

Environmental Feasibility Studies
GOLDCORP CANADA LTD.

HOLLINGER PROJECT
(TIMMINS, ONTARIO)

Environmental Sound and Vibration Assessment
(Blasting)

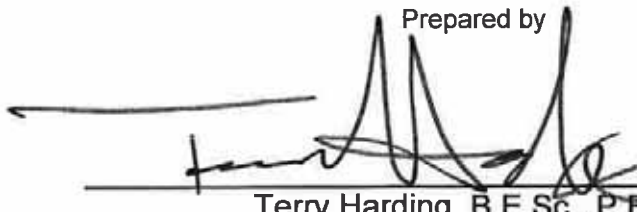
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VALCOUSTICS

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Environmental Feasibility Studies

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1.0 INTRODUCTION

Porcupine Gold Mines (PGM), a joint venture between Goldcorp Canada Ltd. (51%) and Goldcorp Inc. (49%) (Goldcorp), is conducting pre-feasibility level studies to determine the potential for re-developing the former Hollinger and McIntyre Mines area, in Timmins (see Figure 1.1), as a new open pit mine and underground (UG) mining complex. For the purpose of this report, this undertaking is referred to as the Hollinger Project.

The former Hollinger Mine is located immediately adjacent to downtown Timmins and the urban area of Schumacher, on the south side of Highway 101. The former McIntyre Mine is located directly north and east of the former Hollinger Mine site. Ore from the proposed Hollinger Project would be processed at the existing Dome ore processing facility (Dome Mill), located approximately 5 km east of the former Hollinger Mine site. Considerable residual gold resources have been identified at the Hollinger Project Site, and development of the Site would have the added advantage of removing a number of known mine hazards (open stopes, mini pits, and near surface underground workings) that are associated with past activities.

This document deals with the ground vibration and sound due to the concussion (blast) wave in the atmosphere associated with the blasting operations at the working face within the pit, and is one of a series of baseline and modelling reports prepared to describe existing environmental conditions, associated with the Hollinger site area, in part to assist with obtaining future environmental approvals to re-open the Hollinger Mine; as well as to assist with project planning and to provide further information for Closure planning.

This introduction, or an abbreviated version of it in some instances, is included in each document, such that the reports can be read independent of one another. Baseline reports are being prepared to describe the following environmental aspects:

- Air Quality;
- Aquatic Environment;
- Cultural Heritage Environment;
- Noise;
- Hydrology;
- Hydrogeology;
- Socio-Economic Setting;
- Terrestrial Environment; and
- Noise.

The reports have been prepared by AMEC Earth & Environmental, a Division of AMEC Americas Limited (AMEC), with the exception of the baseline reports related to noise and vibration (Valcoustics Canada Ltd.), the cultural heritage environment (Woodland Heritage Services Limited), and the socio-economic setting (PlanningAlliance). The latter three entities worked under the direction of AMEC to ensure an appropriate level of study integration.

1.1 SITE HISTORY

The Hollinger gold deposit was discovered in 1909, as one of the three original major Timmins properties, along with that of the Dome and McIntyre Mines. The main Hollinger Mine operated from 1910 to 1968 and further mining took place in the 1970's and 1980's. The Hollinger, McIntyre and Coniaurum underground mine workings are all interconnected, along with those of a number of other smaller mines in the area.

Because of their connection to the McIntyre Mine, the Hollinger underground workings were kept dry while McIntyre operations continued until 1988, when the McIntyre Mine was shut down. The pumps at Hollinger and McIntyre Mines were shut down in 1991, and the underground working allowed to flood. A surface pump was installed in the McIntyre No 11 Shaft in 2000 and currently the upper mine levels are de-watered to a level ranging between 24 to 34 m below ground surface (mbgs), to help manage near-surface groundwater levels in the area. Mine water from the Hollinger, McIntyre and Coniaurum Mines is managed through the McIntyre No. 11 Shaft, with discharge to Little Pearl Tailings Pond. The McIntyre Mine operated from 1911 to 1988.

1.2 PROJECT OVERVIEW

Goldcorp, through PGM, is planning to develop the Hollinger Project by redeveloping the former Hollinger and McIntyre Mines area as a new open pit and UG mining complex. The open pit complex would involve the sequential development of an open pit, through a series of phased push-backs that would be used to access shallow ore zones within 200 to 250 mbgs. The UG portion of the mine complex would involve the potential development of two new UG ramps and associated ventilation raises that would be used to access deeper ore zones.

Development of the new Hollinger Project would require comparatively limited new infrastructure, as ore from the Project Site would be hauled to and processed at the existing Dome Mill, with tailings from ore processing to be discharged to the existing Dome Mine tailings deposition area.

The UG operations would consist of the Millerton and Central Porphyry Zone (CPZ) UG operations. Ramps developed at the Millerton and CPZ locations would be developed to approximately 400 mbgs. Mining beyond that point would likely involve shaft hoisting. Opportunities to use existing infrastructure for the deeper mining could potentially involve using the existing Hollinger No. 26 Shaft to develop the Millerton UG, and the McIntyre No. 11 Shaft to develop the CPZ UG. Ramp development and associated UG exploration would be used to confirm UG ore resources, and the viability of UG mining.

Under the current open pit design, there would be a requirement for the disposal of approximately 37,000,000 m³ of mine rock. The majority of the mine rock (estimated at 20,000,000 - 30,000,000 m³) would be retained on the Hollinger Project Site and would be used to backfill and overfill the initially excavated phased mine pits. Rock will also be used to build the Environmental Control Berm and the Transportation Corridor with the remainder being stored at the Dome Mine site.

Infrastructure used and/or developed to support the Hollinger Project would include:

- At the Hollinger Project Site:
 - ▶ permanent mine rock and overburden stockpiles;
 - ▶ site water collection and drainage systems (if required);
 - ▶ potentially some small fuel and petroleum product storage facilities (if required);

- ▶ electrical connections from nearby, currently in place, Hydro One infrastructure; and
- ▶ natural gas (if required) from nearby, currently in place, Union Gas infrastructure.
- Off the Hollinger Project Site:
 - ▶ the approximately 4.8 km long Transportation Corridor linking the Hollinger Project Site with the Dome Mill;
 - ▶ potentially additional mine rock stockpiles (at the Dome site) (if required); and
 - ▶ mine dewatering system from McIntyre No. 11 Shaft to Little Pearl Tailings Pond.

In addition, the Project would include the construction of an Environmental Control Berm around the Hollinger Project Site. This is a key feature of the Project with the main purpose of the Environmental Control Berm being to manage noise and other effects on nearby receptors.

Throughout the operations phase, mine rock material would be used to progressively backfill the phased mined pits. At closure, the remaining pit will be allowed to flood, and the pit discharge will likely be routed by gravity flow south to either the Skykker Creek or Perch Lake systems, both of which drain to the Mountjoy River. All remaining Project infrastructure would be removed at closure, and the Project Site would be rehabilitated in accordance with established mine closure protocols. In addition, closure will be carried out such that existing safety hazards would be removed. Part of the Closure Plan would be to ensure, through stakeholder input and working collaboration with the City of Timmins' Planning Department, that the Project Site would be landscaped in an aesthetically pleasing manner.

1.3 GENERAL SETTING

The Timmins area is characterized by a mix of urban and industrial development superimposed on a forested background. The City of Timmins consists of a major downtown urban area, as well as a number of other smaller urban centres scattered throughout the area, with Schumacher, South Porcupine, and Porcupine being the more prominent of these smaller centres. Various other smaller hamlets also occur throughout the area. All of these areas were amalgamated in 1973 to form the City of Timmins.

South Porcupine and other communities to the east are linked to Timmins by Highway 101, with a commercial strip occurring along this highway between downtown Timmins and Schumacher. Highway 655 extends north from Highway 101, with linkages to the Timmins airport via Airport and Laforest Roads, and linkages further north to Xstrata Copper's Kidd Mine site and Highway 11. Several major transmission, gas, water and sewer lines pass through the area, as well as local services.

Timmins was founded as a mining centre, with the three prominent original mines being the Hollinger Mine, the McIntyre Mine, and the Dome Mine. Of these, only the Dome Mine is still in operation. Numerous other smaller mines also operated in the local area (see Section 1.4); many of which were or became linked to the three major mines at one time or another. None of these smaller historic mines are currently active. Above and below grade tailings, associated with these active and former mine sites, are widespread throughout the study area (Figure 1.1). Prominent mine rock piles are associated with the Dome Mine. There is little evidence of mine rock piles associated with the other mining operations, because all the mines, except for the Dome open pit operation, were underground mines. Mine rock produced by these underground mines was typically used as material for construction and backfill operations.

Topography in the Timmins area is dominated by its location at the transition of Precambrian Shield terrain to the south and southwest, and by flat-lying glaciolacustrine silt and clay plains to the north and east. An extensive glaciolacustrine sand plain area lies to the south of Timmins, including dune formations, and extends into the lower, southwest portion of the study area (Figure 1.2). A prominent esker system extends immediately adjacent and parallel to the east side of Highway 655, north from Highway 101. The local topography reaches a maximum of about 365 m above mean sea level (amsl) in the area just southeast of the Hollinger site and north of Gold Mine Road. Further east towards South Porcupine, and within the glaciolacustrine silt and clay plains, the local topography decreases to as little as 280 m elevation.

The geology of the Timmins area is structurally complex, and includes several major fault zones, and anticline/syncline systems, many of which control surface topographic expressions. The Pearl Lake/Little Pearl Pond and the Gillies Lake area are controlled by these features, and as a result are the location of deeper sediment accumulations. Bedrock exposures are widespread and frequent throughout the major portion of the study area, but with much reduced expression in the areas dominated by glaciolacustrine silt, clay and sand plains.

Several small lakes and numerous ponds are scattered throughout the area, with larger numbers of ponds having formed along low gradient creek valleys as a result of beaver activity. Most of the area's drainage is captured by the Porcupine and South Porcupine Rivers, which flow east, converging just upstream of Porcupine Lake, northeast of the Dome Mine site. The Porcupine River is a low gradient system that has its headwaters in the area just north and east of the Hollinger site. The Porcupine River drains into Night Hawk Lake and the Frederick House River system. Areas south and west of the Hollinger site drain to either the Skynner Creek or Perch Lake systems, both of which drain to the Mountjoy River, which flows into the Mattagami River. Areas north and west of the Hollinger site drain to Gillies Lake and the Town Creek system, which drains to the Mattagami River; or slightly further north there are a number of smaller drainages that drain directly west to the Mattagami River.

Virtually all drainages in the area have been affected by existing or past mining activities, which have affected water quality, and to a lesser extent drainage patterns themselves.

The majority of the landscape that has not been developed for urbanization or mining remains in forest cover, with the exception of principal agricultural areas to the north and south of Timmins, near to the Mattagami River, and a number of smaller parcels of land in and around the Porcupine Lake area. Forest communities in the area are virtually all second growth as a result of past logging activities, and fires. Throughout the generally lower-lying, eastern portion of the study area, forest communities are dominated by varying mixtures of Black Spruce and poplar (Trembling Aspen and Balsam Poplar), with White Spruce, Jack Pine, Balsam Fir, Larch and White Birch as common associates. Central portions of the study area, where rock outcroppings are common, show similar forest community types but with a somewhat stronger representation of Jack Pine. Sandy areas north of Gillies Lake bordering Highway 655, and south and west of the Kayorum (Hollinger) tailings stack, show a dominance of Jack Pine, or Jack Pine with poplar. The abundance of poplar in the area is indicative of the level of past disturbance, as poplar species are typically successional and not characteristic of mature forest communities. Virtually all major forest blocks are transected by roads, transmission lines, trails, or other such linear features.

