: Strike 082°, Dip 87°
- Set 3: Strike 046°, Dip19°

Potential wedges form where two planes intersect as shown in Figure 4.2-B below. Only wedges which could result in movement toward the free face of the slope are considered potential wedges.

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
March 2009

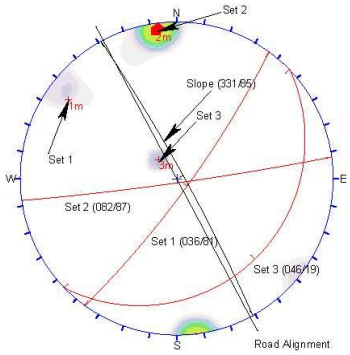


Figure 4.2-A - Contour Plot

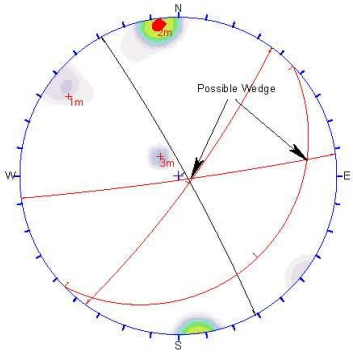


Figure 4.2-B – Wedge Plot

Information regarding these wedges were subsequently entered into a second computer program (Swedge) that graphically produced a 3D analysis along with an anticipated factor of safety, using known and assumed variables.

5.0 DISCUSSION AND RECOMMENDATIONS

It is recommended that the ends of the guide rails be surveyed to properly reference the locations discussed in this report.

5.1 ROCK CUTS

Generally, rock falls have continuously occurred since the road's construction and are mainly due to environmental conditions, such as repetitive freezing and thawing during winter and excessive wind and rain and flowing surface water throughout the year. It has been reported that after the spring melt and following major weather events, rock fragments have been observed on the roadway.

Computer modeling has shown two potential wedge failure mechanisms (shown east side of the stereonet). The wedge identified furthest east of the centre of the stereonet poses no immediate concern as the computed factor of safety is greater than 2. The second wedge mechanism, nearest the centre of the stereonet, does pose a concern as its factor of safety has been computed to be less than 1. This wedge mechanism is small (possibly the origins of many of the smaller fallen rock fragments) and most have been removed either during construction or have subsequently fallen. Any of these rock fragments which may fall are anticipated to be small in size (cobble and small boulder size) and quantity and continue to fill

the ditch and not block travel along the roadway, provided the ditches are kept clear of excessive debris.

There were three locations at the toe of the blasted slope where blocks or rock had fallen from the cliffs above. The ditches were just about full at these locations. If additional material falls this coming frost season there would be little or no room in the ditch and debris will reach the road.

Long term remediation of these areas is recommended to reduce the ongoing cleanup of rock falls and to reduce the risk rock fragments falling onto the roadway. This work would involved a detailed study of the rock cut faces, clean up of all ditches, and scaling of the rock cut faces, particularly in areas where there exists a risk of falling rock.

Any material removed from the ditches must **not** be thrown over the road embankments on the east side. This material must be transported off site or to areas on the west side of the road where the ditch is wide enough to accommodate it and where no potential rock falls can be expected. One such area is the wide valley between Posts 20 and 40 opposite the second guide rail. There is also an old borrow pit near the powerhouse that would also be suitable for rock waste disposal.

5.2 ROAD EMBANKMENT

As part of this study, recommendations were requested by Hydro to address the apparent erosion of the road embankment at 5 locations along this section of roadway. These recommendations were presented above and in an Interim Report to Hydro on October 29, 2008 (see Appendix C).

More detailed studies of these areas are required to provide a detailed remediation plan. This study would include inspection of the lower section of the embankment as viewed from the shoreline. Possible remedial activities include: construction/reconstruction of bin walls; armoring of the toe of the embankment to prevent the continued undermining by the seashore wave action; reconstruction of the embankment to a less steep angle with an engineered, erosion controlled, surface; or combination thereof.

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
March 2009

6.0 CLOSURE

This report has been prepared for the exclusive use of Hydro. The investigation was conducted in accordance with the work plan developed for this site and verbal requests from the client. The work was performed using assessment practices and procedures commonly used in the industry. The limitations of this report are attached in the Appendix D.

