REPORT ON

BLASTING IMPACT ASSESSMENT
PROPOSED FLAMBOROUGH QUARRY
ST MARYS CEMENT INC.

Submitted to:

St Marys Cement Inc. (Canada)
55 Industrial Drive
Toronto, Ontario
M4G 3W9

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November 2008 08-1117-0009

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The following report is an assessment of the potential effects from blasting operations for a proposed quarry project located on Part of Lots 1, 2 and 3, Concession 11 in the geographic Township of East Flamborough, now the City of Hamilton. Specifically, this report assesses the potential effects of ground and air vibration levels that could be produced at neighbouring residential and commercial properties, and whether these effects could meet the applicable recommended guidelines set out by the Ontario Ministry of Environment.

The investigation involved an initial site visit to view the existing property, as well as a review of the ground and air vibration monitoring results from blasting operations at other limestone quarries in the region.

This report addresses the following topics:

- reviews existing provincial and federal guidelines for the assessment of environmental impacts from blasting,
- provides recommendations for the continued control of ground and air vibration effects,
- evaluates the potential impact of the blasting operations on bedrock strata and adjacent water wells,
- evaluates the long term impact of the blasting operations on surrounding structures, and
- evaluates the impact of ground vibration effects at adjacent Canadian Fisheries waters.

This assessment was carried out by Mr. Marcus van Bers, P.Eng., an Associate with Golder Associates, who has been involved in rock mechanics and blasting engineering for over 20 years. Mr. van Bers provides supervision and technical involvement in all aspects of blasting control, including design, blast optimization, feasibility studies, preparation of specifications, design and implementation of monitoring programs, and assessing the environmental impact of blasting operations on adjacent facilities. Mr. van Bers, whose curriculum vitae is found in Appendix B, has been involved with blasting projects throughout North and South America, Asia, Africa and the Caribbean.

2.0 SITE CONDITIONS

The proposed quarry property is situated approximately 6 km north of Carlisle and about 10 km west of the Town of Milton, Ontario in the Township of East Flamborough, now the City of Hamilton, as seen in Figure 1. The area being considered for quarry development is bounded by Milburough Line to the east and 11th Concession Road East to the south (see Figure 2).

As seen in Figure 2, the proposed limits of extraction for the site indicate that the closest residences around the property are located at the following distances:

- 150 m to the northwest on Bronte Lane,
- 470 m to the north on GlenIron Road,
- 470 m to the east on the west side of Milburough Line,
- 590 m to the southeast on the north side of 11th Concession Road East,
- 140 m to the south on the south side of 11th Concession Road East, and
- 160 m to the southwest on the north side of 11th Concession Road East.

The general topography of the proposed quarry property consists of gently rolling terrain with bedrock outcrops evident at several locations around the site.

3.0 PROPOSED QUARRY EXTRACTION AND BLAST PROCEDURE

The limestone bedrock would to be excavated to the base of the Amabel Formation, at an approximate elevation of 247 – 250 m. The limestone would be extracted in a single bench ranging in height from 35 to 38 m or two benches of 16 to 20 m in height, as discussed below. The quarry is anticipated to operate throughout the year with an annual maximum production of 3 million tonnes.

Bedrock excavation within the proposed St Marys Flamborough quarry would commence with a 16 to 20 m deep sinking cut in the east quadrant of the quarry, shown adjacent to Area 1 on Figure 2. Once the area had been opened up the exposed faces would be mapped to assess the continuity of jointing previously identified within the rock mass (Golder Associates, 2008). If continuous joints are noted then subsequent extraction would be carried out with two 16 to 20 m benches, separated by 8 to 10 m. If the joints are found not to be continuous a second sinking cut would be taken out to the final floor elevation of the quarry and subsequent extraction would be carried out in a single bench. Area 1 in the northeast portion of the property would be extracted first in a north and westerly direction. The westerly face in Area 1 would proceed into Area 2, in the north western quadrant of the property, as shown on Figure 2. Area 3 in the south western quadrant would be extracted in a southerly direction, as would Area 4 upon the completion of Area 3. To ensure a suitable number of working faces during extraction, it is expected that subsequent Areas would be started prior to completion of earlier Areas. No more than two Areas however, would be working concurrently.

Table 1 shows blast design parameters and details that would be reasonable for the proposed quarry, based on the bench height, production requirements and distances to the nearest residences. Common quarry blasting terms are illustrated in Figure 3. Depending on the bench height it is anticipated that blasting would occur from one to three times per week at peak production levels. The duration of each blast would generally be less than about one second.

All explosives used for the purposes of blasting would be brought on site on the day of each blast. No explosives would be stored on site at any time.

4.0 IMPACT IDENTIFICATION

The environmental effects most often associated with blasting operations are ground and air vibrations.

The intensity of ground vibrations, which is an elastic effect measured in units of peak particle velocity, is defined as the speed of excitation of particles within the ground resulting from vibratory motion. For the purposes of this report, peak particle velocity is measured in mm/s.

While ground vibration is an elastic effect, one must also consider the plastic or non-elastic effect produced locally by each detonation when assessing the effects on the bedrock strata and local water wells. The detonation of an explosive produces a very rapid and dramatic increase in volume due to the conversion of the explosive from a solid to a gaseous state. When this occurs within the confines of a borehole it has the following effect:

- The bedrock in the area immediately adjacent to the explosive product is crushed. As the energy from the detonation radiates outward from the borehole, the bedrock between the borehole and quarried face becomes fragmented and is displaced while the bedrock behind the borehole is fractured.
- Energy not used in the fracturing and displacement of the bedrock dissipates in the form of ground vibrations, sound and air vibration. This energy attenuates rapidly from the blast site due to geometric spreading and natural damping.

