APPENDIX IX.13

BLASTING REPORT

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October 4, 2001 012-6492

De Beers Canada Mining Inc.
702-5201 50th Avenue
Yellowknife, NT
X1A 3S9

Attention: Mr. Jack Haynes
Asst. Site Manager

RE: MINE BLASTING IMPACT ON CANADIAN FISHERIES WATERS
DEBEERS SNAP LAKE PROJECT
NORTHWEST TERRITORIES

Dear Sir:

The following report describes the results of an impact assessment of existing and proposed future blasting operations at the Snap Lake Diamond Project as they relate to the guidelines published by the Department of Fisheries and Oceans (DFO) for the use of explosives in or near Canadian fisheries waters (1998). This assessment specifically addresses whether the DFO guidelines with respect to underwater overpressure and ground vibration effects can be met during the mining life of the Snap Lake Project. Our investigation involved the monitoring and recording of underwater overpressure and ground vibration levels during a site visit between July 14 and 22, 2001, from which overpressure and ground vibration attenuation characteristics were developed.

DFO Guidelines

The DFO "Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters" set out in Section 8 that "No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change greater than 100 kPa in the swimbladder of a fish." Similarly in Section 9, "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, marine mammals and their habitat.

Site Visit and Monitoring Procedure

The Snap Lake Diamond Mine was visited from July 14 to 22, 2001 during which nine regular development blasts were monitored at four sites for ground vibration and overpressure effects. The four monitoring sites are shown on Figure 1 and consisted of:

Station	Monitoring Location
A	Depth of 5 m in water approximately 1 m above lake bottom over current blasting site.
B	Approximately 1 m below water surface at west shore of Snap Lake, east of south ventilation shaft.
C	Spawning bed southeast of the current blasting site.
D	West shore of Snap Lake east of south ventilation shaft.

The two in water monitoring sites were established immediately prior to each blast. Station A was only accessible by boat during each blast (see Plate 1). A hand held GPS and radio was also necessary in establishing Station A to ensure that monitoring occurred over the actual blast site and that the correct blast window was monitored. The instrument at Station A could not be deployed on July 15 and the afternoon of July 19 due to rough waters on Snap Lake caused by high winds. The geophone transducers for monitoring ground vibration intensities at Stations C and D were spiked into the ground to ensure a secure coupling (Plates 2 and 3).

Instrumentation

Instrumentation at Stations A and B consisted of Instantel DS-477 self-triggering, digital data loggers equipped with hydrophone attachments. The instrument at Station A was programmed to measure and record peak underwater overpressure levels for a 8 to 10 second duration upon activation above a threshold trigger level that varied between 0.3 and 1.7 kPA. To ensure that data was captured during each blast, the instrument at Station B was programmed to record on a continuous basis, providing peak overpressure levels at 1 to 5 minute intervals.

Instrumentation at Stations C and D consisted of Instantel DS-077 Minimate Plus Series III self-triggering, digital seismographs capable of measuring and recording peak ground vibration levels in each of three orthogonal directions. As these instruments were unmanned during each blast, similar to Station B, each instrument was programmed to record ground vibrations on a continuous basis to ensure suitable data capture during the blast, providing peak ground vibration levels at 1 to 5 minute intervals.

Blasting Procedure

The nine blasts monitored between July 14 and 22 consisted of either full face development rounds or side-wall slashes. A full face development heading measured approximately 5.0 x 5.0 m. As detailed in Table 1, each blast consisted of drilling from 12 to 157 x 44 mm diameter holes to a depth of about 4.2 m. All drilling was carried out using a twin boom jumbo. All holes were pneumatically loaded with ANFO and primed with a 32 x 400 mm semi gelatin dynamite. Perimeter holes were loaded with 19 x 600 mm diameter Xactec for wall control (Plates 4 to 6). Charge weights per hole varied from between 3.8 to 6.3 kg while charge weights per delay varied from 13 to 86 kg. Long period delays were used resulting in delay periods ranging from 250 to 1000 ms. On occasion, multiple rounds were fired together without the benefit of a delay between rounds.

All blasting occurred at a depth of approximately 160 m below Snap Lake, 550 to 580 m from the west shore, as shown on Figure 1.

Monitoring Results

The results recorded at each of the four monitoring sites during the nine blasts are summarized on Table 2. The actual waveform records are reproduced in Appendix A. While not necessarily relevant to this study, it was possible to identify from the waveform records where the actual peaks occurred and to which delays or holes they corresponded. This may be of some benefit at a later date during regular production blasting if the ground vibration or overpressure levels were to exceed the DFO guidelines.

The monitoring results given in Table 2 were used in establishing attenuation characteristics for both the ground vibration and underwater overpressure levels.

Underwater Overpressure Attenuation Curve

Cube root scaling was used in establishing the Scaled Distance relationship for underwater overpressure levels, as defined by the following relationship:

$$\text{Scaled Distance (SD)} = D/E^{0.33}$$

where,

D = distance between the blast and the monitoring station (m)
E = maximum weight of explosive detonated per delay period (kg).

The scatter typically seen in many scaled distance plots, as seen in Figure 2, are introduced by such factors as differing explosive products, length of collar, variations in burden distance,

differing geologic conditions of the bedrock (structure etc.), different wave types, errors in blast initiation timing, degree of confinement, and differences in blast efficiencies.

The equation for the 95% regression line developed in Figure 2 can be expressed as:

$$P = 6352\ (SD)^{-1.87}$$

where

P = Peak Overpressure (kPa)
SD = Scaled Distance ($m/kg^{0.33}$)

Ground Vibration Attenuation Curve

Cube root scaling was also used in establishing the Scaled Distance plot for the ground vibration attenuation characteristics for this site.

The equation for the 95% regression line, as shown in Figure 3 can be expressed as:

$$PPV = 4931\ (SD)^{-1.87}$$

where,

PPV = Peak Particle Velocity (mm/s)
SD = Scaled Distance ($m/kg^{0.33}$)

Impact Assessment

As shown by the Scaled Distance plots, the most critical parameters for controlling ground vibration and consequently underwater overpressure levels are distance from the blast and the amount of explosive detonated per delay period. Based on the attenuation characteristics established from the development rounds discussed above, Table 3 shows the calculated maximum charge weights per delay for increasing set-back distances from a blast site for maintaining the DFO guidelines limits. It is our understanding that production blasting could conceivably approach to within 115 m of the bottom of Snap Lake

The maximum explosive loads given in Table 3 for limiting peak ground vibration and underwater overpressure levels to 13 mm/s and 100 kPa, would be 111 and 1937 kg respectively, based on a minimum distance of 115 m. Based on initial production round estimates of about 230 kg per delay as provided by the Snap Lake mine planners, the set-back distances calculated for maintaining the limiting peak ground vibration and underwater overpressure levels of 13 mm/s and 100 kPa, would be approximately 150 and 60 m respectively.

It is apparent from Table 3 that, at equivalent distances, the ground vibration limit of 13 mm/s at the nearest spawning bed becomes the more restrictive guideline when determining maximum

explosive loads for the mine's production blasts. This guideline however, is only pertinent during periods of egg incubation, and as seen in Figure 1, only applicable to specific sites that have been identified as spawning habitat. Therefore, in those circumstances when blasting could conceivably take place where the ground vibration level may exceed the DFO guideline (within 150 m of lake bottom), they should be carried out outside identified spawning and egg incubation windows. Alternatively, the maximum explosive weight detonated per delay period could be adjusted as dictated by the Scaled Distance equations.

While this assessment has been based on a series of development blasts, we recommend that additional monitoring be carried out at the commencement of production blasting to better define the equations developed for the Snap Lake site. These equations, as they become better defined may be used as a design tool for ensuring compliance with the DFO guidelines when within 150m of Snap Lake.

Conclusions

Based on the foregoing considerations, it is our opinion that blasting operations may be performed in compliance with the current blasting guidelines published by the Department of Fisheries and Oceans. As such, we do not expect that there would be a requirement for any additional mitigative measures for protecting fish, marine mammals and their habitat. Monitoring of underwater overpressure and ground vibration effects during the initial stages of regular production blasting should however, be carried out to better define the attenuation characteristics developed for this site.

If you have any questions pertaining to this report, or we can be of any further service in this matter, please do not hesitate to contact our office.