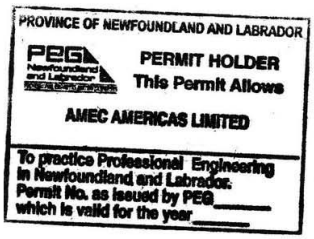
Respectfully Submitted,

AMEC Earth & Environmental
A division of AMEC Americas Limited

Kevin Penney, P.Eng.
Geotechnical Engineer

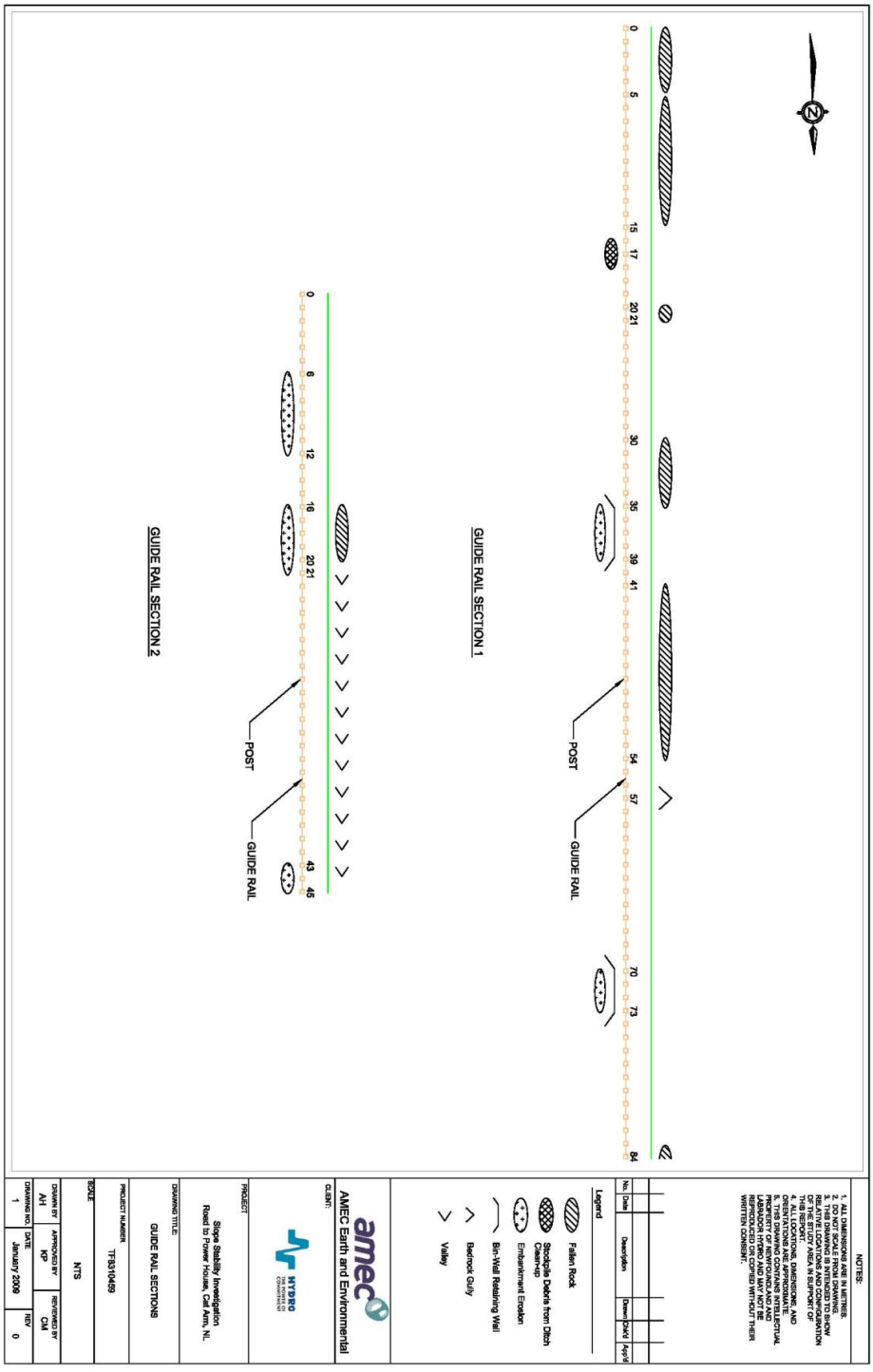
Reviewed by,

Calvin Miles, P.Geo
Senior Associate



APPENDIX A

DRAWING


NOTES:
1. ALL DIMENSIONS ARE IN METRES.
2. DO NOT SCALE FROM DRAWING.
3. THIS DRAWING IS INTENDED TO SHOW RELATIVE LOCATIONS AND DIMENSION OF THE STUDY AREA IN SUPPORT OF THE REPORT.
4. ALL LOCATIONS, DIMENSIONS, AND ORIENTATIONS ARE APPROXIMATE.
5. THIS DRAWING IS INTELLECTUAL PROPERTY OF NEWFOUNDLAND AND LABRADOR HYDRO AND MAY NOT BE REPRODUCED OR COPIED WITHOUT THEIR WRITTEN CONSENT.
No. Date Description Drawn Chkd Appvd
Legend
Fallen Rock
Stockpile Debris from Ditch Cleanup
Embankment Erosion
Bin-Wall Retaining Wall
Bedrock Gully
Valley
GUIDE RAIL SECTION 1
GUIDE RAIL SECTION 2
POST
GUIDE RAIL
POST
GUIDE RAIL
AMEC Earth and Environmental
CLIENT:
HYDRO
PROJECT:
Slope Stability Investigation
Road to Pioner Hutsak, Cat Arm, NL
DRAWING TITLE:
GUIDE RAIL SECTIONS
PROJECT NUMBER
TF8310469
SCALE
NTS
DRAWN BY AH
APPROVED BY KP
REVIEWED BY CM
DRAWING NO. 1
DATE January 2009
REV 0