Air vibration, or airblast, is a pressure wave traveling through the air produced by the direct action of the explosive on air or the indirect action of a confining material subjected to explosive loading. Air vibration from surface blasting operations consist primarily of acoustic energy below 20 Hz, where human hearing is less acute (Siskind et al., 1980), while noise is that portion of the spectrum of the air vibration lying within the audible range from 20 to 2000 Hz. It is the lower frequency component (below 20 Hz) of air vibrations, that which is less audible, that is of interest as it is often the source of secondary rattling and shaking within a structure. For the purposes of this report, air vibration is measured as decibels in the Linear or Unweighted mode (dBL). This differs from noise (above 20 Hz) which is measured in dBA.

Both ground and air vibration effects produced at private structures adjacent to surface or underground mining operations are subject to guidelines contained in Noise Pollution Control (NPC) publication 119 of the Model Municipal Noise Control By-Law, dated August, 1978, published by the Ontario Ministry of Environment. The guideline limits for ground and air vibration levels at the nearest private structure to the quarry property are 12.5 mm/s and 128 dBL respectively. These limits apply under conditions where monitoring of the blasting operations is routinely carried out, which would be the case for the proposed quarry. A copy of Publication NPC 119 is contained in Appendix A.

The Department of Fisheries and Oceans (DFO) has established a set of guidelines for the use of explosives in or near Canadian fisheries waters (1998). These guidelines set out that "No explosive may be used that produces or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during egg incubation". Under conditions where these guidelines could not be met the proponent would be required to prepare a mitigative plan outlining additional procedures for protecting fish and their habitat. As discussed in Section 5.4 following, compliance with the DFO guidelines will be maintained.

5.0 IMPACT ASSESSMENT

5.1 Compliance with NPC 119

Both ground and air vibration levels lose energy and dissipate with increasing distance from the blast source. The rate at which these effects attenuate or dissipate from a particular site are dependent on geologic and environmental conditions, topography and the particulars of the blast design. The intensity of ground and air vibration effects from any surface blasting operation are primarily governed by the distance between the receptor and the blast and the maximum weight of explosive detonated per delay period within the blast. In the absence of specific monitoring data from the proposed quarry, as no blasting has yet been carried out, attenuation characteristics are estimated based on a literature review and the use of blast monitoring data collected by Golder at other limestone operations in Southern Ontario.

5.1.1 Ground Vibrations

Attenuation rates based on blast monitoring data collected from several currently active limestone quarries in Southern Ontario represents considerably more stringent estimates for ground vibration intensities than that given in the literature, as shown below.

$PPV = 770\ (D/\sqrt{W})^{-1.29}$ (Data compiled from Golder Associates records)
$PPV = 443\ (D/\sqrt{W})^{-1.38}$ (Crum et al., 1995)

where PPV = peak particle velocity (mm/s)
D = distance from blast to receptor (m)
W = maximum explosive weight per delay period (kg)

Table 2 illustrates the maximum allowable explosive weight that may be detonated per delay period for maintaining a peak ground vibration level of 12.5 mm/s at varying distances from the blast for both equations. It is evident from Table 2 that the maximum explosive weight anticipated to be used at the proposed quarry, as seen in Table 1, could be used for all blasting beyond a minimum distance of about 500 m for a single bench or 300 m for two benches from adjacent residences while maintaining the recommended provincial guideline ground vibration limit of 12.5 mm/s. This is based on use of the more restrictive Golder equation. Using the Crum equation would imply the MOE guidelines could be met for all blasting within about 265 m of adjacent residences, assuming a single bench and using the proposed blasting parameters contained in Table 1. Establishing site specific ground and air vibration attenuation characteristics at the commencement of blasting however, would better define when changes to the blasting procedures become necessary.

For the purposes of this report, we have assumed that the ground and air vibration attenuation rates follow the more stringent equation derived from the Golder data compiled from other limestone quarries in Southern Ontario. As such, any blasting within about 500 m of adjacent private residences, assuming a single ench, would necessitate a reduction in the maximum explosive weight detonated per delay period so that the peak ground vibration levels could be maintained below 12.5 mm/s. Any one or combination of the following operations would reduce the maximum explosive weight per delay:

1. Reducing the borehole diameter with a corresponding reduction in the drill pattern. Due to the potential for hole wander, a minimum hole diameter of 114 mm is recommended when extracting a single 35 -38 m bench height.

2. Introduce decked charges within each borehole, as illustrated on Figure 3. Multiple decks fired on different delays are anticipated as extraction proceeds to the quarry limits to the northwest, south and southwest.

3. Reduce the borehole length (depth) by reducing the bench height.

For example, a reduction in the borehole diameter from 127 mm to 114 mm would reduce the explosive weight per hole from approximately 350 kg to about 275 kg for a 35 m bench height. Alternatively, introducing a second explosive deck per hole, as shown in Figure 3 would reduce the maximum explosive weight per delay from 350 kg to about 165 kg. Introducing a second deck in a 35 m deep hole would conceivably allow blasting to approach to within about 300 m of adjacent residences based on the attenuation data discussed previously. Using a combination of multiple decks and a smaller borehole diameter would result in a further reduction in maximum explosive weight per delay period.

5.1.2 Air Vibrations

The air vibration data compiled by Golder from limestone quarries in Southern Ontario also represents more restrictive estimates for maximum allowable explosive weights for maintaining the recommended provincial air vibration guideline limit of 128 dBL, compared to that given in the literature, as shown in the following equations.