Yours very truly,

GOLDER VME LIMITED

Andrew Curic, P. Eng.
Engineer

Marcus V. van Bers, P.Eng.
Associate

AC/ac/dd

\\mis_main\data\active\6000\012-6492 debeers eis document\summary report - october 2001\rpt-04oct01-mine blasting impact.doc

TABLE 2
Snap Lake Blast Monitoring Results

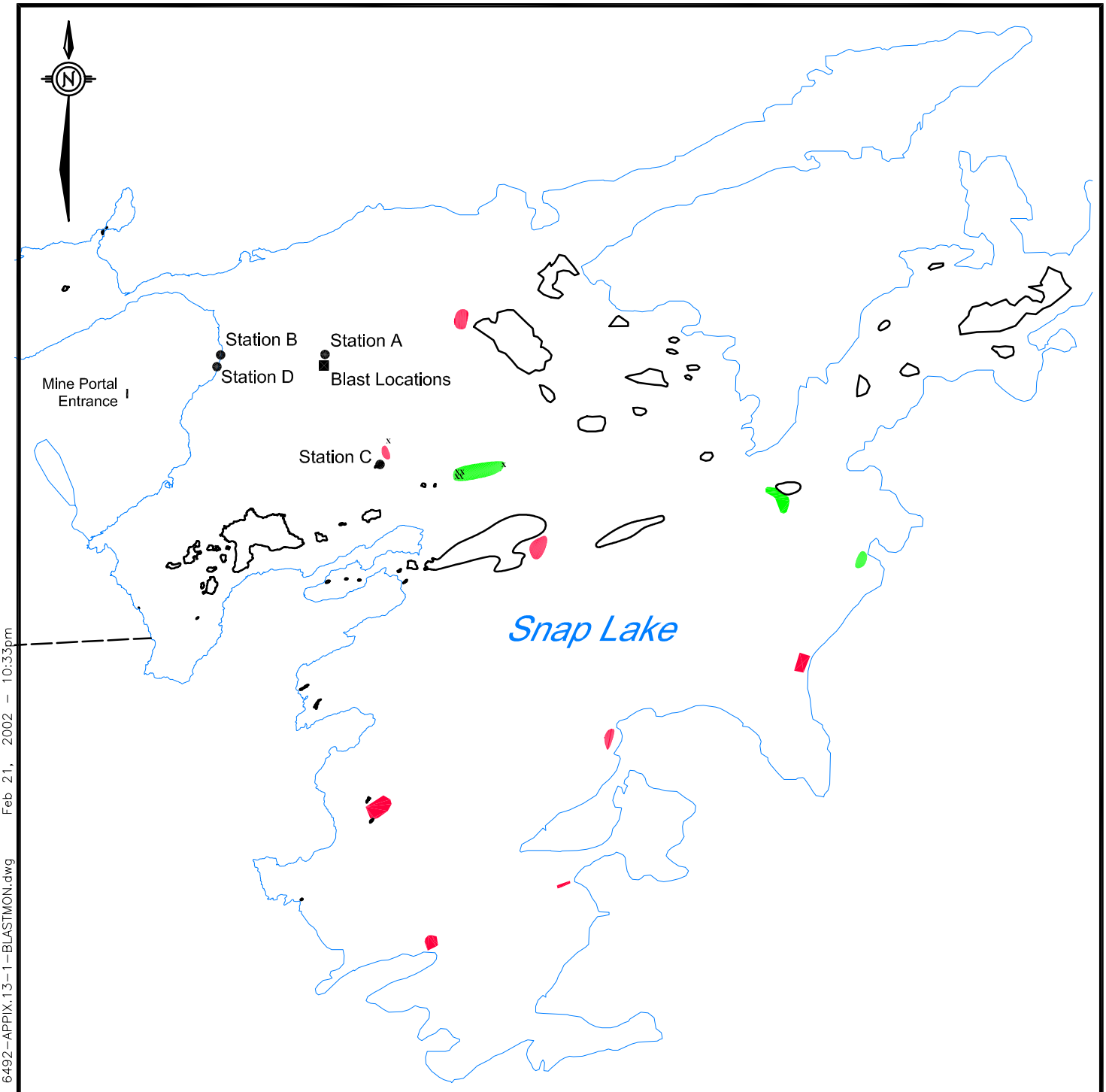
Date (2001)	Blast Time	Blast No.	Station A (kPa)	Station B (kPa)	Station C (mm/s)	Station D (mm/s)
July 14	03:36	1	3.7	<0.34	0.9	1.0
July 15	12:30	2	NR	<0.28	NR	0.3
July 15	21:30	3	NR	0.4	NR	1.1
July 16	22:29	4	6.3	<1.0	<0.75	<1.5
July 18	02:44	5	5.2	0.4	1.3	NA
July 19	05:27	6	3.3	0.9	0.9	2.0
July 19	18:05	7	NR	0.8	0.5	0.9
July 20	16:57	8	4.8	0.8	<1.0	0.6
July 22	05:49	9	7.0	0.1	0.9	0.9

NR – Denotes no record due to high winds at Snap Lake

NA – Denotes reading due to electrical interference

TABLE 3
Setback Distances for Overpressure and Ground Vibration Limits for Snap Lake

Setback Distance from the Blast (m)	Maximum Charge Weight per Delay in (kg) to Limit Overpressure Levels to 100 kPa	Maximum Charge Weight per Delay in (kg) to Limit Ground Vibration Levels to 13 mm/s
50	159	9
100	1274	73
115	1937	111
125	2488	143
150	4299	247
170	6257	359
200	10189	585
250	19900	1142
300	34388	1973
350	54607	3134
400	81512	4678
450	116060	6660
500	159205	9136