1.4 SPATIAL AND TEMPORAL BOUNDARIES

To encompass all potential development areas and immediate drainages there from, Local Study Area (LSA) boundaries for natural environment investigations were focused on watershed and riverine boundaries, with the exception of the northwest study area boundary, which was defined by Laforest Road and a narrow strip of land bordering the east side of Highway 655 (Figure 1.1). The narrow strip of land bordering the east side of Highway 655 was included because this area includes a small trailer park and a single residence north of the trailer park, which have the potential to be affected by possible Hollinger related developments. Biophysical environmental studies are limited to this larger area, but depending on the specific discipline, may focus only on the relevant portions of the LSA.

The socioeconomic study area (SESA) is based on the City of Timmins limits, which encompass both urban and rural areas (Figure 1.3).

1.5 STUDY APPROACH

Consideration was given to developing a single environmental baseline report, or a series of baseline reports. In the final analysis, it was determined that development of a series of separate baseline reports was most

advantageous, with an attempt to standardize these reports to the extent practicable. The entire study team functioned as an integrated unit to a coordinated effort.

2.0 METHODS

2.1 GENERAL OVERVIEW

The materials to be removed from the open pit will include gold bearing ore and mine rock. This will be accomplished via blasting operations which will give rise to ground vibration as well as air blast (noise).

The current pit design envisions a large excavation at the top of the deposit, which will eventually focus down into three to four smaller sub-pits towards the bottom of the deposit. For planning and design purposes, these sub-pits have been named according to their general location within the project area. The excavation will occur in several distinct phases over an anticipated approximate six year life span. However, this assessment does not account for the pit phasing sequence over the lifespan of the pit. Rather, it is assumed that blasting can occur at or very close to the ultimate pit boundary, and at any point within the boundary. The assessment and results is therefore only contingent upon the ultimate pit boundary, which has been updated and has changed slightly from the outline considered in this assessment. See Section 2.2 below.

2.2 CHANGES TO PROPOSED PLAN

As is often the case for studies conducted during the feasibility phase of a large project, the design has been advanced somewhat relative to the conditions considered in this report. This includes the ultimate pit outline, and including the addition of a small fourth pit (Vipond pit) at the east side, adjacent to Central pit. This additional pit results in a bulge in the ultimate pit outline relative to the outline considered in this assessment. Elsewhere, there are a few differences in the pit outline, but these are minor.

Some preliminary discussions regarding the change to the ultimate pit outline including the additional pit, are presented in Section 3.4 below. However, the main findings of this study are still valid. Any changes to address the final conditions are expected to be very minor relative to the conclusions presented here. The blasting assessment will be revised once the pit design has been frozen in the detailed engineering phase.

2.3 GUIDELINES

2.3.1 Sound and Vibration Reference Limits

The extraction of material from the working face requires the use of explosives. This gives rise to ground vibration and a concussion (blast) soundwave in the atmosphere. This assessment is based on theoretical (predictive) methods, that is, it is not based on actual site measurements. The predictions follow the procedures outlined in Ministry of the Environment (MOE) publication "*Guidelines on Information Required for Assessment of Blasting Noise and Vibration – December 1985*" (Reference 1). See Appendix A.

The guideline presents limits for vibration and sound. In either case two limits are given; a "cautionary" limit and a "standard" limit, with the cautionary limit being the lower of the two. The standard limit is applicable to operations where routine monitoring of the sound and vibration are carried out. Goldcorp has historically monitored sound and vibration from blasting at their other sites in Timmins, and it is expected this will be done for this site as well. The standard limits for vibration and for sound have therefore been used.

For either sound or vibration, general MOE guidelines typically address effects on noise sensitive uses only, which do not include commercial development. The MOE blasting guideline does not explicitly state whether the limits apply only to residential uses, but this is implied within section "Required Information", which states the need to identify nearby residences only. Regardless, it is also appropriate to consider the potential sound and vibration effects at the nearby commercial uses due to their close proximity to the pit. There are, however, no specific noise or vibration limits for non-residential uses within the blasting guideline. The ground vibration "standard" limit appearing in the MOE guideline also appears in the reference vibration limits of

International Standards Organization publication ISO 2631-2 "Evaluation of Human Exposure to Whole Body Vibration - Part 2 : Continuous and Shock Induced Vibration in Buildings (1 to 80 Hz) -216" (Reference 2). Unlike the MOE guideline, the ISO limits do address non-residential uses also, including office uses. The MOE ground vibration limit of 12.5 mm/sec coincides with the ISO upper limit for residential uses. Therefore, the ISO upper limit for office uses of 18 mm/sec has been used here as a guide to defining the maximum limit for the non-residential uses. The vibration limit is in terms of peak-particle-velocity (ppv), that is, it is not a root-mean-square (rms) average. See the Glossary of Terms for the definition of ppv and rms.

Similarly, the blasting guideline does not address sound level limits for non-residential uses. For commercial uses, the "standard" sound pressure level limit of 128 dB appearing in the guideline was increased by 5 dB to 133 dB. The 5 dB adjustment is based on information contained in other MOE guidelines, which show sound limits for commercial uses 5 dB higher than the residential limits, and the same reasoning was applied here. A difference of 5 dB is only just noticeable.

To summarize, the reference sound and vibration limits used in this study are:

- Vibration:
 - ▶ 12.5 mm/sec residential ("standard" limit from MOE); and
 - ▶ 18.0 mm/sec commercial (from ISO for office uses).
- Sound:
 - ▶ 128 dB residential ("standard" limit from MOE); and
 - ▶ 133 dB commercial (inferred using other MOE guidelines).

2.3.2 MOE D-1 and D-6 Land Use Compatibility Guidelines

The MOE D-1 and D-6 guidelines are intended to assist in the planning process when new sensitive land uses are proposed within the potential influence area of existing facilities or when new facilities are proposed where existing sensitive uses would be within the new influence area. The stated objectives of the MOE guidelines are to "...minimize or prevent, through the use of buffers, the exposure of any person... to adverse effects associated with the operation of specified facilities...". Environmental noise and vibration is one identified, potential, adverse effect.

Separation distance is one buffering technique. Other types of buffers or mitigation are recognized, such as sound barrier berms, walls or buildings. Where a specific site is proposed for development, it is the proponent's responsibility to investigate, propose and implement mitigation that can be located either at the source, elsewhere on the facility site, on the sensitive land use site, or on intervening sites.

The D-6 guideline is a direct application of D-1, specific to industrial facilities and sensitive land uses.

Guideline D-6 identifies potential separation distances between sensitive land uses and industry, based on categorizing industry into one of three classes.

- | | |
|------------|--|
| Class I: | potential zone of influence 70 m; minimum 20 m. |
| Class II: | potential zone of influence 300 m; minimum 70 m. |
| Class III: | potential zone of influence 1000 m; minimum 300 m. |

The setbacks are typically lot line to lot line. Where zoning setbacks preclude uses with potential for conflict, setbacks on source or receptor properties can be part of the minimum setback.

There are several pit-falls in the literal application of Guideline D-6:

- The D-1 and D-6 guidelines are broad guidelines considering a variety of potential environmental impacts, including noise, vibration, air quality, etc. Distance separation alone is generally not an efficient mitigation technique for noise or vibration, because of the non-linear relationship between sound or ground vibration level and distance from a source. That is, the rate of fall off of sound or vibration level diminishes with increasing distance. Thus, relying on distance alone can lead to inefficient use of infrastructure and available land. Including mitigation such as sound barriers, building orientation (e.g., direction that loading docks face), or noise control at source (e.g., equipment selection, silencers on fans, etc.) can often lead to appropriate compliance with noise criteria and land use compatibility, using separation distances less than the minimum in the D-6 guidelines.
- Applying the minimum recommended (or other arbitrary) separation distance provides no assurance that there will be no environmental noise impacts and that no mitigation will be required. There have been occasions where planners assumed that implementing either the minimum or a separation distance equal to the indicated potential zone of influence automatically resolved all issues. Conversely, there are examples where noise sensitive developments have been approved with buffer setbacks much less than the minimums under D-6, on the basis that the applicable MOE noise guideline limits of LU-131 or NPC 205/232 are met. In other words, compliance with the numeric sound level limits of the MOE can be a better predictor of land use compatibility, rather than buffer setbacks alone and in the absence of numeric sound limits.

In general, compliance with the numeric sound level guideline limits outlined in MOE publications LU-131 or NPC 205/232 have been adequate to demonstrate land use compatibility between industrial facilities and noise sensitive uses, for buffer setbacks less than the suggested minimums outlined in the D-1 and D-6 publications.

2.4 ASSESSMENT RECEPTORS

The residential and commercial receptors considered in this assessment are shown in Figure 2.1, with the red areas representing residential dwellings (and motel which is classified the same as residential), and the yellow areas representing commercial buildings.

Existing residential uses are located immediately to the west in downtown Timmins, with the closest being at the east side of Laidlaw Street and Brunette Road; to the east at Schumacker; to the south at the Fairway Village Trailer Park; and to the north and northwest of Algonquin Boulevard (Hwy 101). A high-rise condominium is also located at the south side of Algonquin Boulevard, immediately north of the site. A two storey motel (Comfort Inn) is just under 1 km east of the condominium, at the south side of Algonquin Boulevard. Existing detached residential properties are located to the east and southeast, but are further removed than the areas noted above.

Existing commercial uses are located immediately to the west, at the east side of Laidlaw Street; to the northwest at the west side of Park Road; and immediately to the north and to the northeast along the south side of Algonquin Boulevard. One commercial use is located immediately south (Shania Twain Centre).

2.5 DATA ANALYSIS

The equation for predicting sound and vibration levels is based on the charge size used (per delay). Using this measure, and the separation distance between the blast location and assessment receptor, the absolute sound pressure level and ground vibration level due to the blast can be determined.

The general location of the ultimate pit outline has been established. Although the operations will proceed in three distinct phases, this phasing has not been accounted for in the assessment of blast noise and vibration. Rather, it is assumed blasting can occur at or very close to the ultimate pit boundary, which defines the worst case condition in terms of closest setback to the off site receptors.

The analysis method has been used in such a way to show the closest setback from a receptor location within the ultimate pit outline so as to not exceed the sound or vibration limits for a given charge size. The method uses a grid with an on-centre spacings of 25 m over an area extending about 1 km out from the general pit location. The minimum setback to trigger the sound and vibration limits was calculated at the nearest point on the grid mesh for each receptor location (each red or yellow area) shown in the attached figures. The corresponding minimum setback points for all receptors for a given charge size were then joined to form setback contours within the ultimate pit outline. The contours illustrate the closest setback for a given charge size, from 50 kg up to 1000 kg. The mine operators indicated that the maximum charge size is typically 200 kg, with 50 kg being the practical lower limit. An upper limit of 1000 kg was assumed simply for calculation purposes.