$AC = 163.3 - 21.32\log^{10}(D/\sqrt[3]{W})$ (Data compiled from Golder Associates records)
$AC = 1.0(D/\sqrt[3]{W})^{-1.1}$ (Oriard, 1999)

where AC = Air Vibration (dBL – Golder, psi - Oriard)
D = distance from blast to receptor (m – Golder, ft - Oriard)
W = maximum explosive weight per delay period (kg – Golder, lb - Oriard)

Table 3 shows the maximum allowable explosive weights for maintaining the provincial guideline limit of 128 dBL using these two equations. It is evident in comparing Tables 2 and 3 that the ground vibration limit (see Table 2) represents the more restrictive effect at adjacent residences. It is also evident from Table 3 that a majority of the proposed quarry may be extracted while maintaining the provincial guideline limit of 128 dBL, based on the blast design parameters identified in Table 1. Reducing the maximum explosive weight per delay period for maintaining the ground vibration limit, as discussed previously, would by consequence also reduce the air vibration effects.

5.2 Blast Effects on Bedrock and Water Wells

As discussed previously, under typical blasting conditions stresses introduced into the bedrock by the explosive detonation and the accompanying gas pressures create and extend fractures within the bedrock around each borehole. Fracture development is usually limited to a distance of about 20 to 30 times the borehole diameter. In the case of the blast procedures given for the proposed quarry, this would be limited to an area immediately around each blast. The gas pressures within the hole may extend micro-cracks or existing natural discontinuities within the bedrock, such as joints or bedding planes. Studies on crack development within bedrock from blast detonations (Keil et al., 1977) indicate that peak ground vibration levels of 300 to 600 mm/s are required to create micro-cracks or open existing discontinuities. Our own experience within the limestone of Southern Ontario indicates that such values would not be anticipated beyond a distance of about 5 to 10 m from the blast, depending on such parameters as drill hole diameter and the type of explosive product. The creation or extension of fractures within the bedrock would remain confined to an area immediately around the blast site. This is the principal reason why each blast is made up of a pattern of holes. The explosive in each hole has only sufficient energy to fracture the bedrock around that particular hole.

Several studies have been carried out to investigate the effects of blasting on ground water wells (Froedge, 1983). These studies have concluded that:

1. When blast induced ground vibrations are less than about 25 mm/s maximum resultant particle velocity, the response of the well is limited to a slight temporary variation in water level on the order of 3 to 6 cm either up or down. The specific capacity of the water well is unchanged based on drawdown tests.

2. Vibration measurements made at the surface and at the bottom of the observation wells indicate the vibration levels are always lower at the bottom of the well.

3. All of the data collected indicates that a ground vibration limit of 50 mm/s peak particle velocity is adequate to protect the wells from any significant damage. There is a possibility that temporary turbidity may be caused at lower levels periodically, although not at any constant threshold level.

The research consistently indicates that blast vibrations below 25 mm/s should have no adverse effects on nearby wells. As the maximum provincial guideline vibration limitation at the nearest residence is only half of this value, at 12.5 mm/s, the ground vibrations produced from the quarry's blasting operations would have no effect on the neighbouring water wells.

5.3 Repeated Vibration Effects on Structures

Blast vibrations characteristically produce temporary transient strains within the various materials that makeup a residential structure. These strains would typically have durations of no more than one or two seconds for each blast as the vibration passed the structure. While the blasting may introduce these temporary strains a few times each week for one or two seconds, Table 4 shows the strain levels produced in a household by changes in temperature and humidity (environmental changes), as well as those produced by regular household activities (Dowding, 1985), which take place on a recurring and significantly more frequent basis. These strain levels are compared to equivalent levels of ground vibration produced from blasting operations. It is evident from Table 4 that routine household activities and environmental changes can produce strains within a structure that are well in excess of those produced by blasting.

Several studies have also been carried out to look at the long-term effects of repeated blasting on structures (Stagg et al, 1984, Siskind et al, 1980). These studies concluded that repeated blasting over several decades, producing peak vibration levels well in excess of the provincial guideline limit, were required to cause cosmetic threshold cracking to occur. By ensuring that blasting continues to remain within the provincial guideline limits, there would not be any noticeable cumulative effect associated with the blasting operations from the proposed quarry.

5.4 Effect on Canadian Fisheries Waters

Fish habitat has been identified to occur in a number of creeks and tributaries around the proposed quarry. Those closest to the extraction footprint include:

- Flamborough Creek to the southeast at 470 m,
- Mountsberg Creek to the northwest at 180 m,
- Tributary A to the north at 140 m, and
- Tributaries C and D to the south at 70 m.

A more comprehensive description of the fish habitat can be found in the Stantec report entitled “EIS and Level 2 Natural Environment Report: Proposed Mountsberg Quarry”, dated February 24, 2006.

Based on the ground vibration attenuation rates discussed previously in Section 5.1.1, peak ground vibration levels would be expected to fall below the DFO draft guideline limit of 13 mm/s at a distance of about 500 m from the blasting operations, assuming a single bench. The ground vibration limit would only apply during the spawning season at identified spawning depressions. Maintaining compliance with the DFO guidelines could therefore easily be achieved during extraction of a majority of the proposed quarry. In the event that spawning depressions are identified within 500 m of the blasting operations, maintaining compliance with the DFO guidelines could be achieved by ensuring that blasting occurred outside spawning periods. This would only be required for Tributaries A, C and D. While the Mountsberg Creek is situated within 500 m of the extraction footprint, maintaining compliance with the MOE guideline limits for those residences on Bronte Lane, which are closer to the footprint, would by consequence ensure the DFO limit was maintained.