LEGEND

PRIMARY SPAWNING HABITAT

SECONDARY SPAWNING HABITAT

x ROCK

REFERENCE

BASE PLAN PROVIDED BY GOLDER ASSOCIATES, SASKATOON DATED DECEMBER 2000, PROJECT No. 992-6018

0 1000 2000 metres

SCALE 1:15000

PROJECT

De Beers

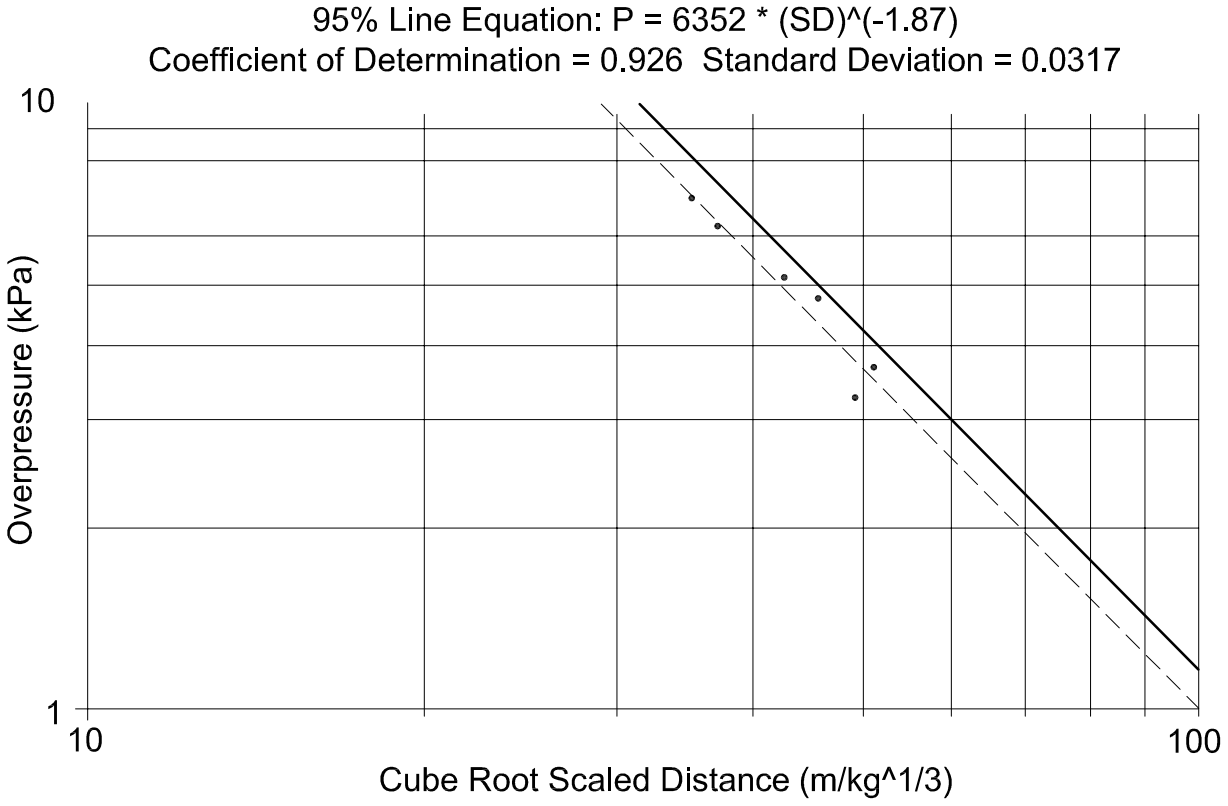
TITLE

BLAST MONITORING LOCATIONS AND AREA OF MOST ACTIVE LAKE TROUT SPAWNING GROUNDS IN SNAP LAKE

Golder Associates
Saskatoon, Saskatchewan

PROJECT No.		012-6492	FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
CADD	SIB/FC	14/02/02	FIGURE: IX.13-1	
CHECK				
REVIEW				

N:\Active\6400\012-6492\CAD\appendix IX.13\ Drawing file: 6492-APPIX.13-1-BLASTMON.dwg Feb 21, 2002 - 10:33pm



PROJECT

De Beers

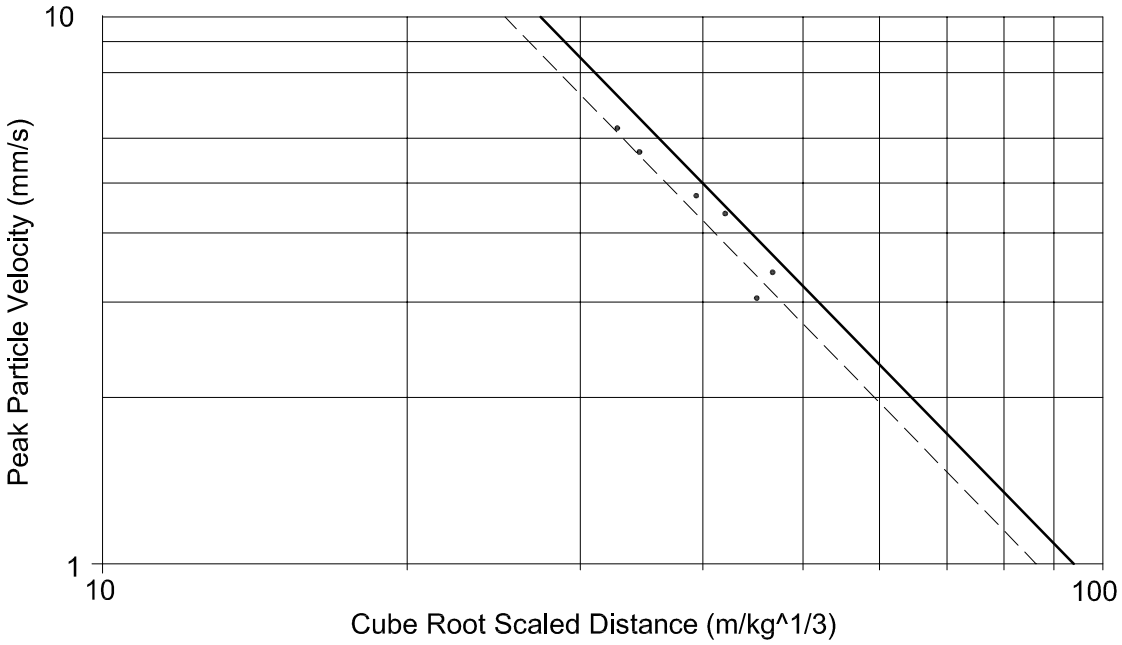
TITLE

UNDERWATER OVERPRESSURE ATTENUATION CURVE SNAP LAKE DIAMOND PROJECT

Golder Associates
Saskatoon, Saskatchewan

PROJECT No.		001-1001	FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
CADD	RJ/SIB	14/02/02	FIGURE: IX.13-2	
CHECK				
REVIEW				

95% Line Equation: P = 4931 * (SD)^(-1.87)
Coefficient of Determination = 0.916 Standard Deviation = 0.0339



PROJECT

De Beers

TITLE

GROUND VIBRATION ATTENUATION CURVE
SNAP LAKE DIAMOND PROJECT

Golder Associates
Saskatoon, Saskatchewan

PROJECT No.		001-1001	FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
CADD	RJ/SIB	14/02/02	FIGURE: IX.13-3	
CHECK				
REVIEW				

Plate 1. Station A Monitoring Location over Blast Facing the West Shore Line.

Plate 2. Stations B and D along the West Shore of Snap Lake.

Plate 3. Station C Monitoring Station Adjacent to a Secondary Spawning Bed.

Plate 4. Explosive Product and Non-Electric Detonators used for Blasting Operations.

Plate 5. Blaster and Helper Loading ANFO in Blast Drill Hole.

Plate 6. Blaster Working Final Tie in Preparations with B-Line Detonating Cord.

APPENDIX A

Sample Calculations

Ground Vibration Conversion from Overpressure Measurements for De Beers Mine Blast Operations

Vibration Overpressure Estimate

Relationship between estimated peak particle velocity and pressure within the saturated rock substrate at the lake bed. The following equations are contained within the DFO's "Guidelines for the Use of Explosives in Canadian Fisheries Waters" in Appendix III.

Pressure transfer from water to substrate

$$P_w = (2(Z_W/Z_R)P_R)/(1+(Z_W/Z_R))$$

$$Z_W/Z_R = (D_W C_W)/(D_R C_R)$$

where D_w = density of water = 1 g/cc
C_w = compressional wave velocity in water = 146300 cm/s
C_R = compressional wave velocity in rock = 457,200 cm/s
D_R = density of substrate(granitic rock) = 2.7 g/cc
Z_W = Acoustic impedance of water
Z_R = Acoustic impedance of substrate

$Z_W/Z_R = (1*146300)/(2.7*457200)$
$= 0.1185$

$P_W = 2(0.1185)P_R/(1.1185)$
$= 0.212P_R$

$P_R=P_W/0.212$

Where, P_R = pressure in substrate (kPa)
P_W= pressure in water (kPa)

Covert kPa to dynes (gcms2),

$$Dynes = kPa \times 10^4$$

Peak Particle Velocity calculated from Overpressure in substrate

$$V_R = (2(P_R)/(D_R C_R))$$

where P_R = pressure in substrate (kPa)
C_R = compressional wave velocity in saturated rock = 457,200 cm/s
D_R = density of substrate(granitic rock) = 2.7 g/cc
V_R = Vibration velocity in (cm/s)

Use 3.7 kPa from July 14th Blast No.1 at Station A

P_R=(3.7)/0.212 = 17.45 kPa
= 17.45 x 10^4 dynes

V_R = (2(17.45 x 10^4)/(2.7 x 457,200)
= 0.2827 cm/s
= 2.8 mm/s

APPENDIX B

Blast Overpressure Waveforms for De Beers Mine Blast Operations

Event Report

Date/Time	Vert at 03:36:17 July 14, 2001	**Serial Number**	1302 V 5.51 BlastMate II/677
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.5 Volts
Range	Geo :254 mm/s	**Calibration**	November 21, 2000 by Instantel Inc.
Record Time	8.0 sec at 1024 sps	**File Name**	C3028MNM.0H0

Notes
Location: Station A
Client: De Beers Canada
User Name: Golder VME Limited
Converted: July 30, 2001 16:44:20 (V4.30)