APPENDIX B

PHOTOGRAPHS

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
January 2009

Photo 1 – Overview, south end of Guide Rail Section 1 looking north

Photo 2 – Fallen rock debris at Post 0, Guide Rail Section 1

Photo 3 – Fallen rock debris at Post 20-21, Guide Rail Section 1

Photo 4 – Area where rock has recently fallen from the rock cut near Post 1, Guide Rail Section 1, as shown by the brown discolouration

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
January 2009

Photo 5 – Bin wall between Post 35-39, Guide Rail Section 1

Photo 6 – Bin wall between Post 70-73, Guide Rail Section 1

Photo 7 – Embankment erosion between Post 6-12, Guide Rail Section 2

Photo 8 – Overview of embankment between Post 16-21, Guide Rail Section 2

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
January 2009

Photo 9 – Embankment erosion between Post 43-45, Guide Rail Section 2

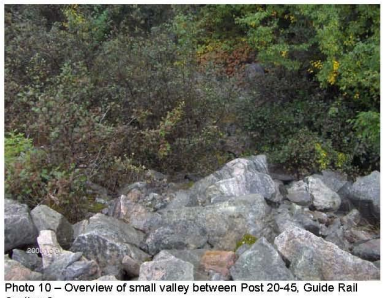


Photo 10 – Overview of small valley between Post 20-45, Guide Rail Section 2

Photo 11 – Overview of rock cut between Post 16-20, Guide Rail Section 2

Photo 12 – Overview of the 2005 embankment reconstruction along Guide Rail Section 3

Slope Stability Study (TF8310459)
Road to Powerhouse
Cat Arm Hydro Development, White Bay NL
Newfoundland and Labrador Hydro
January 2009

Photo 13 – Overview of the rock cut along Guide Rail Section 3

Photo 14 – Soil embankment north of Guide Rail Section 3

Photo 15 – Erosion gully in soil embankment, north of Guide Rail Section 3

Photo 16 – Fallen rock debris, north of Guide Rail Section 3

APPENDIX C

INTERM REPORT TO HYDRO

Memo

To	**Gary Poole, P. Eng.**	File no	**TF8310459**
From	**Calvin Miles, P. Geo**	cc	
Tel	**722 3553**		
Fax	**722 7353**		
Date	**October 29, 2008**		

Subject **Interim Report – Slope Stability Investigation, Cat Arm Hydro Development, Road to powerhouse**

Further to your request we are providing this interim report concerning the road slopes which lead to the powerhouse at the Cat Arm Hydro Development. The purpose of this brief interim report is to allow HYDRO to perform moving of the guide rail and perform some ditch cleaning before winter.

The work is referenced to the guide rail posts installed on the seaward (east) side of the road. Two continuous strips of rail exist at the site, the first starting at a point approximately 1.1 km south of the powerhouse and counting north.

Location With Reference to Posts Within the First Guide Rail Section	Existing Infrastructure	Failure Mechanism	Recommendations to Increase Safety in the Area
35 to 39	Bin wall supporting roadway. Bin wall is partially supported on bedrock. Traffic barrier up to keep traffic away from guide rail.	Erosion at toe of slope has caused over steep conditions.	Keep barrier up and reassess in May 2009.
70 to 73	Bin wall supporting roadway. Bin wall is partially supported on bedrock. Traffic barrier up to keep traffic away from guide rail.	Erosion at toe of slope has caused over steep conditions	Move guide rail in three metres. Reassess in May 2009.
Location With Reference to Posts Within the Second Guide Rail Section	**Existing Infrastructure**	**Failure Mechanism**	**Recommendations to Increase Safety in the Area**
6 to 12	Guide rail only. No bin wall or other support mechanism.	Erosion at toe of slope has caused over steep conditions. Erosion has undermined one of	Move guide rail in three metres. Reassess in May 2009.

AMEC Earth & Environmental

P:Projects\Admin\Forms\Memo.doc

		the posts. Bedrock is visible on the slope at three metres below the crest of the slope.	
16 to 21	Guide rail only. No bin wall or other support mechanism.	Erosion at toe of slope has caused over steep conditions. Erosion has reached one of the posts. Bedrock is visible on the slope at three metres below the crest of the slope.	Move guide rail in three metres. Reassess in May 2009.
43 to 45	Guide rail only. No bin wall or other support mechanism. Guide rail was apparently moved in about 1.5 m previously.	Erosion at toe of slope has caused over steep conditions.	Move guide rail in three metres. Reassess in May 2009.

There were three locations on the land (west) side of the road where blocks or rock had fallen from the cliffs above. The ditches were just about full at these locations. If additional material falls this coming frost season there would be little or no room in the ditch and debris will reach the road.

Any material removed from the ditches must not be thrown over the road embankments on the east side. This material must be transported off site or areas on the west side of the road where the ditch is wide enough to accommodate it and no potential rock falls can be expected. One such area is the wide valley between Posts 20 and 40 opposite the Second guide rail. There is also an old borrow pit near the powerhouse that would also be suitable for rock waste disposal.