It should be recognised that the 500 m discussed here is based on use of the more restrictive Golder attenuation equation and assuming a single bench. On site monitoring at the commencement of blasting operations would define the site specific attenuation characteristics and better identify when and if changes to the blast procedures become necessary.

1.0 RECOMMENDATIONS

As part of the ongoing blasting operations for the extraction of the proposed quarry we recommend the following:

- The initial series of regular production blasts shall be monitored at a minimum of five locations at varying distances from each blast to confirm that the actual ground and air vibration attenuation characteristics are in accordance with the attenuation characteristics discussed in this report. This would entail establishing monitoring stations between the blast site and neighbouring residents to the west and south during the sinking cut and development of the bench face. The site specific attenuation data developed during this monitoring period shall then be used to better define ground and air vibration effects at the nearest properties.

- Subsequent routine monitoring of all blasting operations shall be carried out in the vicinity of the closest receptor to the proposed blasting operations. As extraction continues within the quarry and blasting operations move, the actual monitoring site shall be routinely and regularly reviewed so that the closest receptor is always being monitored for ground and air vibration effects.

- Blasting shall be scheduled so that it occurs routinely during a specific period of time each day. For example, all blasting may occur during a window of time from say 12:00 noon to 2:00 p.m. Whatever window of time is selected by the quarry, this information shall be made available to the neighbouring property owners.

- The minimum blast hole size shall be limited to 114 mm to minimize the potential for holes to wander if drilling a 35 to 38 m bench.

- In the event that the quarry is extracted using a single bench, blast holes shall be periodically surveyed, such as with a Boretrac, to ensure they are being drilled vertically as per the blast design. Only a few holes need to be surveyed in any particular blast. The frequency of the surveys shall be increased if there is evidence of hole deviation but as a minimum the blast holes shall be surveyed four times per year.

7.0 CONCLUSIONS

Based on the foregoing considerations, it is our opinion that the proposed St Marys Cement Flamborough quarry, located on Part of Lots 1, 2 and 3 of Concession 11 in the geographic Township of East Flamborough, now the City of Hamilton, can readily be operated within the current quarry blasting guidelines published by the Ontario Ministry of Environment and Department of Fisheries and Oceans. All blasting and monitoring would occur in accordance with the Aggregate Resources Act prescribed conditions so as to comply with the provincial guidelines.

GOLDER ASSOCIATES LTD.

Andrew Curic, P.Eng.
Senior Engineer

LICENSED PROFESSIONAL ENGINEER
M. V. van BERS
PROVINCE OF ONTARIO

Marcus V. van Bers, P. Eng.
Associate

MVvB/AC/co

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TABLES

TABLE 1

Proposed Blast Design Details
Proposed Quarry Project

Parameter	Two Benches	Single Bench
Blast Pattern	3.2 – 3.5 x 3.8 – 4.3	4.2 - 4.5 x 4.8 – 5.3 m
Approx. # Holes Per Blast	40 – 45	20 – 25
Diameter of Holes	114	127 mm
Depth of Hole	16 – 20	35 -38 m
Subdrill	0.5 – 1.0	0.5 - 1.0 m
Collar Length	2.5 – 3.0	3.0 – 4.0 m
Explosive Product	ANFO and/or ANFO Emulsion Blend	ANFO and/or ANFO Emulsion blend
Explosive Weight per Hole	120 – 150	350 – 400 kg
Number of Holes per Delay	1 – 2	1
Rock Tonnage per Blast	20,000 – 25,000	40,000 - 50,000
Number of Blasts per week	3	1 - 2

All figures are approximate and should be reviewed with the blaster prior to the commencement of blasting.

TABLE 2

Maximum Explosive Loads Vs Distance
For 12.5 mm/s Ground Vibration Limit

Distance between Blast and Sensitive Receptor (m)	Max. Explosive Weight (Golder Equation)* (kg)	Max. Explosive Weight (Crum et al., 1995)* (kg)
150	38	128
200	67	226
300	151	508
400	268	904
500	420	1413
750	945	3180
1000	1679	5653

* See Section 5.1.1 of accompanying report.

TABLE 3

Maximum Explosive Loads Vs Distance
For 128 dBL Air Vibration Limit

Distance between Blast and Sensitive Receptor (m)	Max. Explosive Weight (Golder Equation)* (kg)	Max. Explosive Weight (Oriard, 1999)* (kg)
150	36	80
200	86	190
300	291	641
400	690	1520
500	1348	2970

* See Section 5.1.2 of accompanying report.