Extended Notes
Snap Lake, NWT

Post Event Notes

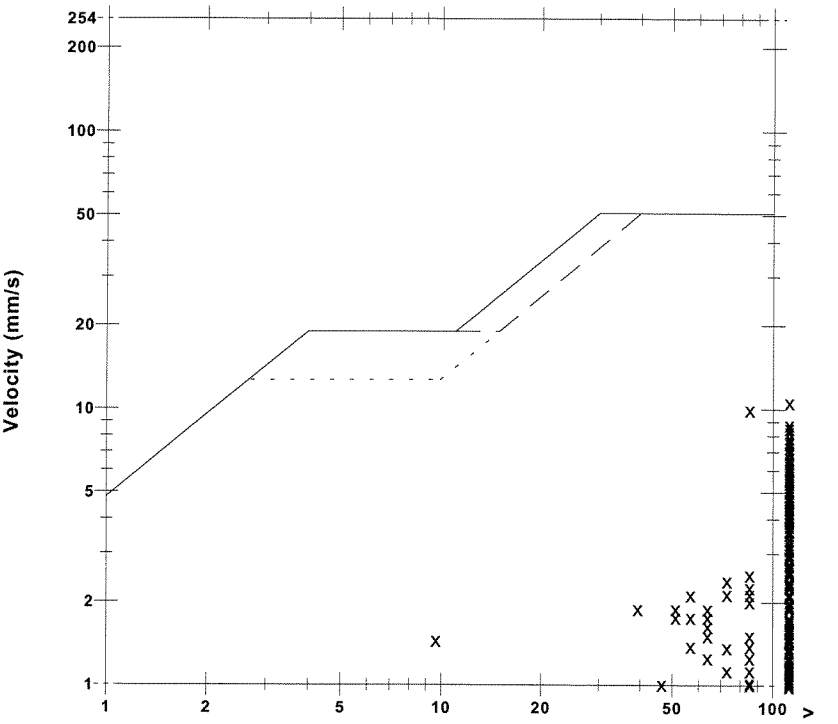
Microphone Disabled
PSPL N/A
ZC Freq N/A
Channel Test N/A

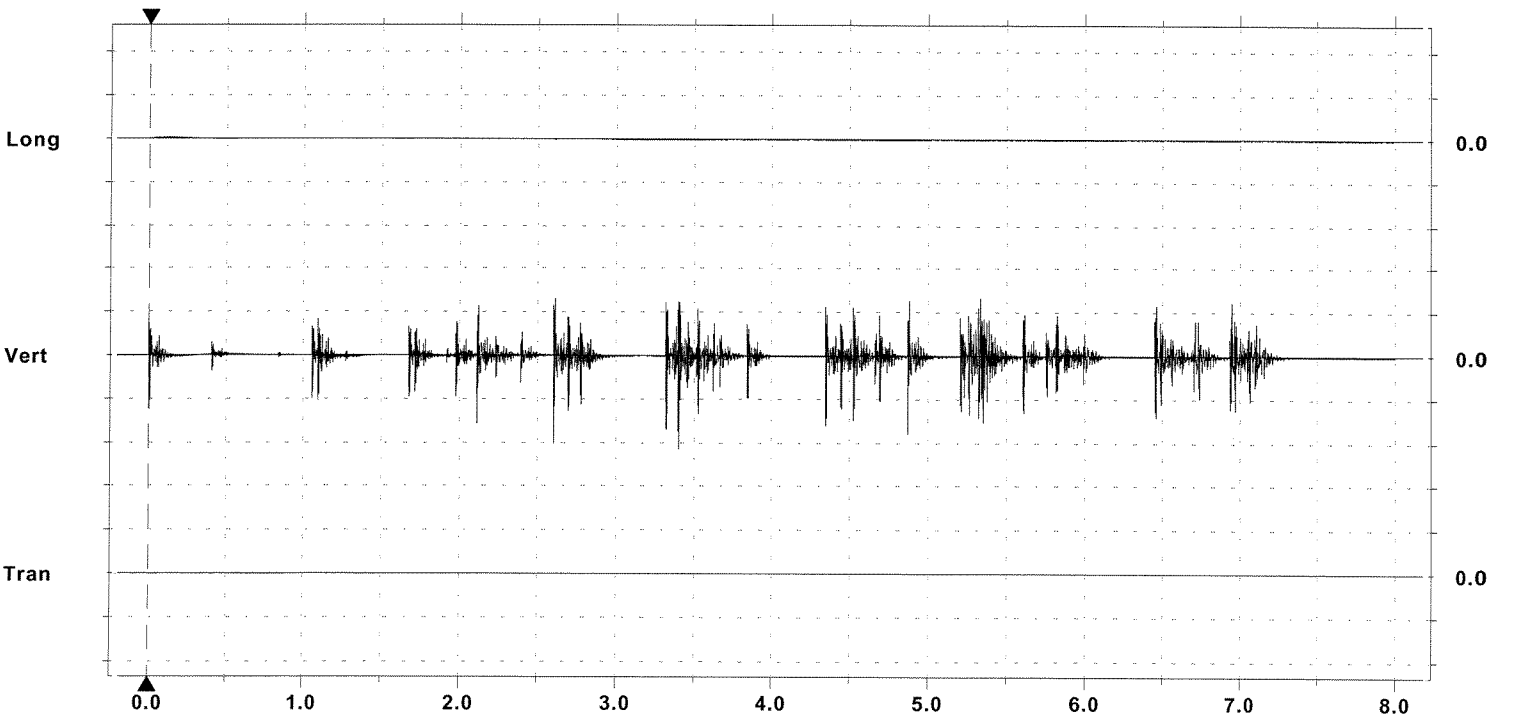
	Tran	Vert	Long	
PPV	0.0318	10.7	0.159	mm/s
PPV	21.1	71.6	35.0	dB
ZC Freq	32	>100	2.0	Hz
Time (Rel. to Trig)	0.014	3.403	0.119	sec
Peak Acceleration	0.00331	1.10	0.0133	g
Peak Displacement	0.00002	0.00905	0.0135	mm
Sensorcheck	Check	Check	Check	

Peak Vector Sum 10.7 mm/s at 3.403 sec

N/A: Not Applicable

USBM RI8507 And OSMRE





Time Scale: 0.50 sec/div **Amplitude Scale:** Geo: 5.00 mm/s/div
Trigger = ▶— — —◀

Event Report

Date/Time	Vert at 22:29:35 July 16, 2001	**Serial Number**	1302 V 5.51 BlastMate II/677
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.5 Volts
Range	Geo :254 mm/s	**Calibration**	November 21, 2000 by Instantel Inc.
Record Time	9.0 sec at 1024 sps	**File Name**	C3028MSR.TB0

Notes
Location: Station A
Client: De Beers Canada
User Name: Golder VME Limited
Converted: July 30, 2001 16:44:57 (V4.30)

Extended Notes
Snap Lake, NWT

Post Event Notes

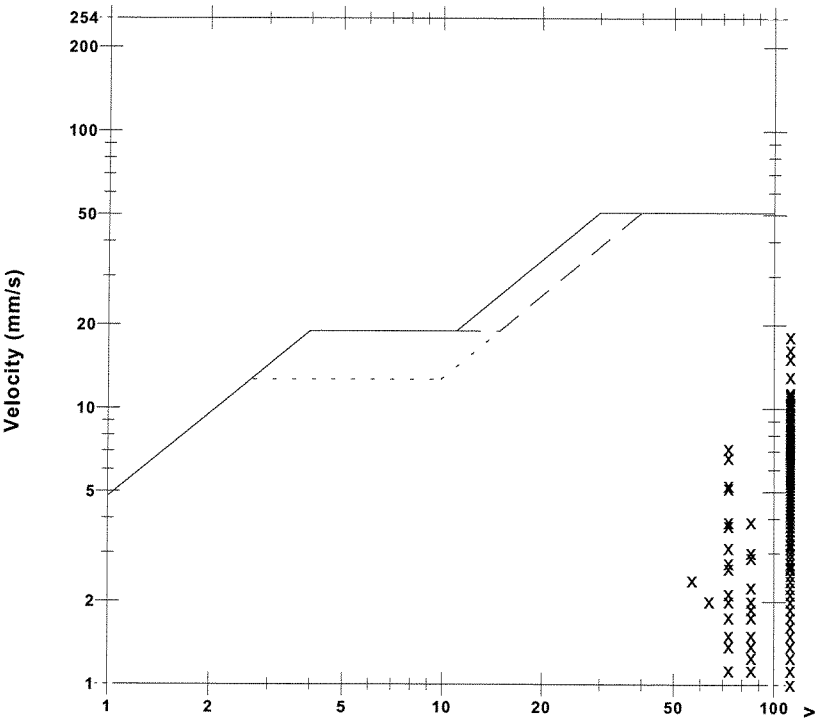
Microphone Disabled
PSPL N/A
ZC Freq N/A
Channel Test N/A

