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Large Haul Truck Mufflers 'That Work'

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Abstract [547] The Genesee coal mine operates in rural Alberta in close proximity with its neighbours. During 2000, one issue that the Genesee Power Project Advisory Committee (GPPAC) members dealt with was the exhaust noise emitted by the mine's three Komatsu 510E, 150 ton, coal haul trucks. Committee members asked if there was anything that could be done to reduce the noise associated with the truck fleet. Noise Solutions Inc. of Calgary was hired to begin a pilot project to design and install an enhanced muffler system on the mine's trucks. Work on the project was conducted over the last six months of 2000, with the first muffler being installed by November. Noise emitted from the exhaust has been reduced by approximately 30 dBA in a cost-effective manner. The enhanced muffler system has now been installed on the entire coal haul fleet. The surrounding neighbours have noticed a significant reduction in the coal haul truck sound levels.

1 INTRODUCTION

1.1 Location

The Genesee coal mine is located approximately 55 kilometres southwest of the city of Edmonton (Figure 1). The mine is found south of the North Saskatchewan River within the county of Leduc. The mine site is adjacent to the existing EPCOR Generating Station east of Secondary Road 770. The Genesee Mine Permit Boundary covers approximately 7,300 hectares while the actual mine encompasses approximately 1,700 hectares. Lands within the mine permit boundary are mostly owned by the City of Edmonton.