TABLE 4

Strain Levels Induced by Household Activities
Environmental Changes and Blasting

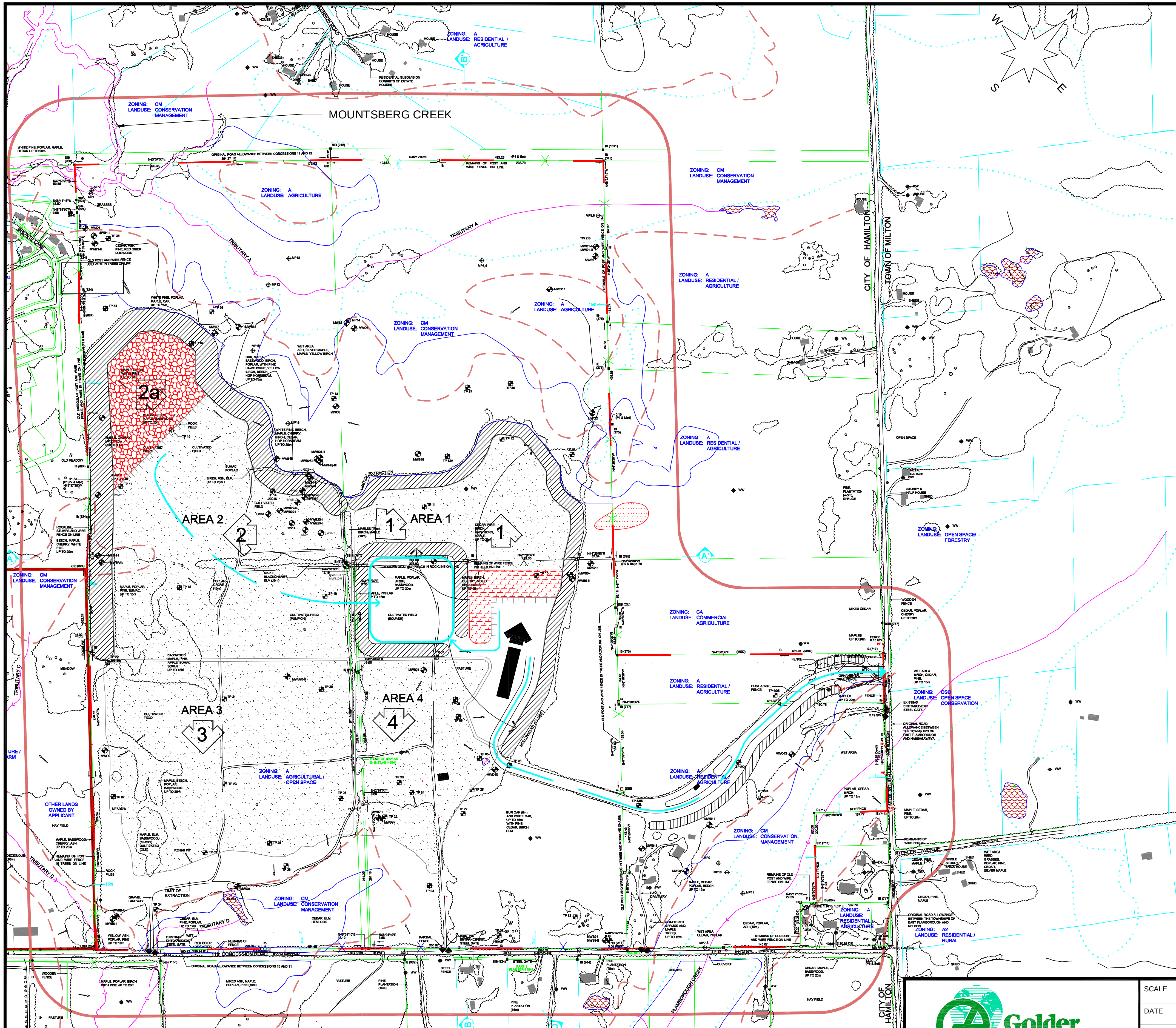
Loading Phenomena	Site[a]	Microstrain Induced by Phenomena (μin./in.)	Corresponding Blast Vibration Level[b] (mm/s)
Daily environmental changes	K_1	149	30.0
	K_2	385	76.0
Household Activities			
1. Walking	S_2	9.1	0.8
2. Heel drops	S_2	16.0	0.8
3. Jumping	S_2	37.3	7.1
4. Door slams	S_1	48.8	12.7
5. Pounding nails	S_{12}	88.7	22.4

[a] K_1 and K_2 were placed across a taped joint between two sheets of gypsum wallboard.
[b] Blast equivalent based on envelope line of strain vs ground vibration.
Source: Dowding (1985)

FIGURES

Golder Associates Mississauga, Ontario, Canada	SCALE: AS SHOWN DATE: Nov. 18, 2008 DESIGN: MVB CAD: JFC	TITLE **PROPOSED QUARRY SITE LOCATION PLAN**
FILE No. 0811170009AC001.dwg	CHECK: MVB	**FLAMBOROUGH QUARRY**
PROJECT No. 08-1117-0009 REV. A	REVIEW: MVB	FIGURE 1

PLOT DATE: November 18, 2008
FILENAME: T:\Projects\2008\08-1117-0009 (LOWNDES, Flamborough)\-AC-\0811170009AC001.dwg



LEGEND:

- BOUNDARY OF AREA TO BE LICENCED
- BOUNDARY OF AREA TO BE EXCAVATED
- LIMIT OF DEVELOPMENT
- LIMIT OF EXTRACTION
- REGULATORY SETBACK LINE
- 120m INFORMATION BOUNDARY
- PROPERTY / LOT/ CONCESSION LINE
- ZONING / LANDUSE BOUNDARY
- PROVINCIALLY SIGNIFICANT WETLAND (LOWER MOUNTSBERG CREEK SWAMP COMPLEX)
- 345.00 — EXISTING 5m CONTOUR LINE
- 344.00 — EXISTING 1m CONTOUR LINE
- X359.73 — EXISTING SPOT ELEVATION
- EXISTING FENCE
- EXISTING TRIBUTARY / RIVER
- EXISTING TRAIL
- EXISTING LANEWAY
- EXISTING VEGETATION
- EXISTING POND
- DIRECTION OF SURFACE WATER DRAINAGE
- EXISTING BUILDING
- TP# — TEST PIT # PREPARED BY: (ZOLTON KATONA), NOV.13, 2003
- BH# ELEV. (2002) — BOREHOLE #, ELEVATION, DATE DRILLED (JEGEL CONSULTING ENGINEERS)
- TW # ELEV. — PRODUCTION WELL, ELEVATION
- WW — WATER WELL

150 0 150 300

SCALE 1:7500 METRES

REFERENCES:

1. BASE MAPPING BASED ON DIGITAL FILE PROVIDED BY HARRINGTON AND HOYLE LTD. LANDSCAPERS AND ARCHITECTS, TITLED "OPERATIONS PLAN" DRAWING No. 2 OF 5, PROJECT No. 06-25, RECEIVED NOVEMBER 2008.