	Tran	Vert	Long	
PPV	0.0318	18.4	0.127	mm/s
PPV	21.1	76.3	33.1	dB
ZC Freq	85	>100	>100	Hz
Time (Rel. to Trig)	0.006	5.350	0.007	sec
Peak Acceleration	0.00331	2.25	0.0133	g
Peak Displacement	0.00002	0.0145	0.00006	mm
Sensorcheck	Check	Check	Check	

Peak Vector Sum 18.4 mm/s at 5.350 sec

N/A: Not Applicable

USBM RI8507 And OSMRE



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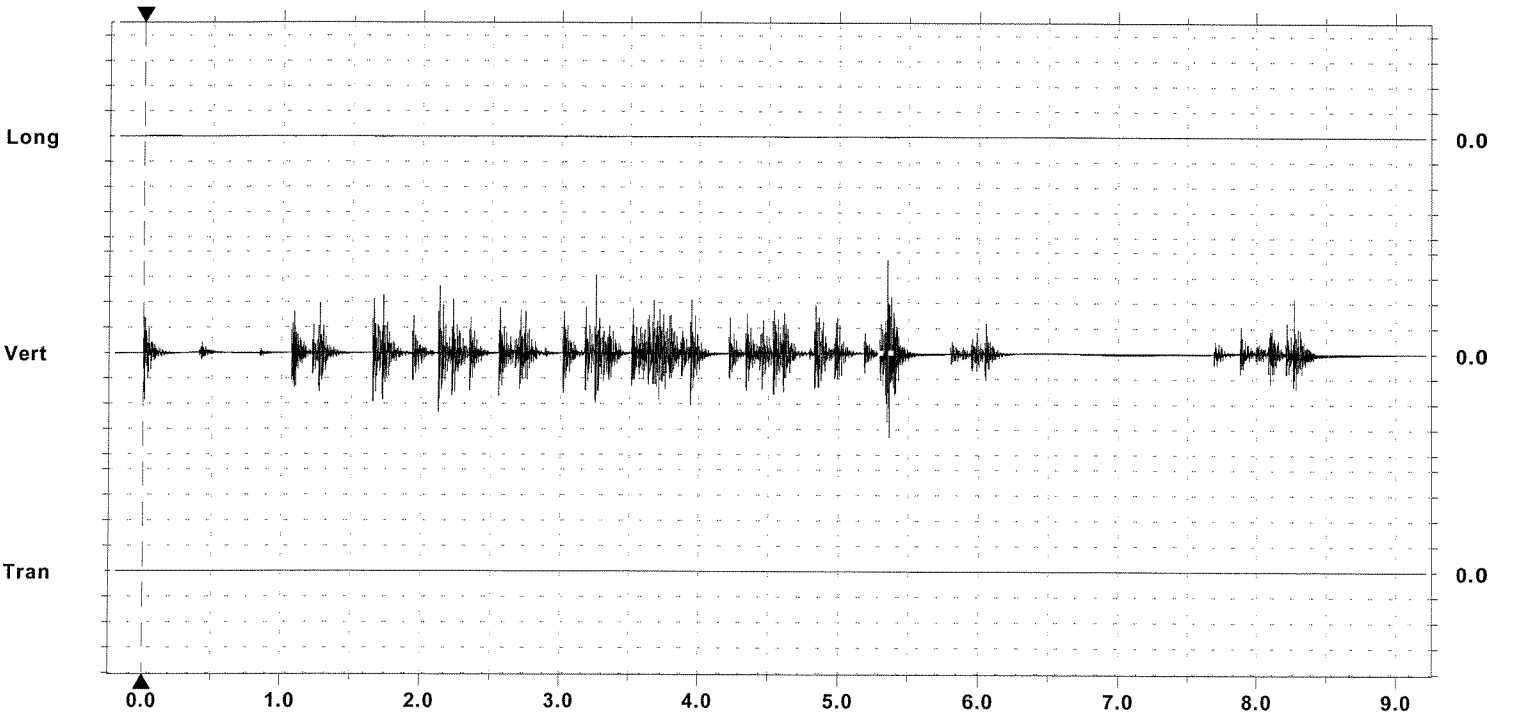


Time Scale: 0.50 sec/div **Amplitude Scale:** Geo: 5.00 mm/s/div
Trigger =

Event Report

Date/Time	Vert at 02:44:12 July 18, 2001	**Serial Number**	1302 V 5.51 BlastMate II/677
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.5 Volts
Range	Geo :254 mm/s	**Calibration**	November 21, 2000 by Instantel Inc.
Record Time	9.0 sec at 1024 sps	**File Name**	C3028MUY.9O0

Notes
Location: Station A
Client: De Beers Canada
User Name: Golder VME Limited
Converted: July 30, 2001 16:45:38 (V4.30)

Extended Notes
Snap Lake, NWT

Post Event Notes

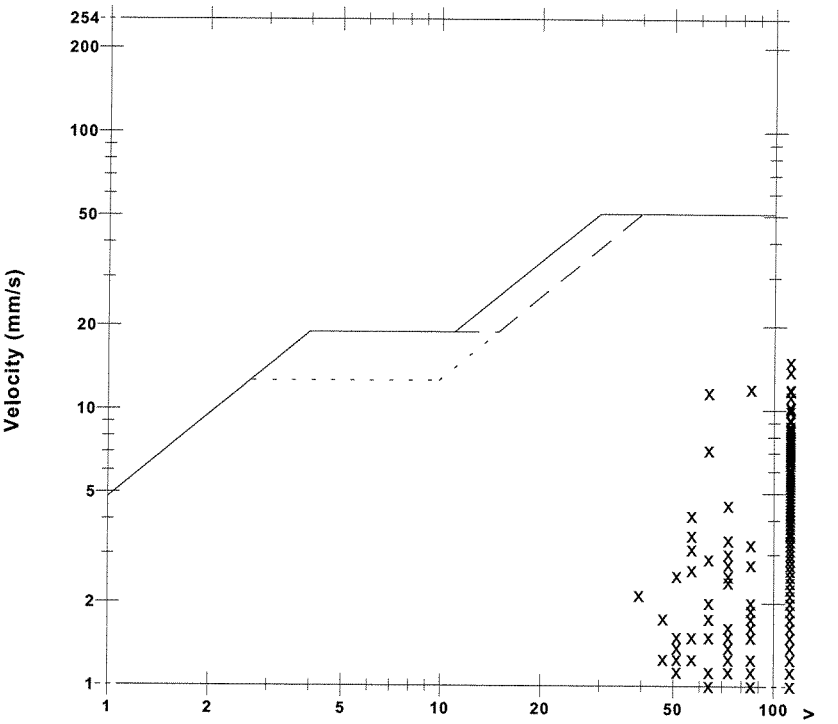
Microphone Disabled
PSPL N/A
ZC Freq N/A
Channel Test N/A