P:\PROJECT\TF104 - Newfoundland Hydro\TF8310459 Cat Arm Road Slopes\Reporting\2005 Embankment\Oct 28 Memo.doc

APPENDIX D

LIMITATIONS

LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the study locations and at the time of the investigation. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Conditions between and beyond the study locations may differ from those encountered at the study locations, and conditions may become apparent during construction/remediation, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Consultant be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered during the investigation. Any locations and elevations used in this report are primarily to establish relative locations and elevation differences between the study locations and should not be used for other purposes, such as grading, excavating, planning development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Any comments made in this report on potential construction problems and possible methods are intended only for guidance of the designer. The number of study locations may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering and geophysical practices. No other warranty is expressed or implied.

The data collected and interpretation outlined in this report were based upon data collected at specific locations on the site. Our opinion cannot be extended to portions of the site for which no data were collected.

The conclusions of this report are based in part on the information provided by others. The possibility remains that unexpected conditions may be encountered at the site in locations not specifically investigated. Should such an event occur, AMEC Earth & Environmental must be notified in order that we may determine if modifications to our conclusions are necessary.

Report on

Slope Stability Investigation (Spring 2011)
Cat Arm Hydro Development
Embankment Erosion

Prepared for

Nalcor Energy
500 Columbus Drive
P.O. Box 12400
St. John's, NL A1B 4K7

Prepared by:

AMEC Earth & Infrastructure
A Division of AMEC Americas Limited
133 Crosbie Road
P.O. Box 13216
St. John's, NL A1B 4A5

TF1110498

June 2011

Slope Stability Investigation (TF1110198)
Cat Arm Hydro Development, Embankment Erosion
Nalcor Energy
June 2011

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

Slope Stability Investigation (TF1110198)
Cat Arm Hydro Development, Embankment Erosion
Nalcor Energy
June 2011

1.0 INTRODUCTION

The report herein presents the results of a slope stability investigation carried out by AMEC Earth & Infrastructure, a division of AMEC Americas Limited (AMEC), on rock cut and road embankments at select locations along the access road to the Cat Arm powerhouse.

This investigation and report was requested by Nalcor Energy to examine the slope erosion and rock falls along a stretch of access road to the Cat Arm powerhouse, between 1.0 km to 1.5 km from the powerhouse gate. The purpose of the investigation was to determine the further extent of the erosion since the 2008 inspection by AMEC and to provide recommendations and cost estimates to address these concerns.

The road was originally constructed in the early 1980's along a high cliff seashore to access the Cat Arm Hydro Development's power house in Devil Cove. This initial construction involved blast and fill operations, with much of the fill being fine to medium grain blast rock fill with some large armour sized stones. Erosion of the high fill embankments in areas where it forms the shoreline has been ongoing since construction. Falling rocks from the rock cuts on the hill-ward side of the road have been a concern since the road construction. Cleanup of this fallen rock involved the removal from the ditch and roadway and placing along the shoulder of the road, outside of the guide rail.

A number of remedial measures have been undertaken since the initial construction, which include removing fallen rocks from the ditches and roadway, construction of bin walls in areas where the embankment had become over steepened and realignment of the guide rail to prevent travel near the eroding edge. Sever erosion required a 300 m section of shoreline embankment to be reconstructed in 2005.

2.0 SCOPE OF WORK

AMEC's work included a visual site investigation and preparing a factual report addressing the items presented above. Also included are recommendations for remedial activities; additional work required to investigate and design the remedial activities and costs estimates for engineering and construction of these remedial activities.

3.0 INVESTIGATION PROCEDURES

A senior geologist and engineering technician from AMEC, performed the field work for this investigation on May 25, 2011. Fieldwork involved the visual observation from the roadway of the embankments where erosion was a concern from approximately 1.0 km to 1.5 km from the powerhouse compound gate. In referencing these areas, the existing guide rails were used. Within the study area, two sets of guide rails were encountered. For reporting purposes, each guide rail section will be reported individually. All locations were surveyed using a Topcon Hyper GA GCD Base and Rover GPS system. All data is referenced to a benchmark provided by Nalcor and was the top of grill on a catch basin at the approach to the powerhouse.

4.0 RESULTS

4.1 SITE VISIT

For reporting purposes the site investigation was divided into two sections of road with reference to the guide rail sections as installed at the time of the investigation. Stations were referenced with respect to the number of posts from the south end of the guide rail sections. The posts were approximately 3.8 m apart. Photographs of the areas of interest are shown in Appendix B.

4.1.1 Guide Rail Section 1

The first section investigated was along the stretch of roadway with a seaward guide rail starting at approximately 1.5 km south of the powerhouse compound gate and proceeded north towards the powerhouse.

During the 2008 investigation a number of rock debris falls were identified at the toe of the rock cuts and within the ditch and shoulder of the road. There had been no cleanup of the ditches since then and except for a small number of gravel, cobble and small boulder sized particles observed on the occasional snow banks the rock cut and ditches were essentially unchanged.