Golder Associates
Mississauga, Ontario, Canada

FILE No.	081117009AD002.dwg		
PROJECT No.	08-1117-0009	REV.	A

SCALE	AS SHOWN
DATE	Nov. 24, 2008
DESIGN	
CAD	JFC
CHECK	MVB
REVIEW	MVB

TITLE

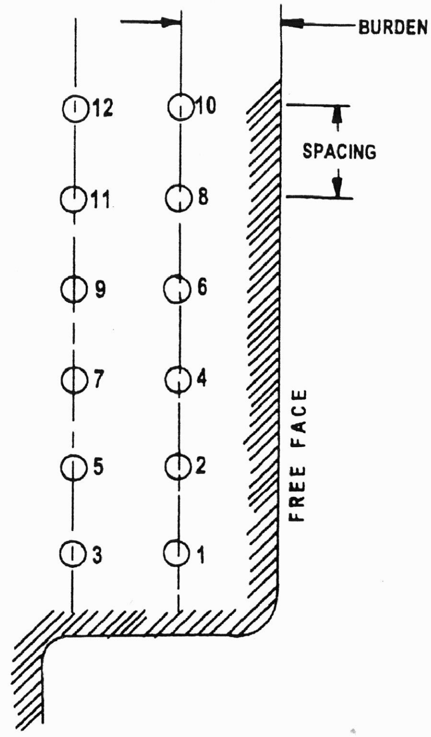
PROPOSED FLAMBOROUGH QUARRY OPERATIONAL PLAN

FLAMBOROUGH QUARRY

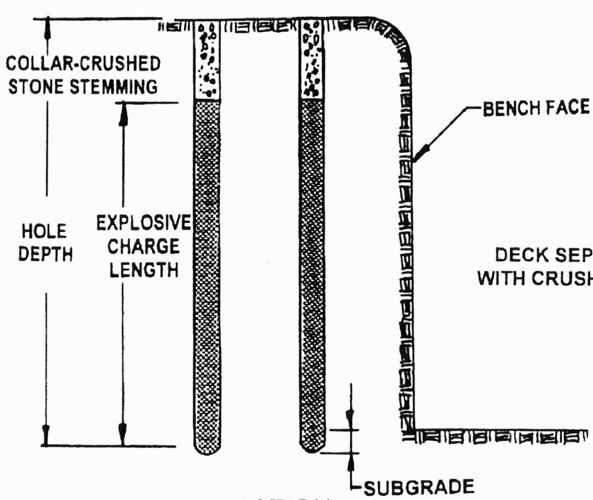
FIGURE 2

PLOT DATE: November 26, 2008
FILENAME: T:\Projects\2008\08-1117-0009 (LOWNDES, Flamborough)\-AD-\081117009AD002.dwg

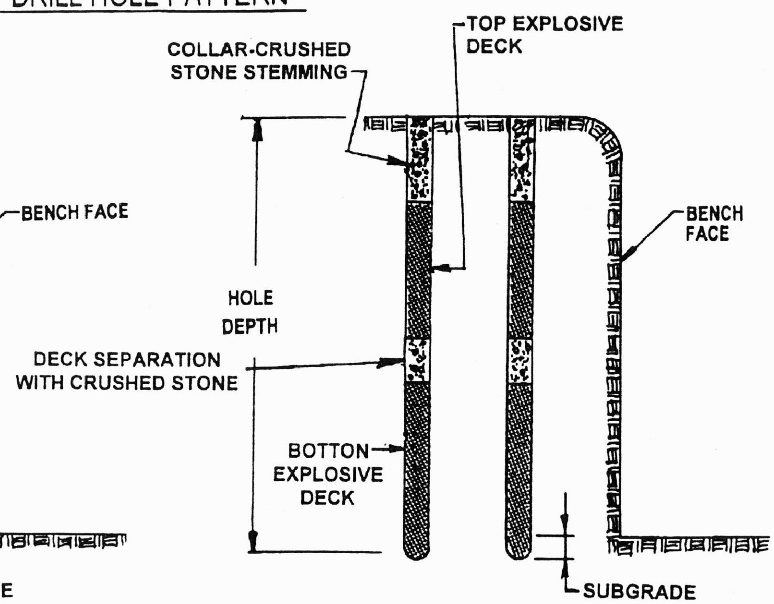
NUMBERS SHOW SHORT PERIOD DELAY	EXAMPLE OF FIRING TIMES (MILLISECONDS)
PERIOD 1	25
PERIOD 2	50
PERIOD 3	75
PERIOD 4	100
PERIOD 5	125



PLAN OF DRILL HOLE PATTERN



SECTION
FULL COLUMN EXPLOSIVE LOAD



SECTION
DECKED EXPLOSIVE LOAD

Golder Associates Mississauga, Ontario, Canada	SCALE AS SHOWN DATE Nov. 18, 2008 DESIGN MVB CAD JFC	TITLE **DESCRIPTION OF BLASTING TERMS**	
FILE No. 0811170009AC003.dwg	CHECK MVB	**FLAMBOROUGH QUARRY**	FIGURE 3
PROJECT No. 08-1117-0009 REV. A	REVIEW MVB		

PLOT DATE: November 18, 2008
FILENAME: T:\Projects\2008\08-1117-0009 (LOWNDES, Flamborough)\-AC-\0811170009AC003.dwg

APPENDIX A

PUBLICATION NPC 119,
MODEL MUNICIPAL NOSE CONTROL
BY-LAW, FINAL REPORT, 1978

Publication NPC-119

Blasting

1. Scope
   This Publication refers to limits on sound (concussion) and vibration due to blasting operations.

2. Technical Definitions
   The technical terms used in this Publication are defined in Publication NPC-101 – Technical Definitions.