The predictions are based on generic environmental and topographical conditions, that is, there are no adjustments in the base equation to suite site specific conditions. However, the ground vibration predictions using a modified case of the classic MOE equation were also investigated (but are not presented here), using actual data based on vibration measurements made by others for blasts at the Porcupine Joint Venture Pamour open pit mine, a short distance (approximately 16 km) to the northeast (Reference 3). The modified case should more closely resemble the resultant vibration levels, assuming the subsurface conditions at the Pamour site are representative of those likely to occur at the proposed site, at least more so than the generic conditions represented by the classic MOE equation. The modification simply amounts to adjusting two constants in the classic MOE equation, specifically the “K” and “e” values. The classic form uses $K = 823.8$ and $e = -1.5283$. The modified values are $K = 341$ and $e = -1.32$. The modified constants were determined by the authors of that study using a best fit regression analysis to match measured ground vibration levels with charge size. The modified case is slightly less conservative than the classic MOE equation, that is, the setbacks are slightly less for a given charge size, with the use of the modified constants. Or in other words, the modified case results in a larger charge size for a given setback. Considering the classic MOE equation is more conservative, that is, gives lower maximum charge sizes, or greater setbacks, only the results based on the classic MOE equation are presented in this report. Appendix B shows the relationship between the classic format and the format used in this report.

The equation for the air blast noise is governed by two conditions; in front of the working face (i.e., no screening) and behind the working face (includes screening). In either case, additional screening beyond the working face is not accounted for in the base equation. A large approximately 30 m tall berm will be required at the perimeter of the pit outline (or portions thereof) to address noise from daily pit operations and equipment. The case without and with additional screening by a perimeter 30 m tall sound barrier berms has been considered. The 30 m berm is based on our concurrent study that addresses noise from the daily pit and hauling operations, and available under separate cover.

3.0 DATA ANALYSIS RESULTS

Figure 3.1 shows the setback contours for *ground vibration* as a function of the charge size, accounting for the residential and commercial vibration limits noted in Section 2.1.

Figures 3.2 to 3.5 show the setback contours for the *sound level* as a function of the charge size. Figure 3.2 accounts for no screening by the working face or perimeter sound barrier berms. Figure 3.3 shows the same, but including screening by a 30 m perimeter sound barrier (berm). Figure 3.4 accounts for screening by the working face (only). Figure 3.5 shows the same, but including additional screening by a 30 m perimeter sound barrier berm. These berm heights at the perimeter of the pit are based on the general conclusions of the concurrent operations noise assessment, although the final requirements may differ slightly from the 30 m height noted here.

3.1 GROUND VIBRATION

The results presented in this section address ground vibration only, and are independent of the sound level results in Section 3.2 below. The combined result for ground vibration *and* sound level are presented in

Section 3.3 below, and which ultimately defines the minimum setback contours for charge size that must be adhered to.

Figure 3.1 shows the contours of maximum charge size. The contour for the anticipated maximum charge size of 200 kg is shown with a heavier line.

For the residential receptors, typical setback distances are approximately:

- 155 m for a 100 kg charge;
- 220 m for a 200 kg charge;
- 270 m for a 300 kg charge.

For the commercial receptors, comparable typical setback distances are:

- 125 m for a 100 kg charge;
- 175 m for a 200 kg charge;
- 210 m for a 300 kg charge.

In some cases the predicted setback contour to the assessment receptor is less the actual setback between the assessment receptor to the ultimate pit outline. In this case, the charge size contour simply coincides with (i.e. defaults to) the ultimate pit outline, since the charge size contour must remain within the pit boundaries.

The sound barrier berms discussed below to mitigate the sound emissions are expected to have an insignificant effect on the vibration levels at the off-site areas.

It is stressed that the reference vibration limits are the maximums permissible so as to not exceed the reference vibration limits at the receptors. Achieving lower vibration levels through increased setbacks, smaller charge sizes, or other methods, would be highly desirable.

3.2 CONCUSSION (AIR BLAST) SOUND

The results presented in this section address sound levels due to the air blast only, and are independent of the ground vibration results in the preceding Section 3.1 above. The combined result for ground vibration *and* sound level are presented in Section 3.3 below, and which ultimately defines the minimum setback contours for charge size that must be adhered to.

For all of Figures 3.2 to 3.5, the contour for the anticipated maximum charge size of 200 kg is shown with a heavier line.

For the worst case condition shown in Figure 3.3, which accounts for no screening by the working face or perimeter berms, the permissible areas are quite restricted. For example, the 200 kg charge would be restricted to a small area at the centroid of the ultimate pit outline. Berms are needed to address noise from the regular pit operations and will also be needed to screen the air blast noise, assuming it necessary to use charge sizes greater than the 50 kg lower limit over the balance of the pit. As shown in Figure 3.3, assuming a berm height of 30 m, the minimum setback to the closest residential for the 200 kg charge size (and higher) coincides with the ultimate pit outline.

With screening by the working face only, the available area is much larger as illustrated in Figure 3.4, with the charge size contours again coinciding with the ultimate pit outline at most areas. The exception is the section immediately north of the trailer park where slightly greater setback is required for 100 kg charge and greater. Accounting for screening by the 30 m sound barrier berm, this setback contours coincide with the ultimate pit outline for all charge sizes reviewed at all areas, as seen in Figure 3.5.

It is also stressed here that the reference sound level limits are the maximums permissible. Achieving lower sound levels either through increased berm heights and extent, smaller charge sizes, or other methods, would

be highly desirable. It is noted that some locations are predicted to be less than the maximum permissible sound levels accounting for screening by the working face and/or anticipated 30 m sound barrier berm, simply because the predicted theoretical minimum setback is less than the actual setback dictated by the pit outline. It should also be noted that sound barrier berms at the pit perimeter will provide increased screening over time, as the pit floor advances in depth and the 'effective height' of the berm increases. The effective height is simply the difference between the top of the berm and the pit floor.

3.3 COMBINED GROUND VIBRATION AND CONCUSSION (AIR BLAST) RESULTS

Figures 3.6 and 3.7 show the maximum charge size contours for the limiting case of blast noise and ground vibration, for "no screening" or "with screening" by the working face, respectively, and including the 30 m perimeter berm in both cases. The anticipated maximum charge size of 200 kg is again shown with a heavier line.

The charge size contours are ultimately dictated by the minimum setbacks to comply with the ground vibration limits, and the combined results therefore is identical to the ground vibration (only) case, shown as Figure 3.1.

3.4 MINOR CHANGES TO PROPOSED PLAN

Some changes to the pit outline have occurred since the bulk of the work had been completed for this report. This addresses preliminary discussions regarding the effects these changes will have on the conclusions presented here.

Future studies as part of detailed design will update the conclusions and control measures, accounting for any changes that have occurred.

3.4.1 Ultimate Pit Outline

There are some minor differences to the pit outline.

These differences will not have an affect on the conclusions presented in this study. This is because the conclusions presented here are in terms of a minimum setback for a given charge size relative to the sensitive off-site receptor locations so as to not exceed the sound or vibration limit. The pit boundary therefore has little relevance, since the minimum setback is defined by other parameters. For example, if the minimum setback from a sensitive receptor for a 100 kg charge size is say 300 m, the location of the pit boundary within that 300 m setback is not relevant; the important aspect only being the 100 kg maximum allowable charge size at that 300 m setback. Similar conclusions would also apply to the concussion (blast) noise.

Despite this argument, the differences in the pit outline are very minor, and the results for the revised pit outline would not be fundamentally different from those arrived at in this report.

3.4.2 Additional (Vipond) Pit

The updated plan shows a small pit at the northeast area, immediately beside Central pit. Although this additional pit creates a bulge in the pit outline not originally considered, it is not expected to place additional noise/vibration producing operations closer to off-site noise sensitive areas. This is because of this pits location adjacent to the vacant lands along the southeast boundary of the site.

By the same argument as noted above in Section 3.3.1 for the ultimate pit outline, the maximum charge size(s) within this new pit will be determined based on minimum allowable setback. The difference in this case is that the allowable charge sizes at this area are currently not know, but would not be fundamentally different from the maximum charge sizes at the locations shown in the enclosed figures on this report, in the immediate vicinity of this new pit

Once the ultimate pit outlines have been frozen, this will be confirmed.

4.0 SUMMARY

Contours of maximum charge size so as to comply with the sound and vibration limits have been developed for all areas within the expected ultimate pit outline. Although it is expected that the excavation will proceed in three distinct phases, that is, three pits, the phasing has not been accounted for in this assessment but this does not affect the results presented here. The outlines of the individual pits simply can be superimposed over the charge size contours within the ultimate pit boundary to establish the contours for each individual pit.

Accounting for screening by the perimeter berm that is required to address noise unrelated to blasting, the contours of maximum charge size are ultimately dictated by the ground vibration limits. The predictions indicate that charge sizes up to 1000 kg are possible for a very small area within the ultimate pit outline, and furthest from the residential and commercial areas to the west north and east. The anticipated maximum charge size of 200 kg is permissible within the balance of ultimate pit outline, except for some areas close to the ultimate outline along the south, west, north and east limits.

The results presented here are considered conservative, since actual attenuation of the ground vibration may be somewhat greater than used here, based on actual testing completed (by others) for other locations in this in this general area.

Some changes to the ultimate pit outline have occurred since the time the bulk of the work for this study were completed. These and any other changes that may occurred will be addressed as part of the ongoing detailed environmental studies. However, it is fully expected the main conclusions presented in this report remain valid, and only very minor modifications would be needed to suite the final design.

It is recommended that all blasting be monitored for noise and ground vibration at all residential areas around the periphery of the site, as well as the closest commercial uses (including the Comfort Inn motel at the south side Algonquin Boulevard).

5.0 REFERENCES

1. "Guidelines on Information Required for Assessment of Blasting Noise and Vibration - December 1985 ", Ontario Ministry of the Environment, October 1995.
2. "ISO 2631-2 : Evaluation of Human Exposure to Whole Body Vibration - Part 2 : Continuous and Shock Induced Vibration in Buildings (1 to 80 Hz)" International Standards Organization, ISO 2631/1-1985.
3. "Blast Monitoring and the Development of Vibration Regression Analysis for the PVJ - Pamour Pit", Technical Memorandum, Golder Associates Ltd, November 12, 2004.
4. "Goldcorp Canada Ltd. Hollinger Project (Timmins Ontario,) Pre-Feasibility Environmental Baseline Studies, Environmental Sound and Vibration Assessment (Blasting)", Valcoustics Canada Ltd, February 11, 2008.

TH\hd
J:\2007\107124\210\Reports\Hollinger Pit- Feasibility Blasting Noise & Vibration Fnl.wpd

GLOSSARY OF TERMS

Class 1 Area (MOE definition):

means an area with an acoustical environment typical of a major population centre, where the background sound level is dominated by the urban hum.

Class 2 Area (MOE definition):

means an area with an acoustical environment that has qualities representative of both Class 1 and Class 3 Areas, and in which a low ambient sound level, normally occurring only between 2300 and 0700 hours in Class 1 Areas, will typically be realized as early as 1900 hours.

Other characteristics which may indicate the presence of a Class 2 Area include:

- ! absence of urban hum between 1900 and 2300 hours;
- ! evening background sound level defined by natural environment and infrequency human activity; and
- ! no clearly audible sound from stationary sources other than from those under impact assessment.

Class 3 Area (MOE definition):

means a rural area with an acoustical environment that is dominated by natural sounds having little or no road traffic, such as the following:

- ! a small community with less than 1000 population;
- ! agricultural area;
- ! a rural recreational area such as a cottage or a resort area; or
- ! a wilderness area.