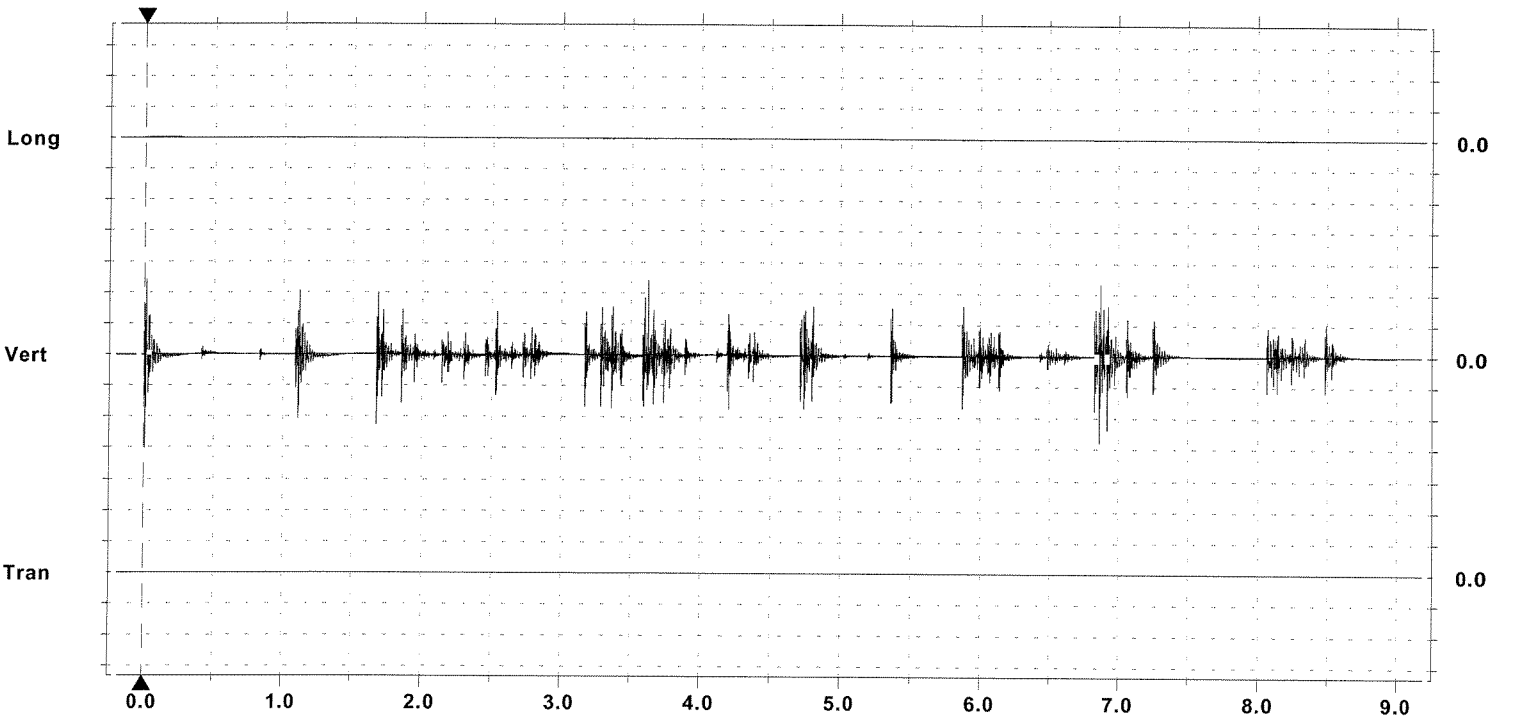
	Tran	Vert	Long	
PPV	0.0476	15.1	0.127	mm/s
PPV	24.6	74.6	33.1	dB
ZC Freq	73	>100	N/A	Hz
Time (Rel. to Trig)	0.005	0.009	0.009	sec
Peak Acceleration	0.00331	1.39	0.0133	g
Peak Displacement	0.00001	0.0143	0.00006	mm
Sensorcheck	Check	Check	Check	

Peak Vector Sum 15.1 mm/s at 0.009 sec

N/A: Not Applicable

USBM RI8507 And OSMRE





Time Scale: 0.50 sec/div **Amplitude Scale:** Geo: 5.00 mm/s/div
Trigger = ▶— — —◀

Event Report

Date/Time	Vert at 05:27:20 July 19, 2001	**Serial Number**	1302 V 5.51 BlastMate II/677
Trigger Source	Geo: 1.00 mm/s	**Battery Level**	6.5 Volts
Range	Geo :254 mm/s	**Calibration**	November 21, 2000 by Instantel Inc.
Record Time	10.0 sec at 1024 sps	**File Name**	C3028MX0.HK0

Notes
Location: Station A
Client: De Beers Canada
User Name: Golder VME Limited
Converted: July 30, 2001 16:46:20 (V4.30)

Extended Notes
Snap Lake, NWT

Post Event Notes

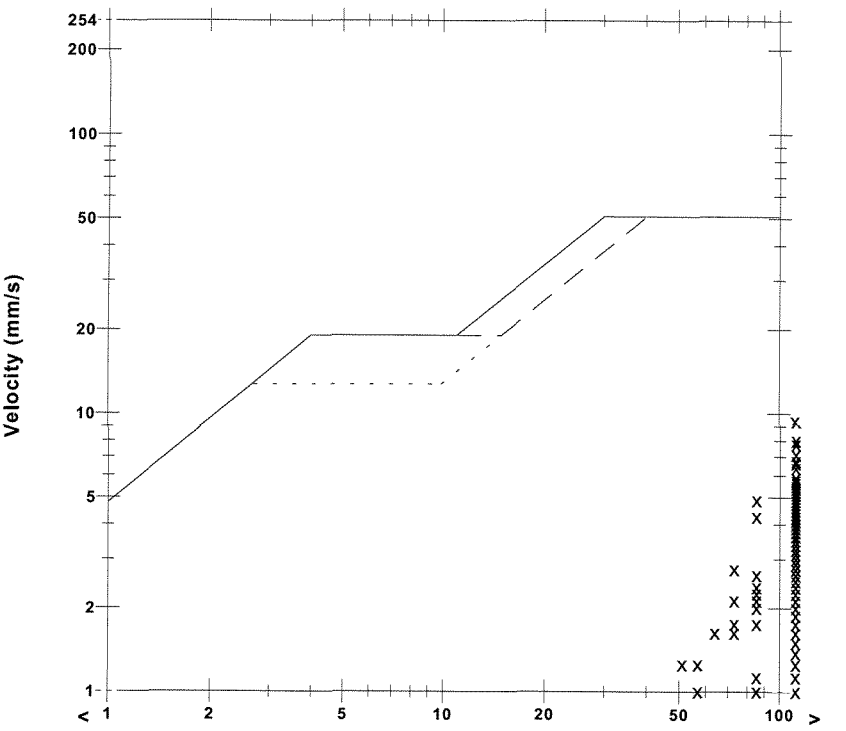
Microphone Disabled
PSPL N/A
ZC Freq N/A
Channel Test N/A

	Tran	Vert	Long	
PPV	0.0	9.53	0.127	mm/s
PPV	0.0	70.6	33.1	dB
ZC Freq	N/A	>100	N/A	Hz
Time (Rel. to Trig)	0.002	4.030	-0.013	sec
Peak Acceleration	0.0	0.915	0.0133	g
Peak Displacement	0.0	0.00998	0.00006	mm
Sensorcheck	Check	Check	Check	