3. Measurement Procedures
   All measurements of peak pressure level and vibration velocity shall be made in accordance with the “Procedure for Measurement of Sound and Vibration due to Blasting Operations” set out in Publication NPC-103 – Procedures, section 5.

4. Concussion – Cautionary Limit
   Subject to section 5 the peak pressure level limit for concussion resulting from blasting operations in a mine or quarry is 120 dB.

5. Concussion – Peak Pressure Level Limit
   If the person in charge of a blasting operation carries out routine monitoring of the peak pressure level, the peak pressure level limit for concussion resulting from blasting operations in a mine or quarry is 128 dB.

6. Vibration – Cautionary Limit
   Subject to section 7, the peak particle velocity limit for vibration resulting from blasting operations in a mine or quarry is 1.00 cm/s.

7. Vibration – Peak Particle Velocity Limit
   If the person in charge of a blasting operation carries out routine monitoring of the vibration the peak particle velocity limit for vibration resulting from blasting operations in a mine or quarry is 1.25 cm/s.

APPENDIX B

CURRICULUM VITAE, MARCUS VAN BERS, P. ENG.

Marcus V. van Bers

Education B.Sc. (Hons.), Geological Engineering, Queen's University, Ontario, Canada, 1984.
Rock Mechanics Practitioners Course, University of the Witwatersrand, South Africa, 1986.

Affiliations Registered Professional Engineer, Ontario
Member, Canadian Institute of Mining and Metallurgy
Member, International Society of Explosives Engineers

Experience

1991 to Date **Golder Associates Ltd.** **Mississauga, Canada**
Associate

Supervision and technical involvement in all aspects of blasting control, including design, blast optimization, feasibility studies, preparation of specifications, design and implementation of monitoring programs, and assessing the environmental impact of blasting operations on adjacent facilities, including:

- Assess the viability and potential impact of blasting for the Millennium Pipeline Project on Consolidated Edison high voltage transmission facilities in New York State.

- Assess blasting procedures, existing monitoring program and quarry operations for a large aggregate operation in New Jersey. Provide recommendations to mitigate ground and air vibration effects within the neighbouring residential community.

- Preparation of blasting impact assessments on adjacent structures, services and slopes for the excavation of a 25m rock cut adjacent to Tuen Mun Highway and the extension of the Yau Tong Subway Station in Hong Kong. This included preparation of detailed blasting operations and design, excavation methodology, and recommendations for a monitoring program.

- Review and amend blasting specifications and provide initial on-site assistance for the excavation of 820,000 cu.m of bedrock for two 700 Mw nuclear power plants in Haiyan, China. This included evaluating seismic monitoring procedures, collection and evaluation of structural bedrock data and establishing blast control procedures to ensure the integrity of the bedrock foundation and walls were maintained, and to control water inflows as the excavation proceeded 13m below sea level.

- Established safe blasting criteria and procedures for the excavation of 20,000 cu.m. of bedrock within 5m of the Parliament Buildings, Canada’s most historically sensitive structures. Prepared blasting specifications and established a comprehensive monitoring program, including specifying vibration limitations for the control of all blasting operations during the excavation phase of the project.

- Preparation of blast impact assessments, including design review, for new quarry license applications, quarry expansions, and quarry production increases for numerous operations throughout southern Ontario.

- Assessment of proposed marine blasting operations adjacent to an existing berth at Fremantle Harbour, Australia. This included an appraisal of ground vibration, air blast and underwater overpressure levels at adjacent structures, establishing blasting protocol and monitoring procedures, and reviewing blast specifications.

- Evaluate and provide recommendations on the blast pattern, initiation sequence and methodology for removal of a tailrace tunnel rock plug below the Nagagami River. Assessed impact of blast on the adjacent powerhouse with regard to ground vibrations, and air concussion or water borne overpressures within the tunnel.

- Blast impact and feasibility assessment to excavate a 2.4 m diameter tunnel below a major residential roadway and various services. Included design of the tunnel round and monitoring of ground vibration and air-blast effects.

- Inspection of existing emulsion explosive manufacturing plants at two coal mining operations in British Columbia to assess explosive risk on plant facilities.

- Blast demolition feasibility study for the submerged portion of a bridge substructure crossing the Ottawa River, including blast impact evaluation on new adjacent bridge structure and fish habitat, and preparation of the blasting specifications.

- Blast impact assessment at neighbouring industrial complex as a result of quarry blasting operations in St. Vincent and the Grenadines.

- Establishment of blast design criteria, consultation and monitoring of ground vibration and underwater overpressure levels during the excavation of 45,000 m^3 of rock in the Vancouver Harbour. This included design of final excavation walls within 5 m of the jetty support piles.

- Preparation of Non-Standard Special Provision for blasting in and around Canadian Fisheries waters for the Ontario Ministry of Transportation, Thunder Bay District.

- Evaluation of all blasting operations adjacent to Union Gas high pressure gas facilities throughout Southern Ontario.

- Blast design, consultation and monitoring for shaft and tunnel excavations adjacent to Bronte Creek in a residential area of Oakville, Ontario.

- Evaluation of blasting procedures and blast monitoring for a tunnel excavation beneath a major highway and residential subdivision in Brampton, Ontario.

- Blast vibration and impact noise evaluation for various new quarry applications and expansions in Southern Ontario.