A visual inspection of the seaward embankment of the roadway identified two areas of particular concern. These areas, along with the existing infrastructure, potential failure mechanisms, and recommendations for remediation, are presented below:

Table 4.1.1 – Road Embankment Inspection, Guide Rail Section 1

Location	Existing Conditions	Failure Mechanism	Recommendations to Increase Safety in the Area
Post 35 to 39 Section 1 Area 1	Bin wall supporting roadway. Bin wall appears to be partially supported on bedrock. Upper structural members appear to be slightly bent outward on the south two sections. Observation of the beach from the roadway indicates that the shoreline appears to be mostly bedrock. Visually aligning the nearby bedrock exposures suggests that about ⅓ the width of the road in this area should be supported by bedrock. A traffic barrier is up to keep traffic away from guide rail.	Erosion at toe of slope has caused over steep conditions. The length of erosion has increased about 4 m to the south and working its way around the bin wall reaching the guiderail.	Add three sections of bin wall to the south end of existing wall. Repair existing bin wall. Clean ditch adjacent to hillside of fallen rocks. Move the guide rail in toward the hill four metres and continue to monitor annually or more frequently if conditions change. Additional geotechnical investigation is required to assist with design and construction of additional bin walls.

Location	Existing Conditions	Failure Mechanism	Recommendations to Increase Safety in the Area
Post 70 to 77 Section 1 Area 2	Bin wall partially supporting roadway. In the 2008 report the bin wall appeared to be partially supported on bedrock. Subsequent erosion now shows what appeared to be bedrock was a large flat boulder. Bedrock is exposed further down the slope about 30 m below the bin wall. There are three gabions installed on the north end of the bin wall, which are showing loss of material at their bases. Erosion has encroached onto the roadway to about one metre inside the guiderail over a length of five metres. Two support posts are completely undermined. Curved tree trunks on adjacent slopes show that downward soil creep is very active in this area. A traffic barrier is up to keep traffic away from guide rail.	Severe erosion at toe of slope has caused over steep conditions. Water from roadway flows down over slope in this area causing erosion.	Add five to six sections of bin wall to the north end of existing wall. Clean ditch adjacent to hillside of fallen rocks. Move the guide rail in toward the hill four metres and continue to monitor annually or more frequently if conditions change. Additional geotechnical investigation is required to assist with design and construction of additional bin walls.

The general location of these areas is shown on Drawing 1 in Appendix A, with select photographs presented in Appendix B.

4.1.2 Guide Rail Section 2

The second section investigated was located approximately 60 m north of the first section investigated above. This section was along the stretch of roadway with a seaward guide rail starting at approximately 1.1 km south of the powerhouse compound gate and proceeded north towards the powerhouse.

During the 2008 investigation a number of rock debris falls were identified at the toe of the rock cuts and within the ditch and shoulder of the road. There had been no cleanup of the ditches since then and except for a small number of gravel, cobble and small boulder sized particles observed on the occasional snow banks, the rock cut and ditches were essentially unchanged.

A visual inspection of the seaward embankment of the roadway identified four areas of particular concern. These areas, along with the existing infrastructure, potential failure mechanisms, and recommendations for remediation are presented below:

Table 4.1.2 – Road Embankment Inspection, Guide Rail Section 2

Location	Existing Conditions	Failure Mechanism	Recommendations to Increase Safety in the Area
Post 6 to 12 Section 2 Area 1	Guide rail only. No bin wall or other support mechanism. Erosion has undermined one of the posts. Apparent bedrock is visible on the slope at three metres below the crest of the slope.	Erosion at toe of slope has caused over steep conditions.	Move guide rail in four metres. Reassess annually or more frequently if conditions change..
Post 16 to 21 Section 2 Area 2	Guide rail only. No bin wall or other support mechanism. Four guiderail posts are completely undermined with a fifth in imminent danger of undermining. There is a considerable loss of material from the slope since the last inspection of 2008. There are tension cracks at the crest of slope in the roadway about one metre inside the guiderail. Maximum loss of material is about two metres inside the guiderail and nearly reaching the temporary barrier. The embankment material at this eroded area is comprised of mostly sand and gravel with some cobbles and boulders. Apparent bedrock is visible on the slope at eight metres below the crest of the slope.	Erosion at toe of slope has caused over steep conditions.	Additional support is required on this slope to protect the road. This may be achieved by: Provide bin walls along the eroding area and for several metres on either side. Found bin walls on suitable bearing stratum or bedrock. A geotechnical investigation through boreholes or deep test pits is required to assist with design and construction of additional bin walls.
Post 32 to 37 Area 3	Guide rail only. No bin wall or other support mechanism. Double culverts installed at this location. Both high and dry and apparently broken and dipping down the slope. Small stream on other side of road runs underground between large boulders. Abundant bedrock on either side of an eroded gully about four to five metres wide.	Erosion at toe of slope has caused over steep conditions.	Monitor annually or more frequently if conditions change.
Post 43 to 45 Area 4 (formerly Area 3)	Guide rail only. No bin wall or other support mechanism. Guide rail was previously moved in about 1.5 m.	Erosion at toe of slope has caused over steep conditions.	Move guide rail in three metres. Monitor annually or more frequently if conditions change.

The general location of these areas is shown on Drawing 1 in Appendix A, with select photographs presented in Appendix B.