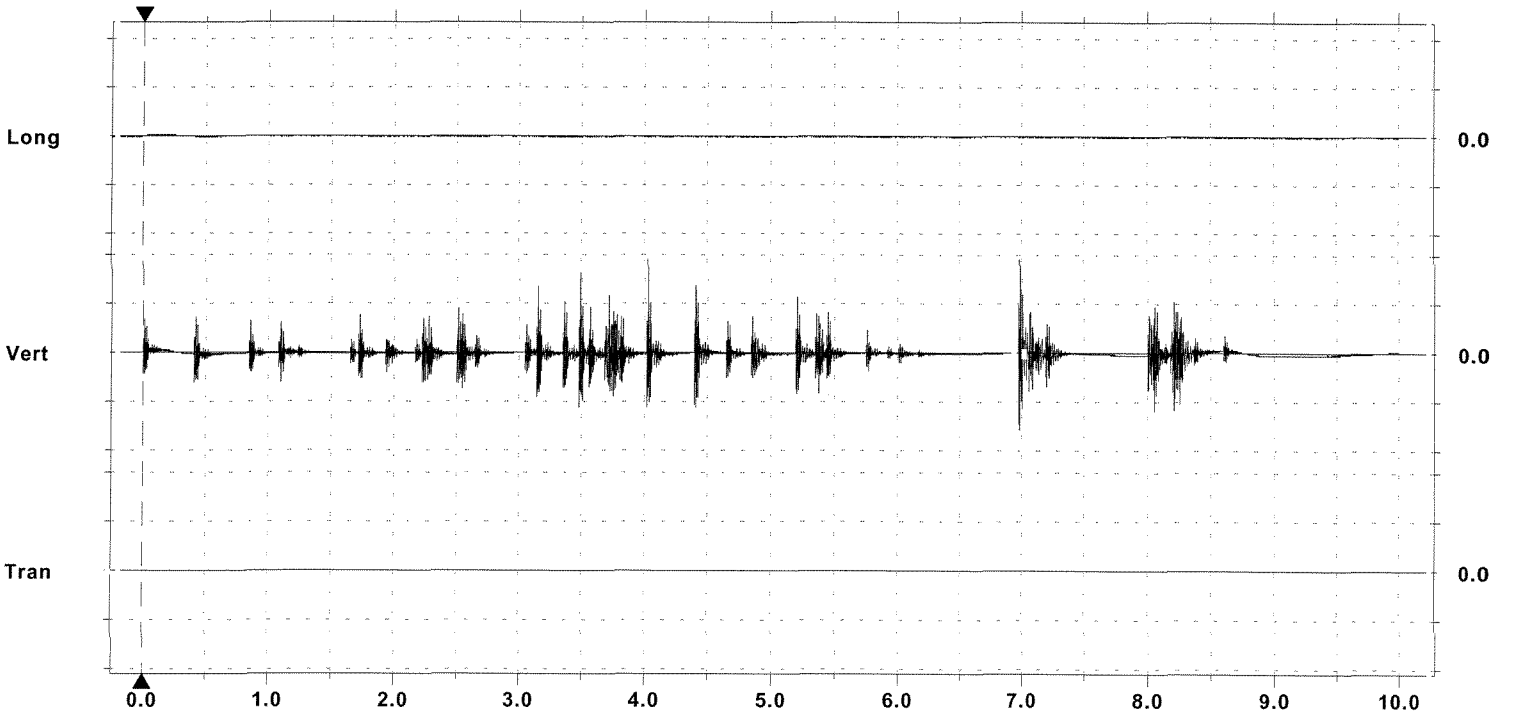
Peak Vector Sum 9.53 mm/s at 4.030 sec

N/A: Not Applicable

USBM RI8507 And OSMRE



Frequency (Hz)
Tran: + Vert: x Long: ø



Time Scale: 0.50 sec/div **Amplitude Scale:** Geo: 5.00 mm/s/div
Trigger =

Event Report

Date/Time	Vert at 16:56:50 July 20, 2001	**Serial Number**	1302 V 5.51 BlastMate II/677
Trigger Source	Geo: 1.00 mm/s	**Battery Level**	6.5 Volts
Range	Geo :254 mm/s	**Calibration**	November 21, 2000 by Instantel Inc.
Record Time	10.0 sec at 1024 sps	**File Name**	C3028MZR.2Q0

Notes
Location: Station A
Client: De Beers Canada
User Name: Golder VME Limited
Converted: July 30, 2001 16:46:58 (V4.30)

Extended Notes
Snap Lake, NWT

Post Event Notes

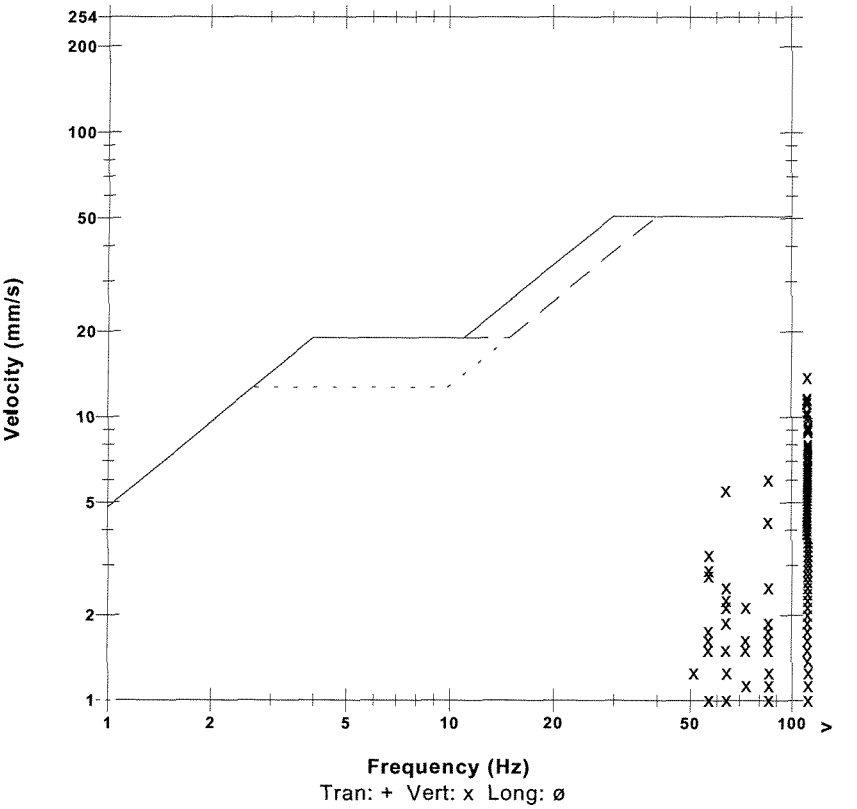
Microphone Disabled
PSPL N/A
ZC Freq N/A
Channel Test N/A

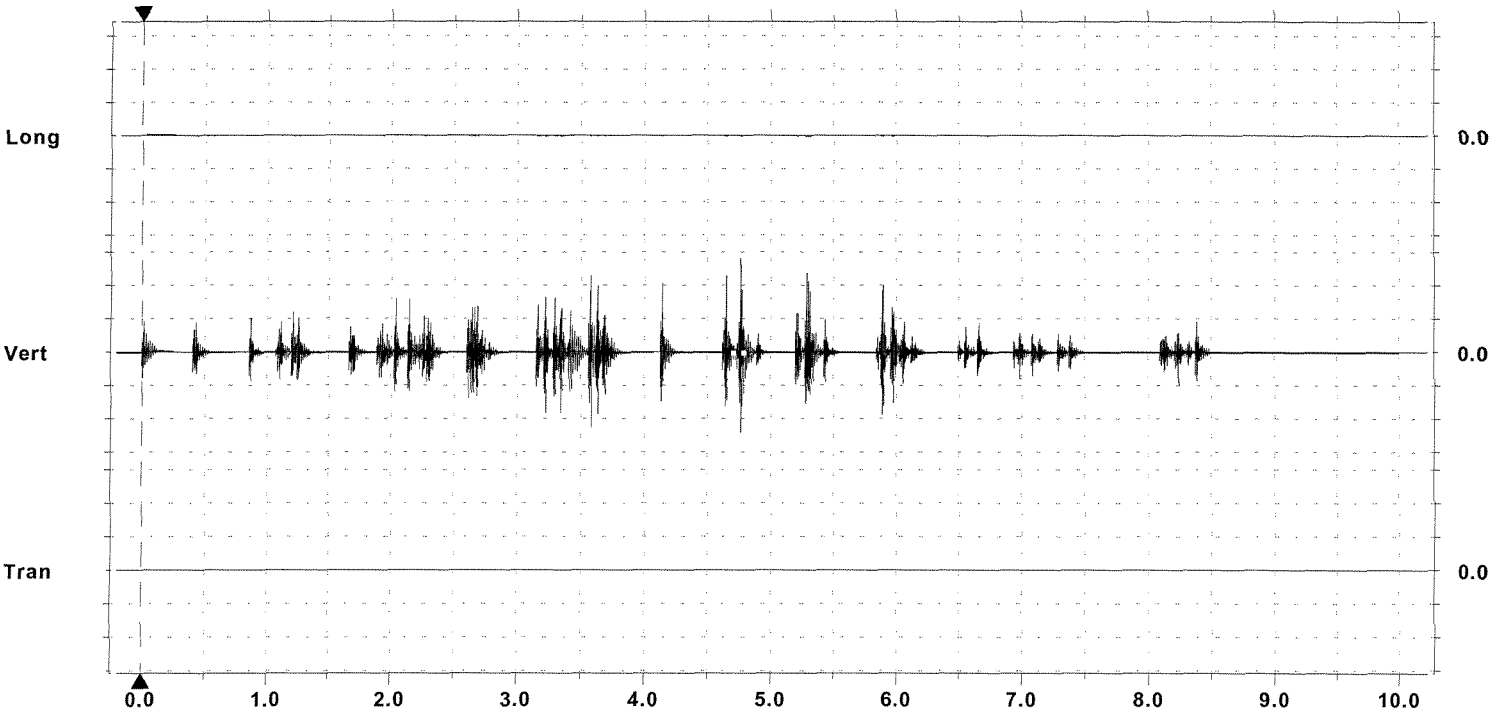
	Tran	Vert	Long	
PPV	0.0	14.0	0.127	mm/s
PPV	0.0	73.9	33.1	dB
ZC Freq	N/A	>100	N/A	Hz
Time (Rel. to Trig)	0.002	4.762	0.031	sec
Peak Acceleration	0.0	1.76	0.0133	g
Peak Displacement	0.0	0.0123	0.00006	mm
Sensorcheck	Check	Check	Check	