- Evaluation of blasting procedures and recommending means to improve blasting efficiency, and reduce ground vibration and air-blast effects at adjacent residential properties, Global Stone (Ingersoll) Quarry, Ontario.

- Blast vibration and impact noise level monitoring for various demolition projects within Canada and the United States.

- Review of blasting procedures, blast monitoring and control during installation of a new 1.07 m diameter gas pipeline adjacent to existing gas lines for TransCanada PipeLines in Manitoba and Ontario.

- Vibration and noise monitoring, and consultation during installation of a geomembrane within a residential neighbourhood in Mississauga, Ontario.

- Instructor in Blasting Control, Technique and Safety, Ontario Ministry of Environment and Energy inspectors course.

- Review blast designs for various construction projects, including:

  - highway rockcut in Newfoundland,
  - excavation of bridge footings for a transit terminal in Ottawa,
  - removal of a major rockfall within a tailrace tunnel,
  - ditch and right-of-way rock adjacent to high pressure gas lines throughout Ontario,
  - shaft excavations for collector sewers in Ottawa,
  - service trenches and building foundations adjacent to historic, residential, commercial and industrial structures.

- Blast vibration and noise consultation for numerous quarry operations across Southern Ontario.

1987-1991 **Golder Associates Ltd.** **Toronto, Canada**
Geological Engineer

Technical involvement in rock mechanics for numerous civil and mining engineering projects, including:

- Mine/Stope stability analysis using empirical and numerical methods for a proposed open stope mine geometry at a new mine property in North-western Quebec.

- Preparation of preliminary specifications and construction drawings for a large open cut excavation adjacent to, and beneath, the Parliament Buildings in Ottawa, Ontario. This included a geological assessment and stability analysis of the slopes around the rock promontory, development of excavation sequencing and support design, and outlining the blasting restraints and excavation limits on the existing structures and services.

- Optimizing recommendations, including blast vibration limits, excavation methodology and sequencing, and final excavation support procedures, for a proposed transitway rock cut in Ottawa, Ontario.

- Preparation of contract specifications and construction drawings for a pipeline tunnel through a rock bluff in Hope, British Columbia, including geological mapping, analysis and support design.

- Site engineer for P.E.B. Replacement Project in Niagara Falls, Ontario; involved with site investigation; support design; quality control of blasting, support installation, instrumentation and data collection; and preparation of as-built reports and drawings for the bench excavation, underground elevator shaft and tunnel.

- Technical supervision of foundation bedrock grouting programme for an earthfill tailings dam at the Holt McDermott Mine, Kirkland Lake, Ontario, including detailed bedrock foundation mapping and grouting, foundation preparation, quality control and materials testing, and preparation of as-built reports and drawings.

- Other projects have included: feasibility studies and capital cost estimates for two aggregate quarries in Newfoundland; feasibility study for increasing the existing mining limits for a brick shale quarry in Southern Ontario; involved with geotechnical aspects of planning for underground mining development and with rock cut stabilization.

1986-1987 **Western Deep Levels South** **South Africa**
Rock Mechanics Engineer

In addition to those activities described below, also involved with ground investigation, insitu stress measurements, design of alternate stope support for thin tabular deposits, and investigating mining sequence and instrumentation for shaft/reef pillar extraction.

1984-1986 **Doornfontein Gold Mining Co. Ltd.** **South Africa**

Rock Mechanics Engineer

Responsibilities included advising and recommending optimal mining strategies for long and short term mine planning, design of major excavations and their support at great depths, stope and haulage support design, stress analysis by computer simulation and instruction/training of mining and supervisory personnel in basic rock mechanics principles.

1984 **Giant Yellowknife Mines Ltd.** **Yellowknife, Canada**

Exploration Geologist

Involved with siting of surface and underground exploratory drills, supervision of drilling crews, logging and geotechnical evaluation of core, surface and underground mapping and detailing geological sections and plans.

Marcus V. van Bers

Publications

Bench Excavation, Shaft and Tunnel Construction for the Maid of the Mist Facility, Niagara Falls, Ontario (with C.M.K. Yuen, J.M. Harris), Tunnelling in the 90's, TAC, Eighth Annual General Meeting, 1990.

Environmental Effects of Marine Blasting in Canadian Game Rivers (with A.L. McAnuff, A.C. Curic), Proceedings of the Twentieth Annual Conference on Explosives and Blasting Technique, ISEE, 1994.

How Do Your Quarry Blasts Rate (with A.L. McAnuff, A. Cameron), Canadian Aggregates & Roadbuilding Contractor, May, 1994.

Designing a Test Blasting Program for an Underground Building on Parliament Hill, (with M. I. Subercaseaux and G. Pernica), APT Bulletin Vol. XXX No.2-3, Journal of Preservation Technology, 1999.

Blasting Operations Near Existing Structures (with A. L. McAnuff), Proceedings of the First Structural Forensic Engineering Seminar on Structural Failure Investigations, January, 1999.

Blasting on Parliament Hill, Ottawa, Adjacent to Canada's No. 1 Heritage Building, (with A. Curic and A.L. McAnuff), Proceedings of the Twenty Fifth Annual Conference on Explosives and Blasting Technique, ISEE, 1999.

Design and Construction Solutions for Excavation Under and Adjacent to the Parliament Buildings, Ottawa, (with T.G. Carter, G.S. Webb and G. Culham), Proceedings 37th U.S. Rock Mechanics Symposium, 1999.

Response of Heritage Buildings to Excavation-Induced Vibrations (with T. G. Carter and G. Pernica), Proceedings Fourth North American Rock Mechanics Symposium, ARMA, 2000.