5.0 COST ESTIMATE

In accordance with the recommendations provided in this report, a Class D cost estimate to conduct the required work is approximately **$ 310,000.00**. A breakdown of the construction costs are shown below.

Item	Est Rate	Amount	Units	Total Cost
Bin Wall	$ 400.00	200	m2	$ 80,000.00
Granular Backfill and Road Surfacing	$ 40.00	1500	m3	$ 60,000.00
Blast Rock Fill	$ 30.00	1000	m3	$ 30,000.00
Excavator (per hour)	$ 200.00	250	m3	$ 50,000.00
Rock Truck (per hour)	$ 150.00	250	m3	$ 37,500.00
Guide Rail Removal and Reinstall	$ 20,000.00	1	est	$ 20,000.00
Misc Items and Expenses	$ 17,500.00	1	est	$ 17,500.00
Mob/demob	$ 15,000.00	1	est	$ 15,000.00
		TOTAL		**$ 310,000.00**

Engineering, tendering, and construction monitoring costs are estimated to be $97,340. Details of these costs are shown in Appendix C.

6.0 SCHEDULE

One week of field work required to advance boreholes to assist with the design and tender. Preparation of the design brief and tender is expected to take three to four weeks to complete, with tendering and award taking another four weeks. Construction activities are expected to be completed in three weeks. Currently the additional field investigation can begin in July with reporting and the tender documents completed by the end of August. Construction can begin in September and finish in October.

7.0 CLOSURE

This report has been prepared for the exclusive use of Nalcor Energy. The investigation was conducted in accordance with the work plan developed for this site and verbal requests from the client. The work was performed using assessment practices and procedures commonly used in the industry. The limitations of this report are attached in the Appendix D.