Construction (MOE definition):

"Construction" includes erection, alteration, repair, dismantling, demolition, structural maintenance, painting, moving, land clearing, earthmoving, grading, excavating, the laying of pipe and conduit whether above or below ground level, street and highway building, concreting, equipment installation and alteration and the structural installation of construction components and materials in any form or for any purpose, and includes any work in connection therewith.

Construction Equipment (MOE definition):

"Construction equipment" means any equipment or device designed and intended for use in construction, or material handling, including but not limited to, air compressors, pile drivers, pneumatic or hydraulic tools, bulldozers, tractors, excavators, trenchers, cranes, derricks, loaders, scrapers, pavers, generators, off-highway haulers or trucks, ditchers, compactors and rollers, pumps, concrete mixers, graders, or other material handling equipment.

Conveyance (MOE definition):

"Conveyance" includes a vehicle and any other device employed to transport a person or persons or goods from place to place but does not include any such device or vehicle if operated only within the premises of a person.

dB - Decibel:

See Sound (Pressure) Level.

dBA - A weighted decibel:

A nationally and internationally standardized frequency weighting applied to the sound level spectrum to approximate the sensitivity of the human hearing mechanism as a function of frequency (pitch).

Peak-Particle-Velocity (ppv):

The peak-particle velocity is the maximum instantaneous velocity experienced by the particles of a medium when set into motion.

Root -Mean-Square (rms):

The root-mean-square value over a given time period is the square root of the average of the square of the waveform over that time period.


Sound (Pressure) Level:

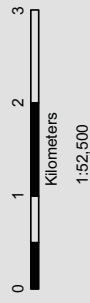
Measured in decibels (dB) it is the logarithmic ratio of the instantaneous energy of a sound to the energy at the threshold of hearing. Mathematically:


$$SPL (dB) = 20 \log \left(\frac{p}{p_0} \right)$$

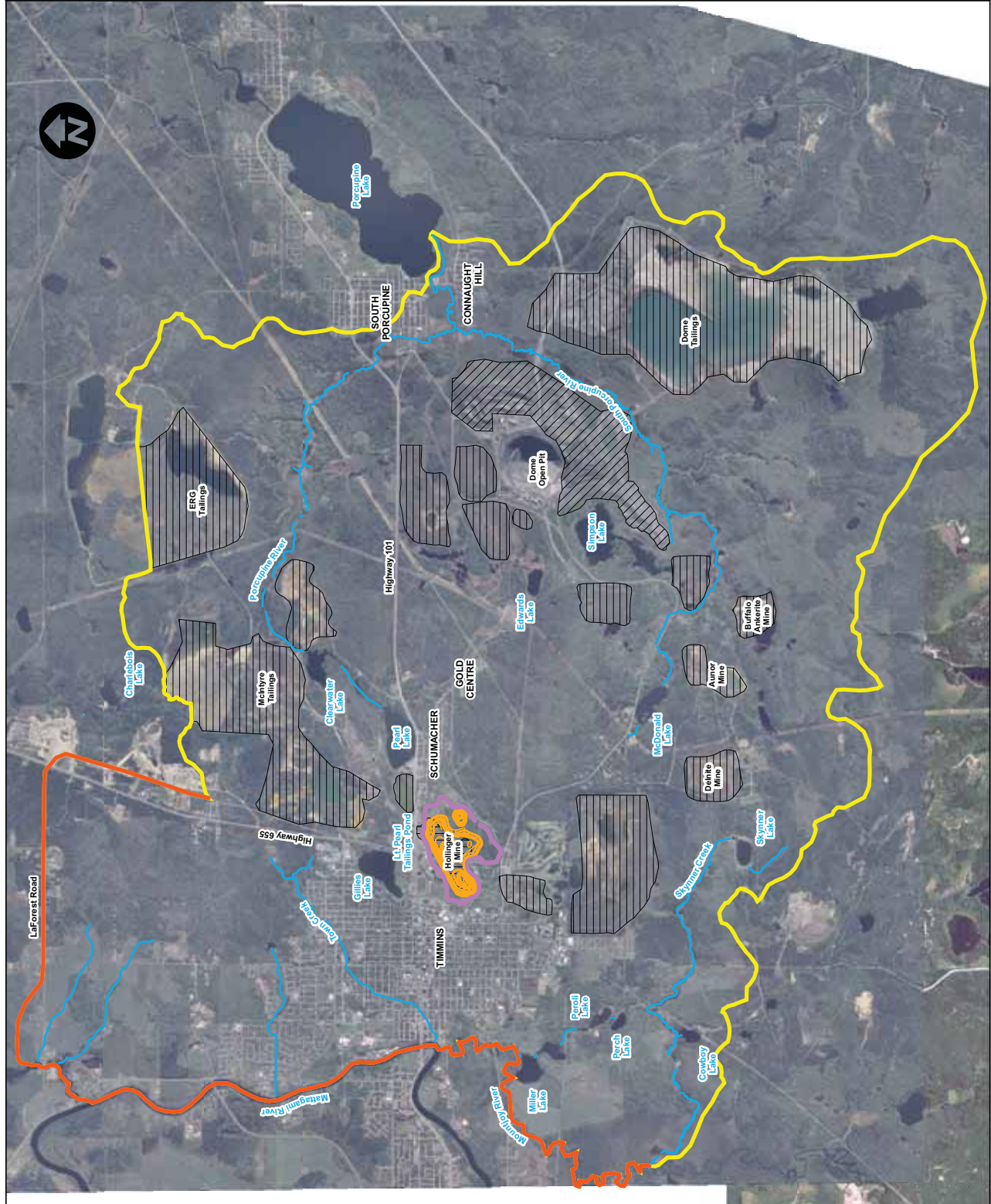
where p is the pressure due to the sound and p₀ is the pressure at the threshold of hearing, taken as 20 micro Pascals.

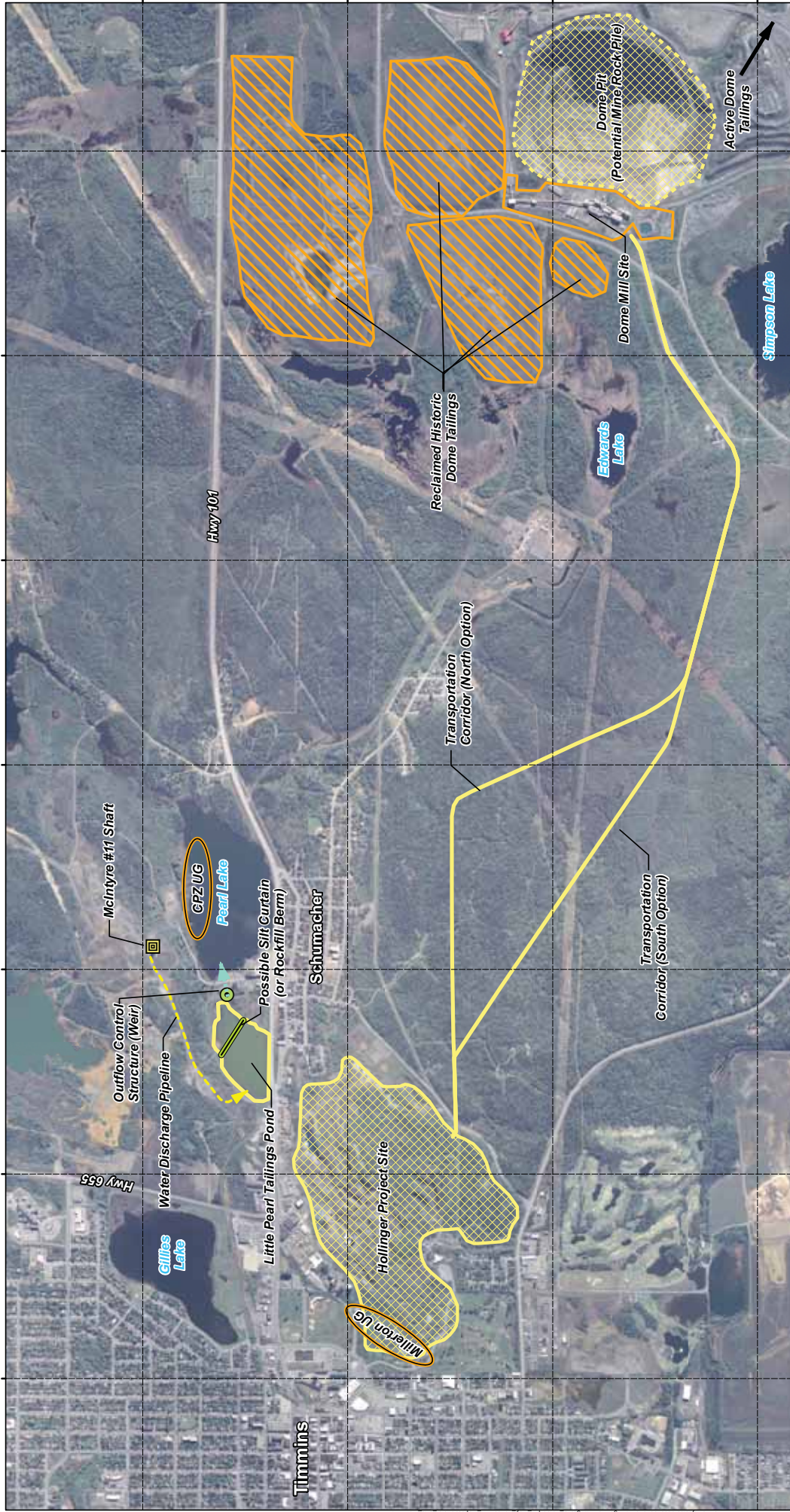
Legend:

-  Study Area (Watershed Boundary)
-  Study Area (Riverine and Road Boundary)
-  Mine Openings to Surface
-  Existing Tailings Deposits
-  Existing Waste Rock Deposits
-  Proposed Open Pit
-  Environmental Control Berm Outline
-  River or Creek



| | |
|---|----------------------|
|  | |
| HOLLINGER BASELINE STUDIES | |
| TIMMINS | ONTARIO |
| Site Location and Study Area | |
| SCALE: 1:52,500 | DATE: September 2007 |
| PROJECT No: TC171607 | FIGURE: 1.1 |
| | REV: 2 |





LEGEND

- Existing and Proposed Site Features within Scope of this Environmental Review
- Existing Site Features not within Scope of this Environmental Review
- Underground Works (Approximate)

NOTES:
 1. Outlines of facilities and site features are approximate.