Peak Vector Sum 14.0 mm/s at 4.762 sec

N/A: Not Applicable

USBM RI8507 And OSMRE





Time Scale: 0.50 sec/div **Amplitude Scale:** Geo: 5.00 mm/s/div
Trigger =

Event Report

Date/Time	Vert at 05:49:24 July 22, 2001	**Serial Number**	1302 V 5.51 BlastMate II/677
Trigger Source	Geo: 1.00 mm/s	**Battery Level**	6.4 Volts
Range	Geo :254 mm/s	**Calibration**	November 21, 2000 by Instantel Inc.
Record Time	10.0 sec at 1024 sps	**File Name**	C3028N2L.IC0

Notes
Location: Station A
Client: De Beers Canada
User Name: Golder VME Limited
Converted: July 24, 2001 12:08:12 (V4.30)

Extended Notes
Snap Lake, NWT

Post Event Notes

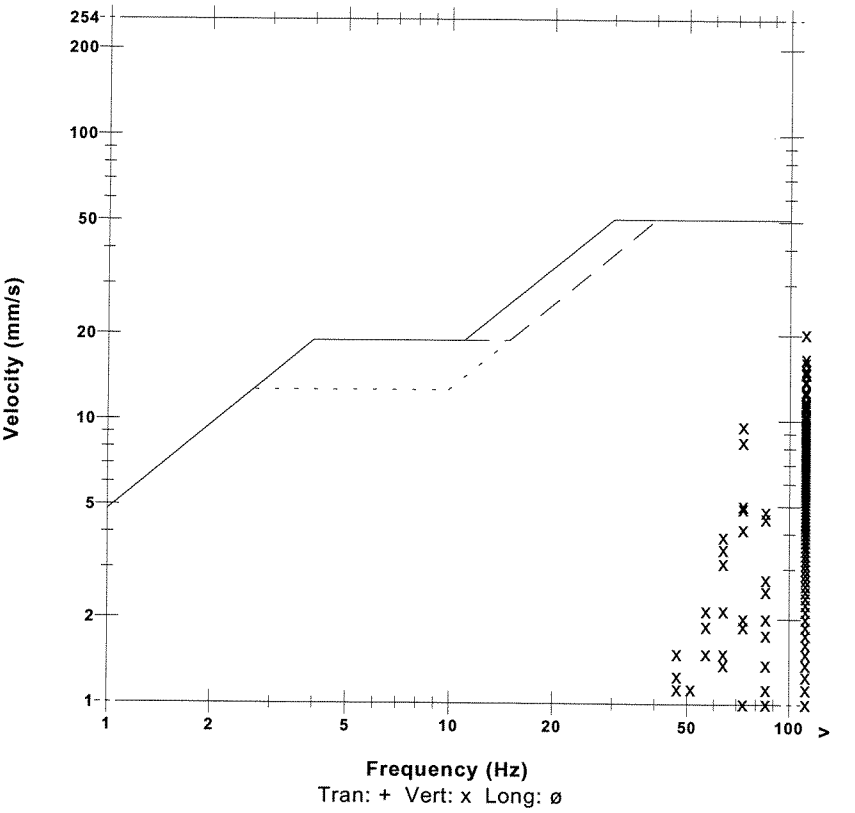
Microphone Disabled
PSPL N/A
ZC Freq N/A
Channel Test N/A

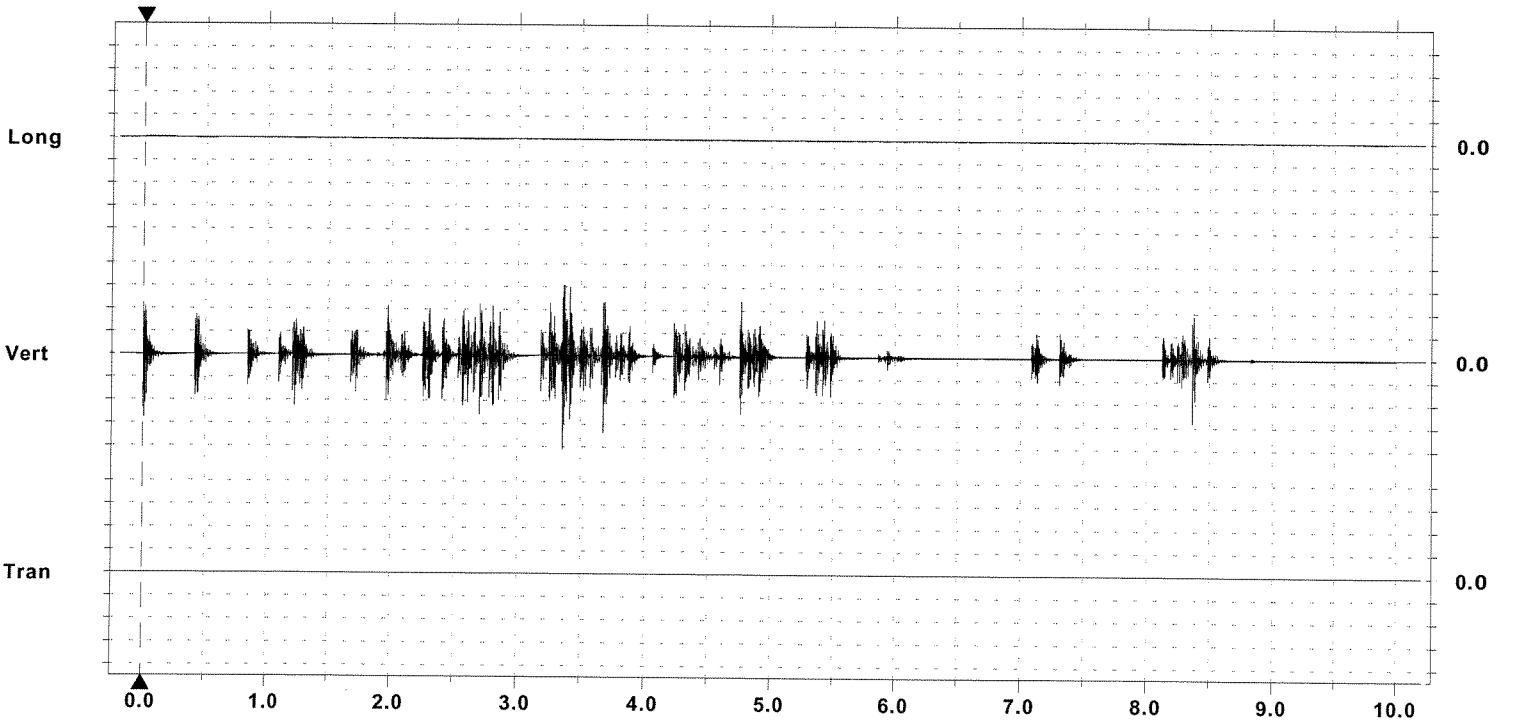
	Tran	Vert	Long	
PPV	0.0	20.4	0.127	mm/s
PPV	0.0	77.2	33.1	dB
ZC Freq	N/A	>100	N/A	Hz
Time (Rel. to Trig)	0.002	3.357	0.001	sec
Peak Acceleration	0.0	2.24	0.0133	g
Peak Displacement	0.0	0.0182	0.00006	mm
Sensorcheck	Check	Check	Check	

Peak Vector Sum 20.4 mm/s at 3.357 sec

N/A: Not Applicable

USBM RI8507 And OSMRE





Time Scale: 0.50 sec/div **Amplitude Scale:** Geo: 5.00 mm/s/div
Trigger =