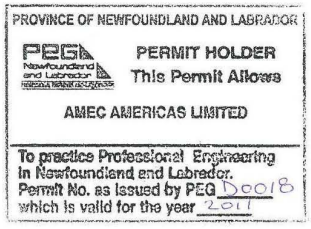
Respectfully Submitted,

AMEC Americas Limited
Earth & Environmental

Calvin Miles, P Geo
Associate

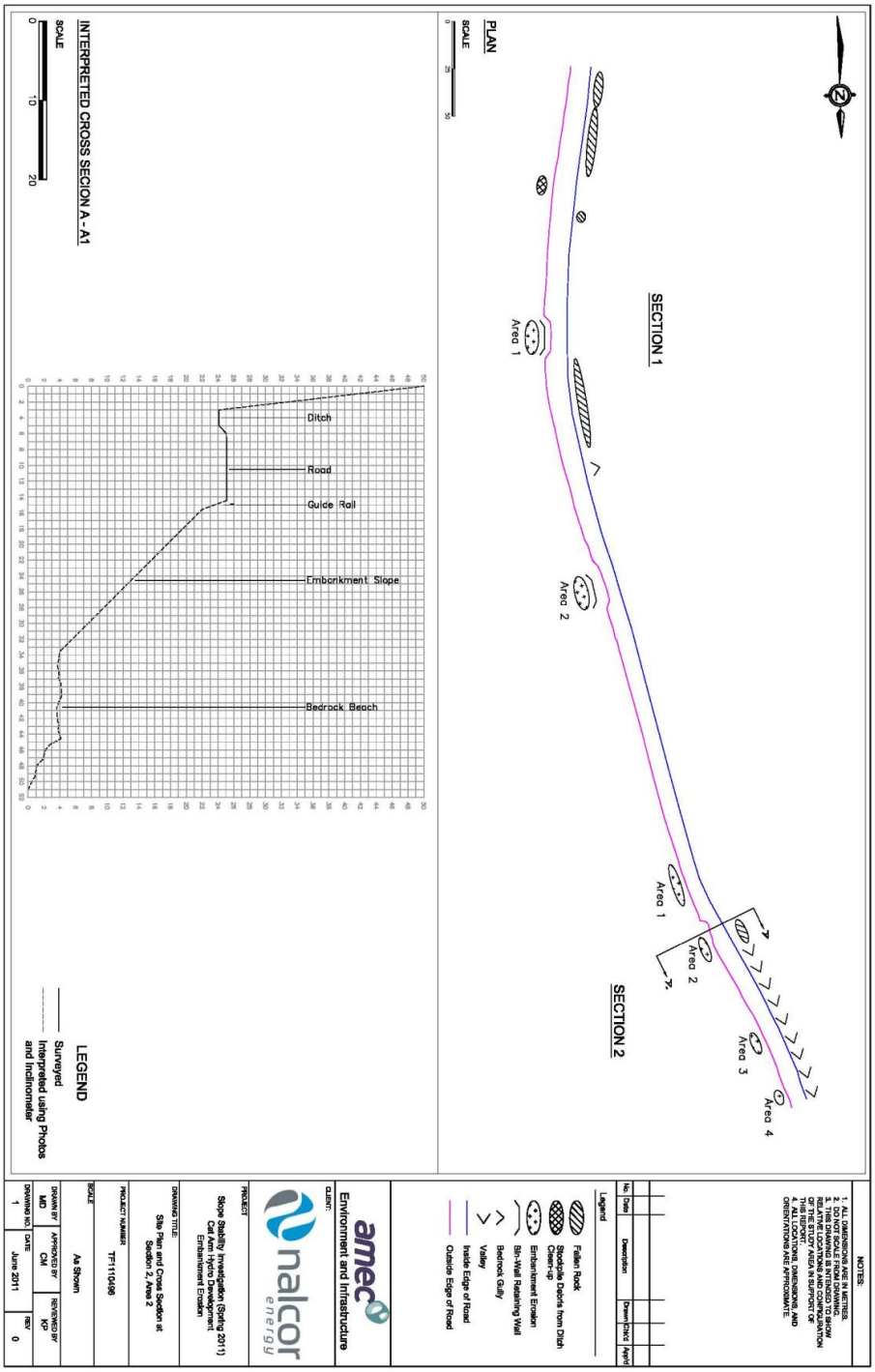
Reviewed by,

Kevin Penney, P Eng
Geotechnical Engineer



APPENDIX A

DRAWING


NOTES:
1. ALL DIMENSIONS ARE IN METRES.
2. DO NOT SCALE FROM DRAWING.
3. THIS DRAWING IS INTENDED TO ILLUSTRATE RELATIVE LOCATIONS AND CONFIGURATION OF THE STUDY AREA IN SUPPORT OF THE GEOTECHNICAL REPORT.
4. ALL LOCATIONS, DIMENSIONS, AND ORIENTATIONS ARE APPROXIMATE.
No. Date Description Drawn Chkd Appvd
Legend
Fallen Rock
Stockpile Debris from Ditch Clean-up
Embankment Erosion
Bin-Wall Retaining Wall
Bedrock Gully
Valley
Inside Edge of Road
Outside Edge of Road
SECTION 1
SECTION 2
Area 1
Area 2
Area 3
Area 4
PLAN
SCALE
0 25 50
INTERPRETED CROSS SECION A - A1
SCALE
0 10 20
Ditch
Road
Guide Rail
Embankment Slope
Bedrock Beach
LEGEND
Surveyed
Interpreted using Photos and Inclinometer
amec
Environment and Infrastructure
CLIENT:
nalcor energy
PROJECT
Slope Stability Investigation (Spring 2011)
Cat Arm Hydro Development
Embankment Erosion
DRAWING TITLE:
Site Plan and Cross Section at Section 2, Area 2
PROJECT NUMBER
TF110496
SCALE
As Shown
DRAWN BY MD
APPROVED BY CM
REVIEWED BY KP
DRAWING NO. 1
DATE June 2011
REV 0

APPENDIX B

PHOTOGRAPHS

Photo 1 – Section 1, Area 1 – Bin wall showing some erosion at the south end

Photo 2 – Section 1, Area 1 – Erosion of the embankment

Photo 3 – Section 1, Area 2 – Erosion progressing into the driving surface of the road. Existing gabions are starting to be undermined.

Photo 4 – Section 1, Area 2 – Tension cracks at edge of road and guiderail post suspended

Photo 5 – Section 1, Area 2 – View looking south showing relative locations of the eroded area and the rock cut

Photo 6 – Section 2, Area 1 – Continuing Erosion has Progressed to Undermining a Guiderail Post

Photo 7 – Section 2, Area 2 – Erosion reaching driving surface and undermined four guiderail posts. Tension crack visible at crest of road

Photo 8 – Section 2, Area 2 – Beach conditions and rapidly eroding slope comprising a high proportion of sand and gravel

Photo 9 – Section 2, Area 2 – Steep rock slope adjacent to and on other side of the road