North Arrow
 Datum: NAD83
 Projection: UTM, Zone 17N

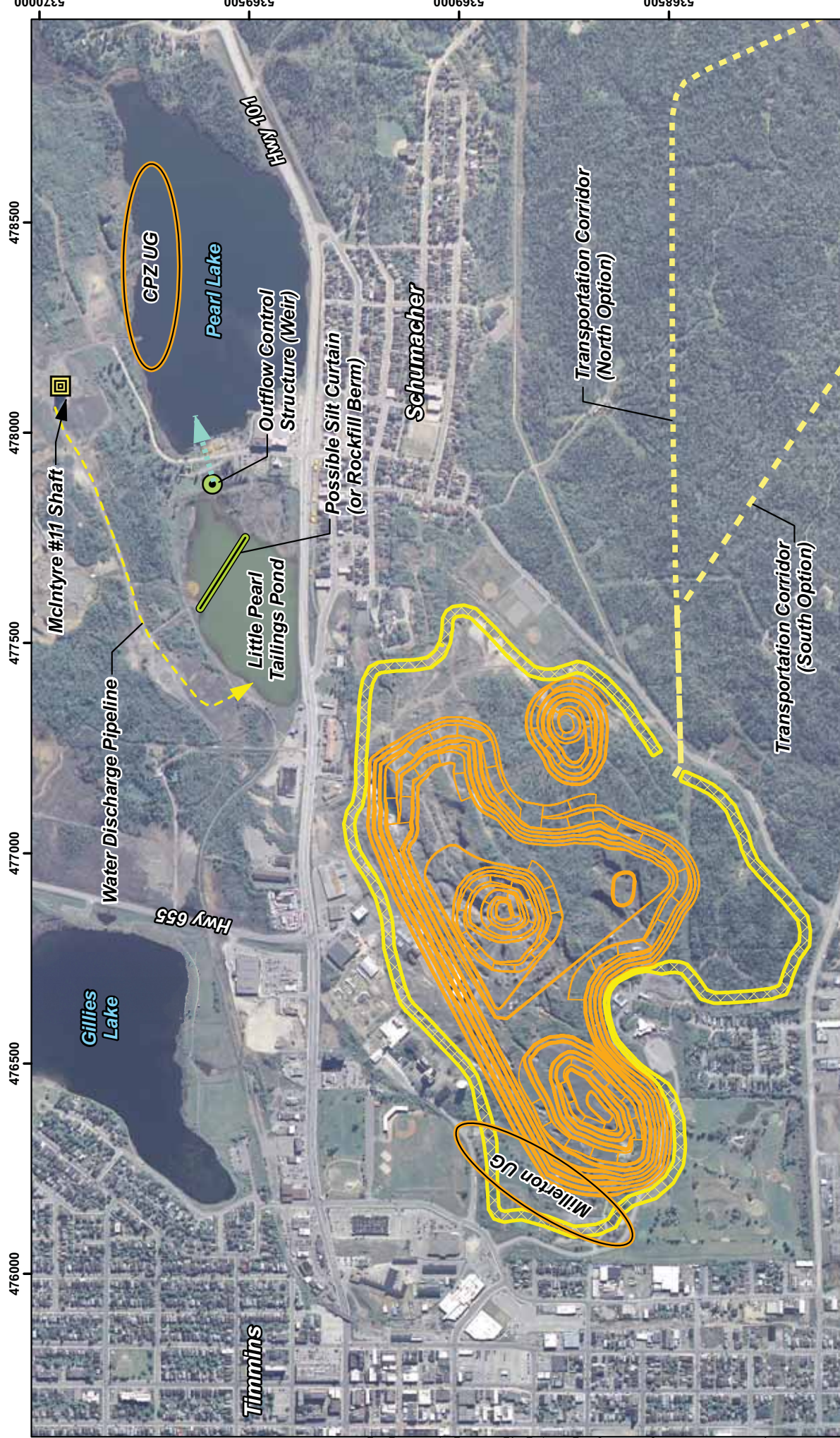
Scale: 0 0.5 1 2 3 4 5 Kilometres

amec
GOLDCORP
 MINERAL RESOURCES

HOLLINGER PROJECT

General Site Plan

PROJECT N°: TC81525
 SCALE: 1:18,000
 FIGURE: 1-2
 DATE: April 2010



LEGEND

- Environmental Control Berm Footprint
- Transportation Corridor (To Dome Site)
- Proposed Open Pit
- Outflow Control Structure (Weir)
- McIntyre #11 Shaft
- Possible Silt Curtain (or Rockfill Berm)
- Water Discharge Pipeline
- Underground Works (Approximate)

NOTES:

Datum: NAD83
Projection: UTM Zone 17N

GOLD CORP
PORCUPINE GOLD MINES

amec

HOLLINGER PROJECT

Detailed Site Plan

PROJECT N°: TC81525
SCALE: 1:12,700

FIGURE: 1-3
DATE: April 2010



- Legend:
- ▭ Residential Receptor Area
 - ▭ Commercial Receptor Area
 - ▭ Ultimate Pit Outline
 - ▭ Berm Location



Goldcorp Canada Ltd.
Hollinger Project
File: 107-124.210

Assessment Receptor Locations

Date: Aug 11, 2010

Figure: 2.1



Model Parameters:
 MOE
 K = 823.8
 e = -1.53

- Legend:**
- ▭ Residential Receptor Area
 - ▭ Commercial Receptor Area
 - ▭ Ultimate Pit Outline

Setback Contours:
 Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

- Charge Size**
- 50 kg
 - 100 kg
 - 200 kg
 - 300 kg
 - 500 kg
 - 750 kg
 - 1000 kg



Goldcorp Canada Ltd.
Hollinger Project
File: 107-124.210

Maximum Charge Size
Ground Vibration Due to Blasting

MOE Model Parameters

Date: Dec 16, 2009

Figure: 3.1



Model Parameters:

MOE
 K = 165.66
 e = -8.426

Legend:

- ▭ Residential Receptor Area
- ▭ Commercial Receptor Area
- ▭ Ultimate Pit Outline
- ▭ Berm Location

Setback Contours:

Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

Charge Size

- 50 kg
- 100 kg
- 200 kg
- 300 kg
- 500 kg
- 750 kg
- 1000 kg



Goldcorp Canada Ltd.
Hollinger Project
File: 107-124.210

Maximum Charge Size

Noise Due to Blasting
 No screening by working face,
 No berm

Date: Nov 11, 2010

Figure: 3.2



Model Parameters:

MOE
 K = 165.66
 e = -8.426

Legend:

- ▭ Residential Receptor Area
- ▭ Commercial Receptor Area
- ▭ Ultimate Pit Outline
- ▭ Berm Location

Setback Contours:

Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

Charge Size

- ▬ 50 kg
- ▬ 100 kg
- ▬ 200 kg
- ▬ 300 kg
- ▬ 500 kg
- ▬ 750 kg
- ▬ 1000 kg



**Goldcorp Canada Ltd.
 Hollinger Project
 File: 107-124.210**

Maximum Charge Size

Noise Due to Blasting
 No screening by working face,
 30m berm

Date: Nov 11, 2010

Figure: 3.3



Model Parameters:

MOE
 $K = 141.44$
 $e = -4.5$

Legend:

- ▭ Residential Receptor Area
- ▭ Commercial Receptor Area
- ▭ Ultimate Pit Outline
- ▭ Berm Location

Setback Contours:

Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

Charge Size

- ▬ 50 kg
- ▬ 100 kg
- ▬ 200 kg
- ▬ 300 kg
- ▬ 500 kg
- ▬ 750 kg
- ▬ 1000 kg



**Goldcorp Canada Ltd.
 Hollinger Project
 File: 107-124.210**

Maximum Charge Size

Noise Due to Blasting

With screening by working face,
 No berm

Date: Nov 11, 2010

Figure: 3.4



Model Parameters:

MOE
 K = 141.44
 e = -4.5

Legend:

- ▭ Residential Receptor Area
- ▭ Commercial Receptor Area
- ▭ Ultimate Pit Outline
- ▭ Berm Location

Setback Contours:

Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

Charge Size

- ▬ 50 kg
- ▬ 100 kg
- ▬ 200 kg
- ▬ 300 kg
- ▬ 500 kg
- ▬ 750 kg
- ▬ 1000 kg



Goldcorp Canada Ltd.
Hollinger Project
File: 107-124.210

Maximum Charge Size

Noise Due to Blasting

With screening by working face,
 30m berm

Date: Nov 11, 2010

Figure: 3.5



Model Parameters:

Vib - MOE
 K = 165.66
 e = -8.426

Legend:

- ▭ Residential Receptor Area
- ▭ Commercial Receptor Area
- ▭ Ultimate Pit Outline
- ▭ Berm Location

Setback Contours:

Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

Charge Size

- ▬ 50 kg
- ▬ 100 kg
- ▬ 200 kg
- ▬ 300 kg
- ▬ 500 kg
- ▬ 750 kg
- ▬ 1000 kg



**Goldcorp Canada Ltd.
 Hollinger Project
 File: 107-124.210**

**Maximum Charge Size
 Combined Noise and Vibration**
 No screening by working face,
 30m berm

Date: Nov 11, 2010

Figure: 3.6



Model Parameters:

Vib - MOE
 Noise - MOE
 K = 141.44
 e = -4.5

Legend:

- Residential Receptor Area
- Commercial Receptor Area
- Ultimate Pit Outline
- Berm Location

Setback Contours:

Contours indicate the maximum allowable charge size at a given location based on the distance to the nearest sensitive receptor location (either commercial or residential). Maximum charge sizes are determined in accordance with the MOE Guideline on Blasting Noise and Vibration (1985).

Charge Size

- 50 kg
- 100 kg
- 200 kg
- 300 kg
- 500 kg
- 750 kg
- 1000 kg



Goldcorp Canada Ltd.
Hollinger Project
File: 107-124.210

Maximum Charge Size
Combined Noise and Vibration

Screening by working face,
 30m berm

Date: Nov 11, 2010

Figure: 3.7

APPENDIX A

MOE BLASTING GUIDELINE

Ministry of the Environment
Ministère de l'Environnement

135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

135 West Avenue St. Clair
Bureau 100
Toronto (Ontario)
M4V 1P5

NOISE

GUIDELINES ON INFORMATION REQUIRED FOR THE ASSESSMENT OF BLASTING NOISE AND VIBRATION

DECEMBER 1985

NOISE ASSESSMENT UNIT

GUIDELINES ON INFORMATION REQUIRED FOR THE ASSESSMENT OF
BLASTING NOISE AND VIBRATION

1. SCOPE

This publication refers to information required for the assessment of impact due to blasting noise and vibration, in compliance with Section 8 of the Environmental Protection Act or the for the purpose of the Environmental Assessment Act. The guidelines apply to impact of noise and vibration generated by quarry blasting.

A simplified prediction model for the evaluation of noise and vibration impact severity is also described in this publication.

2. TECHNICAL DEFINITIONS

The technical terms used in this publication are defined in applicable publication of the Model Municipal Noise Control By-Law.

3. MEASUREMENT STANDARDS AND PROCEDURES

Measurement of blasting noise and vibration, for the purpose of verifying results of prediction calculations, shall be made in accordance with procedures described in applicable publication of the Model Municipal Noise By-Law.

4. BLASTING NOISE AND VIBRATION LIMITS

Two sets of limits are provided:

- (1) Cautionary limit, applicable to operations not subjected to routine monitoring.

- (2) Standard limit, applicable to operations where routine monitoring of Peak Pressure Level, and Peak Vibration Velocity is carried-out by the quarry operator.

The following limits are specified:

i) Concussion - Cautionary Limit:
Peak Pressure Level of 120 dBLin.

ii) Concussion - Standard Limit:
Peak Pressure Level of 128 dBLin.

iii) Vibration - Cautionary Limit: $0.01 \frac{m}{s}$
Peak Vibration Velocity is $1 \times 10^{-2} \text{ m/s} = 10 \frac{mm}{s}$

iv) Vibration - Standard Limit: $0.0125 \frac{m}{s}$
Peak Vibration Velocity is $1.25 \times 10^{-2} \text{ m/s} = 12.5 \frac{mm}{s}$

5. REQUIRED INFORMATION

The following represents the information which should be provided:

(1) Scaled Topographical Map

The map should show residences that may be impacted by the proposed operation, including property boundaries as well as location and elevation of various intervening structures and objects within a distance of approximately 3 km from the blast site. The map should also show access roads, depth of face, berm positions and heights if any, quarry development phases and direction of extraction, and ultimate number of benches.

(2) Blast Design

Particulars of proposed design and pattern of holes etc. should be completed in the following questionnaire:

Name of Quarry:

Contact:

Address:

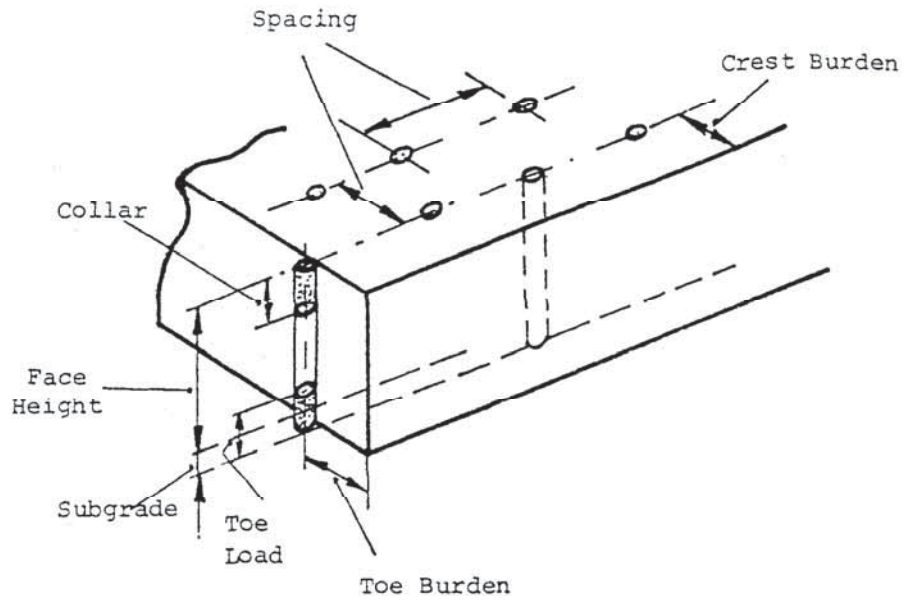
Title:

Tel:No.

Blaster:

| | | |
|--|--|--|
| Blasting Details | 1. Blasting Pattern and pitch of drill holes | |
| | 2. No. of holes | |
| | 3. Size of holes | |
| | 4. Depth of drilling | |
| | 5. Depth of collar or stemming | |
| | 6. Depth of toe load | |
| | 7. Toe explosive particulars: product | |
| | size of stick | |
| | strength % | |
| | 8. Remaining explosive particulars: product | |
| | size of stick | |
| | strength % | |
| | 9. Weight of charge per delay (kg) | |
| | 10. No. of charges per delay | |
| | 11. Total weight of charge per blast (kg) | |
| | 12. Width of toe burden | |
| | 13. Width of crest burden | |
| 14. What material is being quarried | | |
| 15. What tonnage is expected from each blast | | |
| 16. Expected number of blasts per week | | |
| 17. How close will the quarry face finally be to the nearest residence | | |

The following sketch illustrates specific parameters of the blast design:



6. PREDICTION MODEL

(1) Sound

The Peak Sound Pressure Level of blast in dB from a quarry is a function of the Cube Root Scaled Distance, and can be predicted from Figures 1 and 2 (for locations in front of, and behind quarry face). The Cube Root Distance is expressed as:

$$\text{C.R.S.D.} = \frac{D}{W^{1/3}}$$

Where D is distance from blast to receptor in (m). W is maximum weight of explosive (charge) per delay in (kg).

(2) Vibration

The magnitude of ground vibration expressed in terms of Peak Particle Velocity in (m/s) from a quarry is a function of the Square Root Scaled Distance, and can be predicted from Figure 3. The Square Root Scaled Distance is expressed as:

$$\text{S.R.S.D.} = \frac{D}{W^{1/2}}$$

Where D is distance from blast to receptor in (m). W is maximum weight of explosive (charge) per delay in (kg).

(3) Example of Blasting Noise and Vibration Prediction

D = 600 m, Receptor location behind
W = 20 kg the quarry face.

The calculated Cube Root Scaled Distance:

$$\text{C.R.S.D.} = \frac{D}{W^{1/3}} = \frac{600}{20^{1/3}} = 221.04 \text{ m/kg}^{1/3} \checkmark$$

The calculated Square Root Scaled Distance:

$$\text{S.R.S.D.} = \frac{D}{W^{1/2}} = \frac{600}{20^{1/2}} = 296.45 \text{ m/kg}^{1/2}$$

135

From Figure 2, the Peak Sound Pressure Level of the blast is 117.4 dB Lin

From Figure 3, the peak Particle Velocity of the Blast is 4.49×10^{-4} m/s

A set of blasting prediction graphs employing imperial units is also shown in the attached Figures 1A, 2A and 3A.

7. REPORT FORMAT

Information provided in a report should conform to the following general format. Analysis and evaluation by the Ministry will consist of checking the validity of the information based on the best available technology. Observance of the required format may expedite approval by the Ministry.

(1) Planning Objectives:

The scope of the information provided should be predicated on, and include a statement of the planning objectives of the Municipality and a statement of the planning objectives of the approving authority, if other than the Municipality.

(2) Organization of the Report:

The information should be presented in a concise, itemized form with appropriate headings. Sufficient copies of the information should be made available to the Ministry including plans, drawings and appendices.

(3) Body of the Report:

The body of the report should contain the following information:

- (a) Location, date and time of the blast.
- (b) Dimensioned sketch including photographs, if necessary, of the location of the blasting operation, and the nearest point of reception.
- (c) Physical and topographical description of the ground between the source and the receptor location.
- (d) Type of material being blasted.
- (e) Sub-soil conditions, if known.
- (f) Prevailing meteorological conditions including wind speed in m/s, wind direction, air temperature in °C, relative humidity, degree of cloud cover and ground-moisture content.
- (g) Number of drill holes.
- (h) Pattern and pitch of drill holes.
- (i) Size of holes.
- (j) Depth of drilling.

- (k) Depth of collar (or stemming).
- (l) Depth of toe-load.
- (m) Weight of charge per delay.
- (n) Number and time of delays.
- (o) The result and calculated value of Peak Pressure Level in dB and Peak Vibration Velocity in m/s.
- (p) Applicable limits as per Section 4.
- (q) The excess over the prescribed limit.

8. TRANSMITTAL OF INFORMATION

Reports prepared for submission to the approving authority or a Municipality are normally circulated to the Ministry. Technical assistance in preparing a report may be obtained by contacting the Noise Assessment Unit, Operational Services Section, Environmental Approvals and Project Engineering Branch of the Ministry.

FIGURE 1. BLASTING NOISE PREDICTION
Receptor location in front of quarry face.

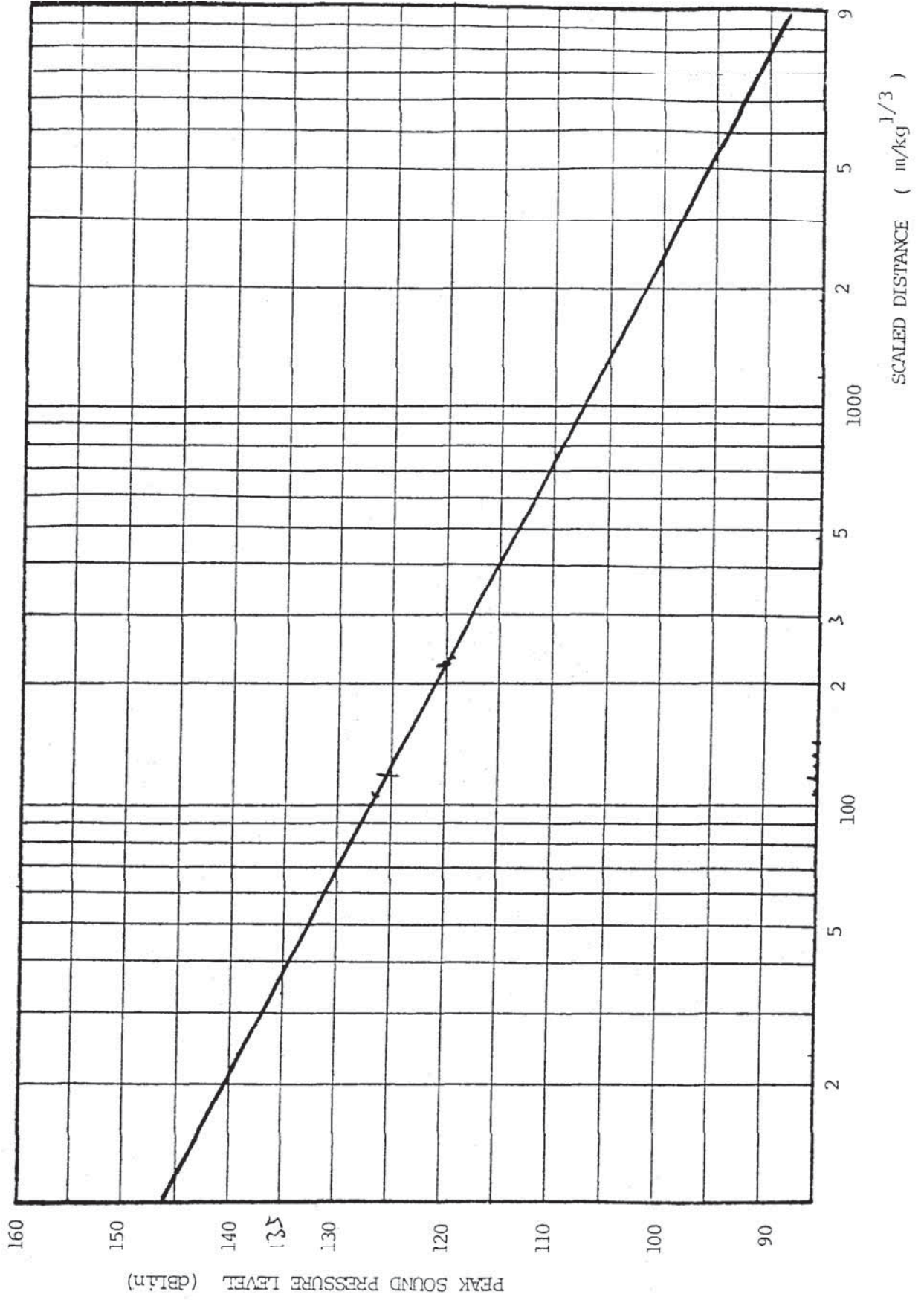


FIGURE 2. BLASTING NOISE PREDICTION
Receptor location behind quarry face.