Photo 10 – Section 2, Area 3 – Eroding embankment and tilted culverts

Photo 11 – Section 2, Area 4 – Moderately eroding slope

APPENDIX C

COST ESTIMATE

Nalcor - Cat Arm Hydro Development
TF1110498
Page 1 of 1

amec

Position	Proposed Personnel	Hours	Rate	Fees	Duties	Expense Item	Units	Cost	Expenses
Site Investigation	Additional geotechnical investigation (includes boreholes)								
Geotechnical Engineer	Kevin Penney	30	$ 121.00	$ 3,630.00	Site Visit & Reporting	Flight + expenses	2	$ 700.00	$ 1,400.00
Sr. Review	Calvin Miles	5	$ 184.00	$ 920.00	Sr review & initial site visit	Daily Expenses (hotel/meals)	6	$ 200.00	$ 1,200.00
Technician	-	60	$ 68.00	$ 4,080.00	Site visit, drilling & drafting	Daily Pickup + Fuel	5	$ 150.00	$ 750.00
Clerical	-	2	$ 65.00	$ 130.00		Driller Mob/demob	1	$ 1,000.00	$ 1,000.00
H&S	-	4	$ 75.00	$ 300.00		Drilling (per hour)	40	$ 300.00	$ 12,000.00
			TOTAL	**$ 9,060.00**				**TOTAL**	**$ 16,350.00**
Design Brief	Prepare a design brief outlining the various remedial options and costs. Remodel the wave height (energy) using the new near shore profile.								
Civil Engineer	Cliff Smith/Janet Williams	10	$ 121.00	$ 1,210.00	Reporting	Misc expenses	1	$ 400.00	$ 400.00
Geotechnical Engineer	Kevin Penney	20	$ 121.00	$ 2,420.00	Reporting				$ -
Sr. Review	Calvin Miles	5	$ 184.00	$ 920.00	Sr review				
Technician	-	40	$ 68.00	$ 2,720.00	Drafting etc			**TOTAL**	**$ 400.00**
Clerical	-	2	$ 65.00	$ 130.00					
			TOTAL	**$ 7,400.00**					
Tender & Spec Preparation	Prepare technical specifications and construction drawings.								
Civil Engineer	Cliff Smith/Janet Williams	15	$ 121.00	$ 1,815.00	Reporting	Misc expenses	1	$ 400.00	$ 400.00
Geotechnical Engineer	Kevin Penney	5	$ 121.00	$ 605.00	Reporting				$ -
Sr. Review	Calvin Miles	2	$ 184.00	$ 368.00	Sr review				
Technician	-	20	$ 68.00	$ 1,360.00	Drafting etc			**TOTAL**	**$ 400.00**
Clerical	-	5	$ 65.00	$ 325.00					
			TOTAL	**$ 4,473.00**					
Tender & Contract Award	Assist Nalcor with tendering and contract award. Includes site visit prior to tender closing.								
EIT/Sr Tech	to be determined	20	$ 90.00	$ 1,800.00	prep + site visit	Flight + expenses	2	$ 700.00	$ 1,400.00
Geotechnical Engineer	Kevin Penney	20	$ 121.00	$ 2,420.00	Meetings, Management, Site Visit	Daily Expenses (meals)	2	$ 50.00	$ 100.00
Sr. Review	Calvin Miles	5	$ 184.00	$ 920.00	Planning, Review, Meeting	Daily Pickup + Fuel	1	$ 150.00	$ 150.00
Civil Engineer	Cliff Smith/Janet Williams	5	$ 121.00	$ 605.00	Meetings, Management				
H&S	-	4	$ 75.00	$ 300.00	Review contractors HASP			**TOTAL**	**$ 1,650.00**
Clerical	-	2	$ 65.00	$ 130.00					
			TOTAL	**$ 6,175.00**					
Construction Supervision (Assume 3 weeks field work)	Supervise construction activities.								
EIT/Sr Tech	to be determined	250	$ 90.00	$ 22,500.00	assume 70 hr week + prep + travel	Flight + expenses	3	$ 700.00	$ 2,100.00
Geotechnical Engineer	Kevin Penney	30	$ 121.00	$ 3,630.00	Meetings, Management, Site Visit	Daily Expenses (Hotel + meals)	20	$ 200.00	$ 4,000.00
Sr. Review	Calvin Miles	20	$ 184.00	$ 3,680.00	Planning, Review, Site Visit	Daily Pickup + Fuel	20	$ 150.00	$ 3,000.00
H&S	-	4	$ 75.00	$ 300.00	Review contractors HASP				
Clerical	-	2	$ 65.00	$ 130.00				**TOTAL**	**$ 9,100.00**
			TOTAL	**$ 30,240.00**					
Completion Report / As Builts	Prepare completion report and as-builts of the construction activities.								
EIT/Sr Tech	to be determined	20	$ 90.00	$ 1,800.00	Reporting	Misc expenses	1	$ 400.00	$ 400.00
Geotechnical Engineer	Kevin Penney	10	$ 121.00	$ 1,210.00	Reporting				$ -
Sr. Review	Calvin Miles	3	$ 184.00	$ 552.00	Sr review				
Technician	-	20	$ 68.00	$ 1,360.00	Drafting etc			**TOTAL**	**$ 400.00**
Clerical	-	3	$ 65.00	$ 195.00					
			TOTAL	**$ 5,117.00**					
			TOTAL FEES	$ 62,465.00	plus 6% of fees	**$ 66,212.90**			
			TOTAL EXPENSES	$ 28,300.00	plus 10% of expenses	**$ 31,130.00**			
			TOTAL COST		**$ 97,342.90**				

APPENDIX D

LIMITATIONS

LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the study locations and at the time of the investigation. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Conditions between and beyond the study locations may differ from those encountered at the study locations, and conditions may become apparent during construction/remediation, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Consultant be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered during the investigation. Any locations and elevations used in this report are primarily to establish relative locations and elevation differences between the study locations and should not be used for other purposes, such as grading, excavating, planning development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Any comments made in this report on potential construction problems and possible methods are intended only for guidance of the designer. The number of study locations may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering and geophysical practices. No other warranty is expressed or implied.

The data collected and interpretation outlined in this report were based upon data collected at specific locations on the site. Our opinion cannot be extended to portions of the site for which no data were collected.

The conclusions of this report are based in part on the information provided by others. The possibility remains that unexpected conditions may be encountered at the site in locations not specifically investigated. Should such an event occur, AMEC Earth & Environmental must be notified in order that we may determine if modifications to our conclusions are necessary.