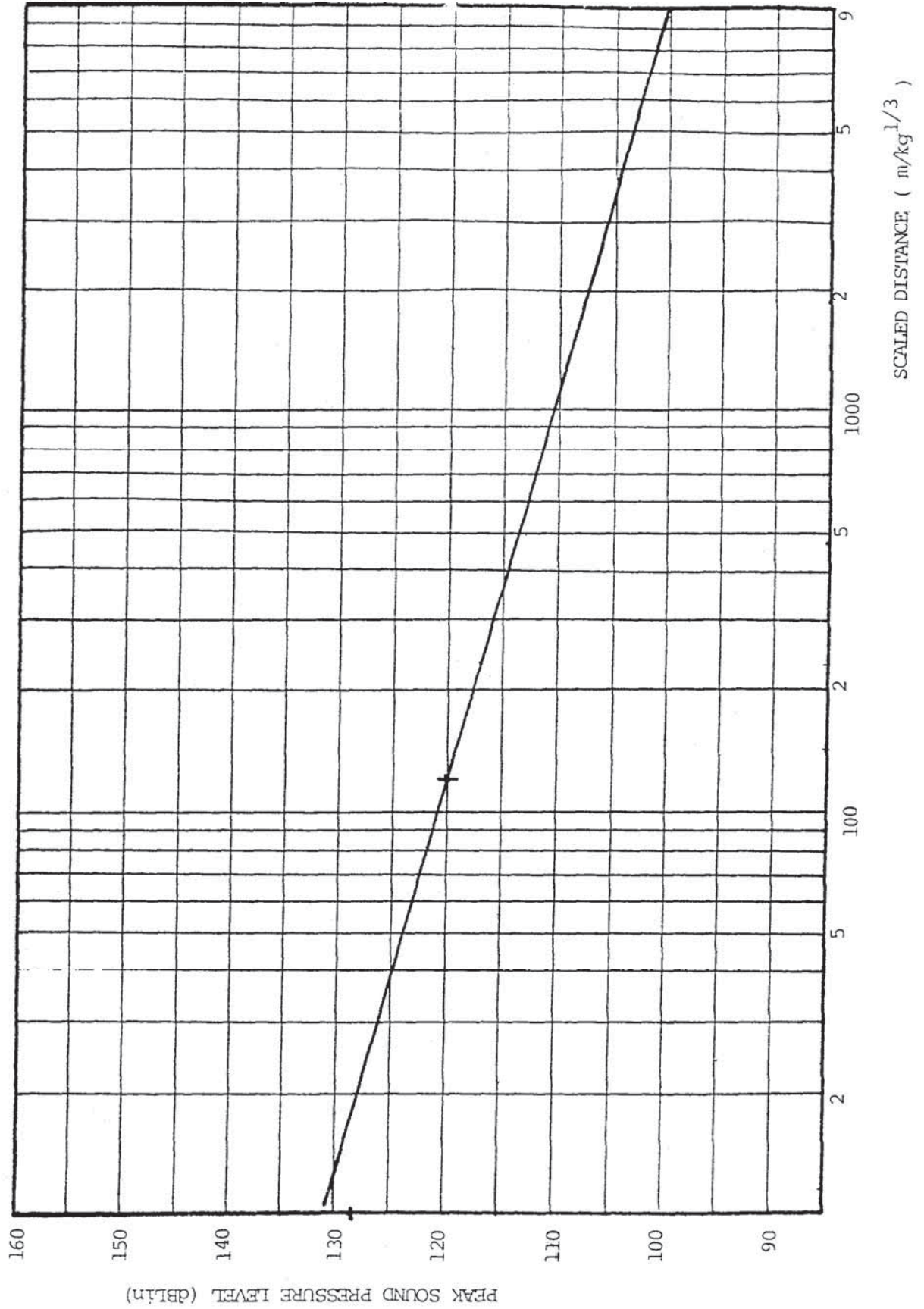


FIGURE 3. BLASTING VIBRATION PREDICTION

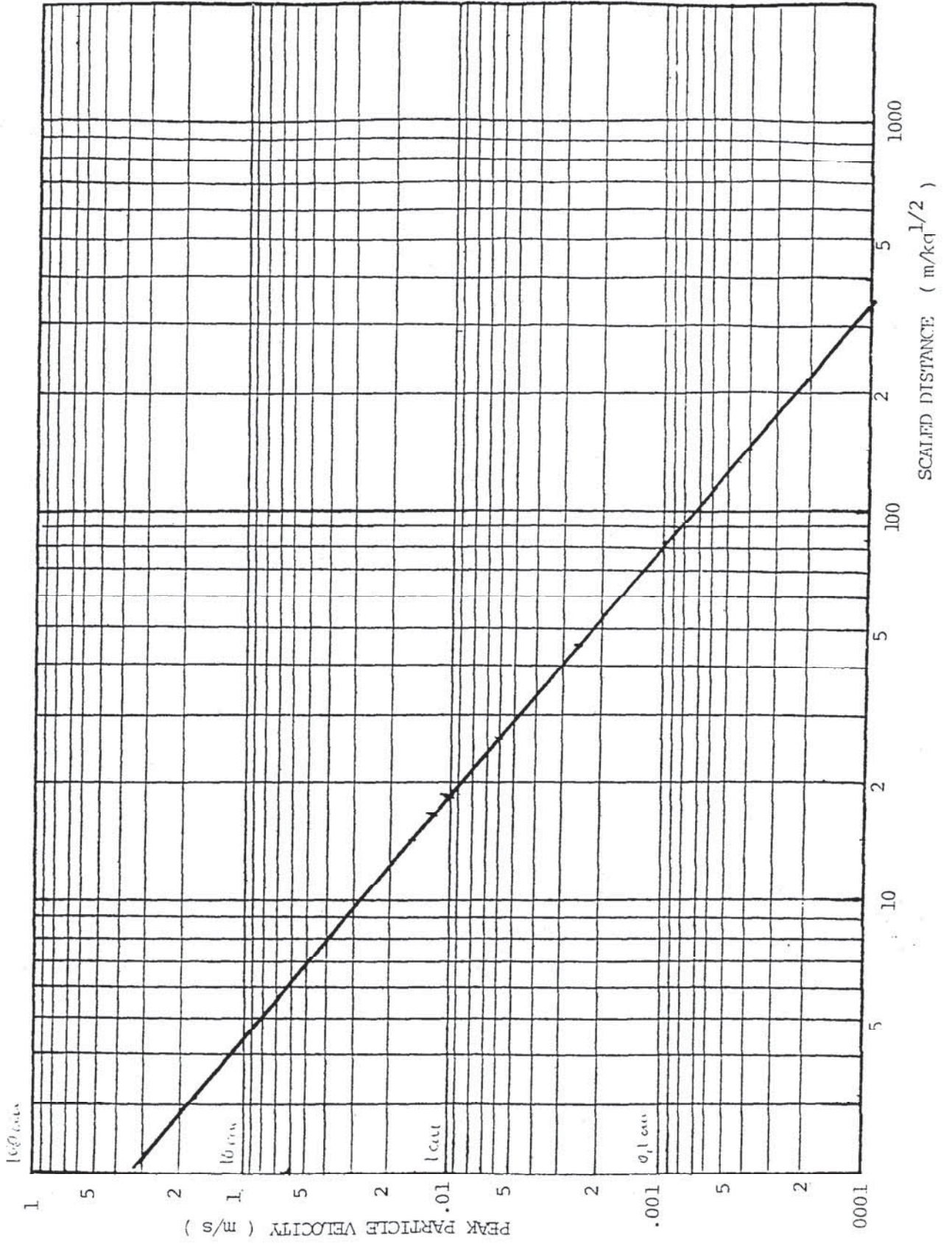


FIGURE 1A. BLASTING NOISE PREDICTION

Receptor location in front of quarry face.

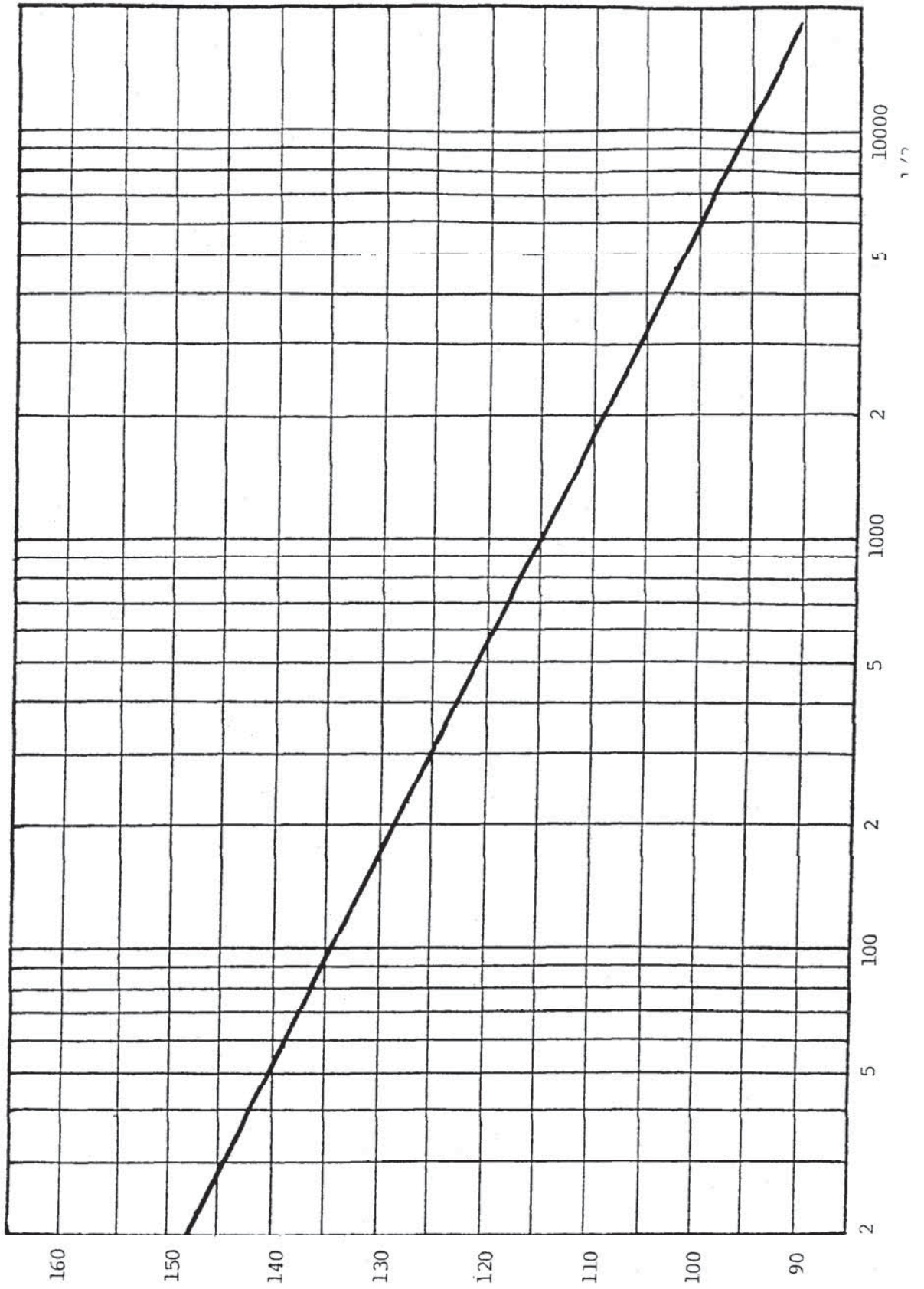


FIGURE 2A. BLASTING NOISE PREDICTION
Receptor location behind quarry face.

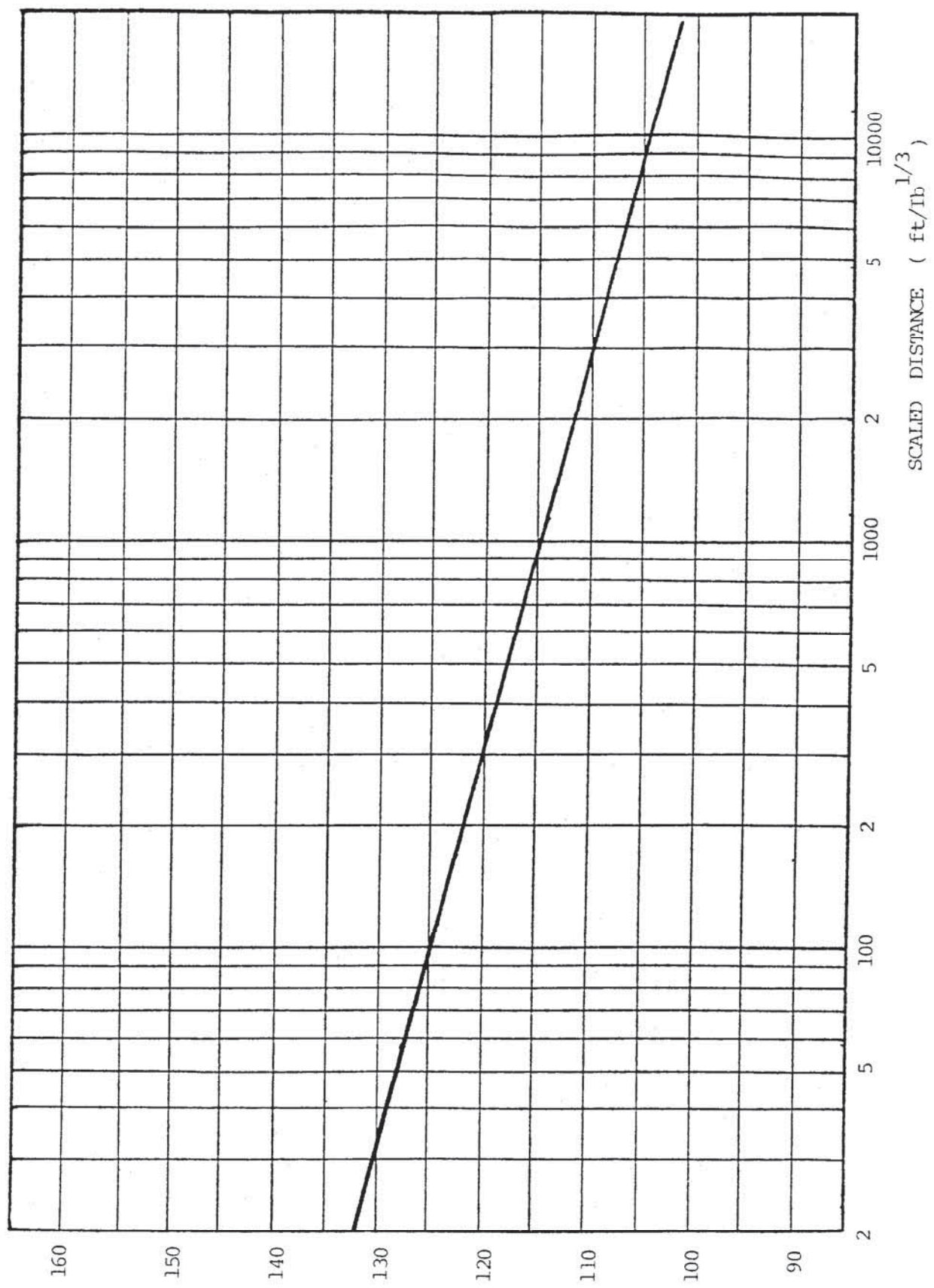
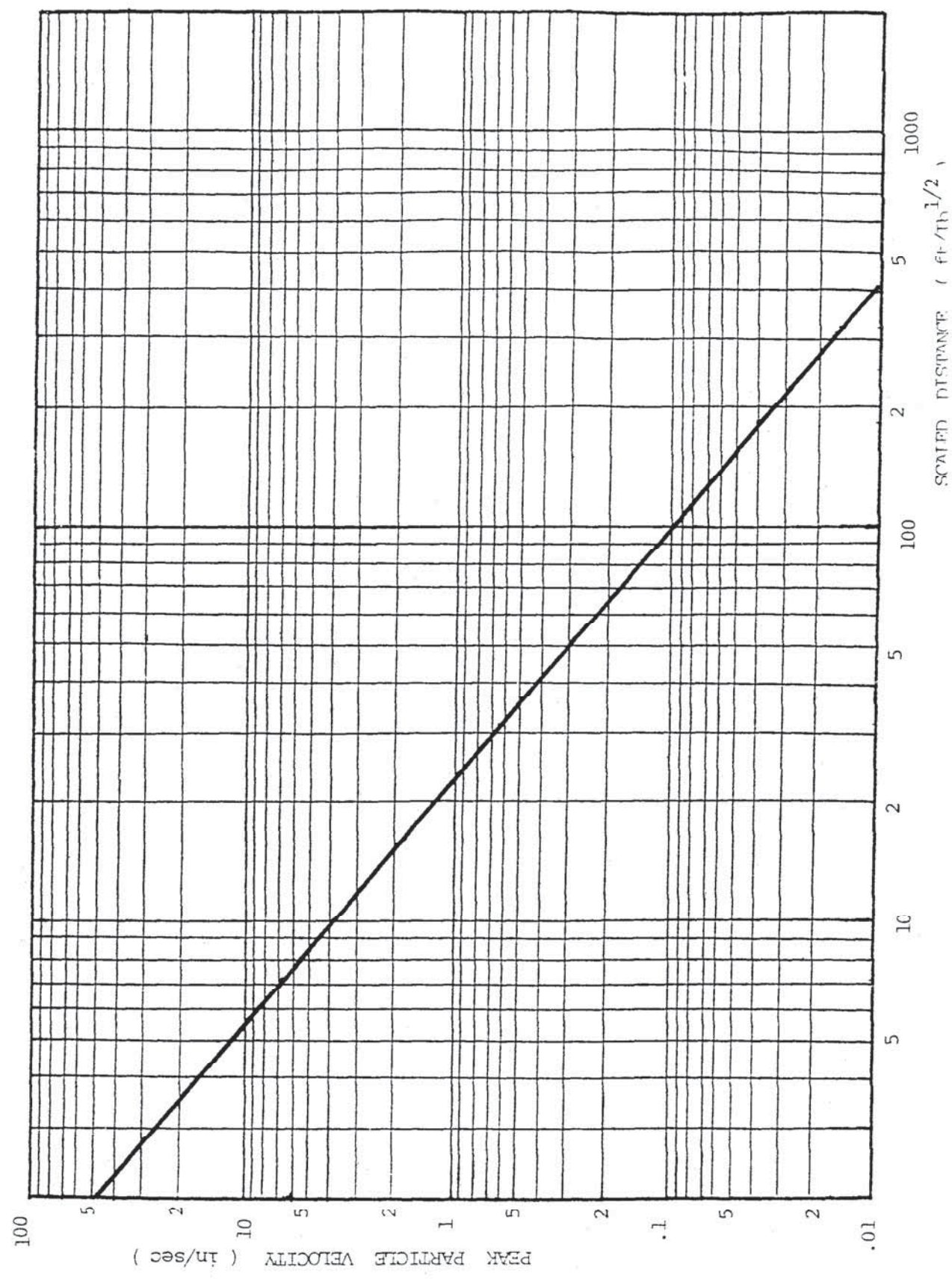


FIGURE 3A. BLASTING VIBRATION PREDICTION



APPENDIX B

PREDICTION MODEL PARAMETERS FOR SOUND AND VIBRATION

Appendix B - Model Design and Model Parameters

1.0 Ground Vibration

1.1 MOE Vibration Model

As per the MOE “Guideline on Information Required for the Assessment of Blasting Noise and Vibration (December 1985)”, the Peak Particle Velocity is related to the “square root scaled distance (SRSD)”. As per Section 6.2, the SRSD can be calculated based on the distance between the receiver and the blast (D) and the charge size per delay (W) according to the relationship:

$$SRSD = \frac{D}{W^{1/2}}$$

Rearranging the formula yields:

$$W = \frac{D^2}{SRSD^2}$$

As per the guideline, the SRSD is to be read from the relationship in Figure 3 of the guideline based on a target Peak Particle Velocity (PPV). However, the linear relationship between $\log(PPV)$ and $\log(SRSD)$ allows for an analytical formula that can be used for determining one value from the other. As per Figure 3 in the guideline:

$$PPV = 0.8238 SRSD^{-1.53}$$

Rearranging this formula yields:

$$SRSD = \left[\frac{PPV}{0.8238} \right]^{1/-1.53}$$

Combining the above relationships, it is possible to determine that:

$$W = \frac{D^2}{\left[\frac{PPV}{0.8238} \right]^{2/-1.53}}$$

where the PPV is measured in m/s. Converting the PPV to mm/s (for comparison with the target values):

$$W = \frac{D^2}{\left[\frac{PPV}{823.8} \right]^{2/-1.53}}$$

In general terms,

$$W = \frac{D^2}{\left[\frac{PPV}{K}\right]^{2/e}}$$

where $K = 823.8$ and $e = -1.53$ for the MOE blasting vibration model.

1.2 Golder Vibration Model

From the results of reference 2, the Golder model stipulates that the relationship between PPV (in mm/s), distance, and charge size per delay is:

$$PPV = 341 \left(\frac{D}{\sqrt{W}} \right)^{-1.32}$$

Rearranging to solve for the charge size yields:

$$W = \frac{D^2}{\left[\frac{PPV}{341}\right]^{2/-1.32}}$$

This is analogous to the MOE model, and can be calculated similarly using the general terms $K = 341$ and $e = -1.32$.

2.0 Sound Level

As per the MOE "Guideline on Information Required for the Assessment of Blasting Noise and Vibration (December 1985)", the Peak Sound Pressure Level of a blast is related to the "cube root scaled distance (CRSD)". As per Section 6.1 in the guideline, the SRSD can be calculated based on the distance between the receiver and the blast (D) and the charge size per delay (W) according to the relationship:

$$CRSD = \frac{D}{W^{1/3}}$$

Rearranging this formula yields:

$$W = \frac{D^3}{CRSD^3}$$

As per the guideline, the CRSD is to be read from the relationship in Figure 1 of the guideline (for the case where the receptor is in front of the quarry face), based on a target Peak Sound Pressure Level (SPL_{pk}). However, the linear relationship between $\log(SPL_{pk})$ and $\log(CRSD)$ allows for an analytical formula that can be used for determining one value from the other. As per Figure 1 in the guideline:

$$SPL_{pk} = 182.07 CRSD^{-0.0781}$$

Rearranging this formula yields:

$$CRSD = \left[\frac{SPL_{pk}}{182.07} \right]^{1/-0.0781}$$

Combining the above relationships, it is possible to determine that:

$$W = \frac{D^3}{\left[\frac{SPL_{pk}}{182.07} \right]^{3/-0.0781}}$$

In general terms,

$$W = \frac{D^3}{\left[\frac{SPL_{pk}}{K} \right]^{3/e}}$$

where $K = 182.07$ and $e = -0.0781$ for the case where the receptor is in front of the quarry face. When the receptor is behind the quarry face, $K = 143.86$ and $e = -0.0382$ based on the relationships in Section 6.1 and Figure 2.