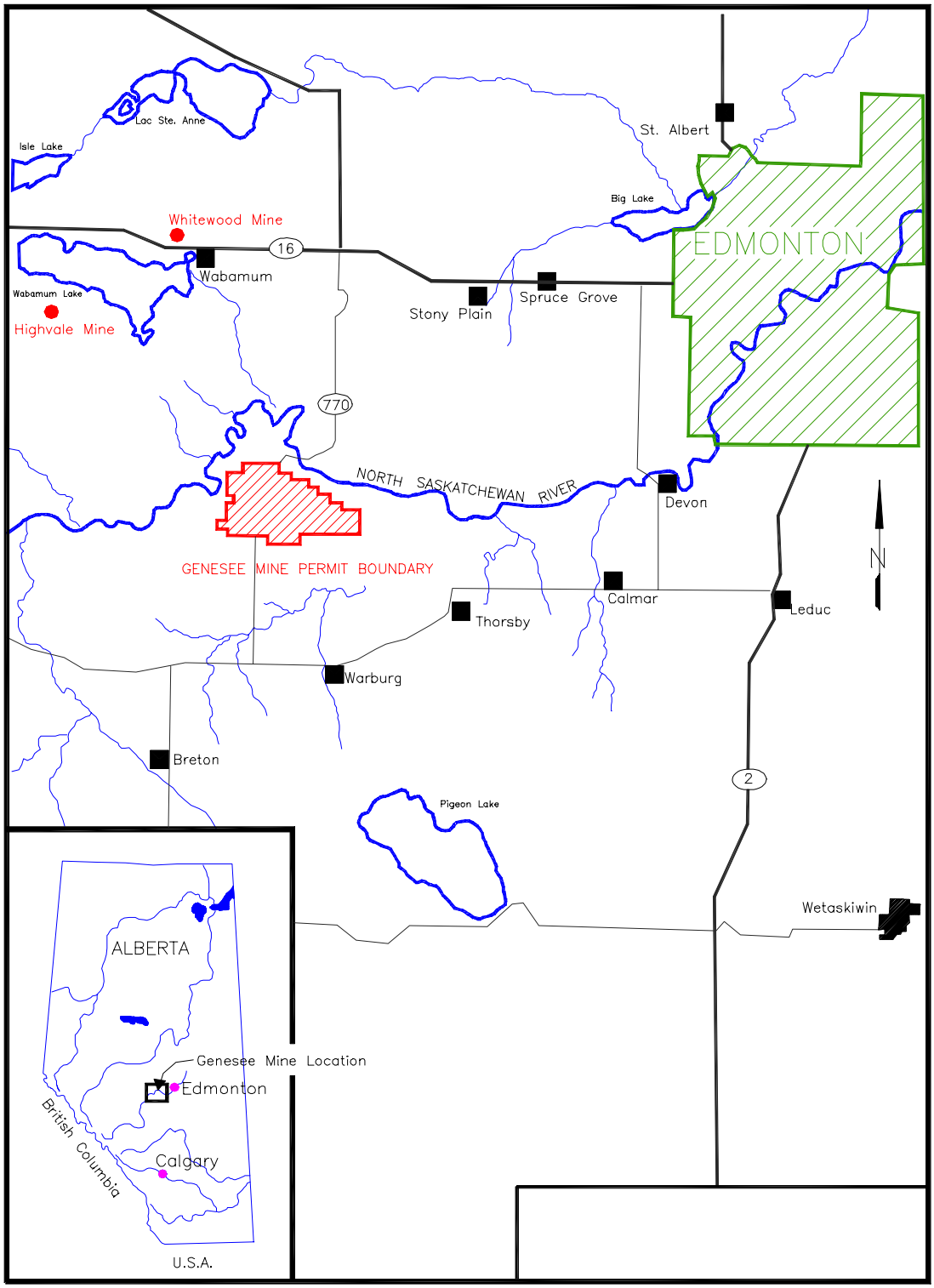

Figure 1: *Genesee Mine access and location map*

1.2 Background

In 1980, Edmonton Power and Luscar Ltd. (formerly Fording Coal Ltd.) became joint venture partners in the development of the Genesee Coal Mine. The Genesee Power Project Advisory

Committee (GPPAC) was established in 1981 by an order-in-council to provide a vital link between the community and the project's proponents, Luscar Ltd. (then Fording Coal Ltd.) and EPCOR (then Edmonton Power). After an initial construction phase, the start of dragline mining began with the erection and startup of the Marion 8200 dragline in December 1988. The completion of Edmonton Power's first 400 MW generating unit soon followed in May 1989. Annual coal production averaged 1.7 million tonnes until 1994 when the erection and startup of the Marion 8750 dragline was completed. The construction and testing of the second 400 MW generating unit was completed and commissioned in September 1994. Annual coal production increased to 3.5 million tonnes per year and has remained constant since that time.

1.3 Personnel and Infrastructure

The Genesee Coal Mine provides all necessary infrastructure and services required for the mine operation. The mine site provides for administration and engineering functions, as well a complete dry, warehouse, equipment maintenance, and first aid facilities.

With 53 employees in the Operations and Maintenance departments and 24 individuals in Administration, the total number of people employed at Genesee is 77. Mine operations and maintenance work 4X4 shifts while administration work a regular 5X2 week.

1.4 Mining Equipment

One M8750 dragline and one M8200 dragline comprise the primary mining equipment at the Genesee mine. Table 1 below lists the present fleet of primary and support mining equipment at Genesee.

Table 1: *Major Equipment Listing at Genesee Coal Mine*

Model Type	Manufacturer	Capacity	Quantity
M8750 Dragline	Dresser/Marion/Bucyrus	81.0m^3	1
M8200 Dragline	Dresser/Marion/Bucyrus	50.5m^3	1
191M Shovel	Dresser/Marion/Bucyrus	20.6m^3	1
510E Hauler	Dresser/Haulpak/Komatsu	150 ton	3
210M Hauler	Dresser/Haulpak/Komatsu	60 ton	3
992C F.E. Loader	Caterpillar	13.8m^3	1
16G Grader	Caterpillar		1
637E Scraper	Caterpillar	23.7m^3	2
PC300HD Backhoe	Komatsu		1
966E F.E. Loader	Caterpillar	3.4m^3	1
D11R Bulldozer	Caterpillar		2
475A Bulldozer	Komatsu		2

2 AMBIENT NOISE

GPPAC has fulfilled many functions since its inception. Besides keeping local residents informed about project activities, GPPAC has also provided a forum through which local residents, Luscar Ltd.: Genesee Operations, and EPCOR Generation Inc.: Genesee Generating Station discuss issues of importance to them. During 2000, one issue that GPPAC members dealt with was the exhaust noise emitted by the mine's three Komatsu 510E, 150 ton, coal haul trucks. Committee members asked if there was anything that could be done to reduce the truck noise. During a conversation

between Whitewood mine manager, Al Brown, and Genesee mine manager, Brad Johnston, a possible solution was discussed and brought forth for the committee's consideration. Noise Solutions Inc. (NSI) of Calgary was identified as the company who had helped Whitewood Operations reduce the noise emitted by the 8200 dragline. Rod MacDonald of NSI was contacted and the company was hired to begin a pilot project to design and install an enhanced muffler system on the mine's trucks.

Figure 2 shows the proximity of residences to the mine property. As can be seen, there are residences within 1 kilometre of the mine and others as far away as 5 kilometres or more. Noise modelling was consistent with the resident's testimonials in that the closest residences were not necessarily the most affected with respect to noise from the mine. Factors such as topography, vegetation and prevailing wind direction needed to be combined with linear distance from the noise source to determine the most affected residences and which noises were the most significant at those points. The topographical features of the North Saskatchewan River valley were examined with particular care: predicting the effects of water and meandering valleys on the acoustics of the area proved to be particularly complicated. The mobile nature of mining also needed to be considered to determine the most significant noise impacts. In the sort term, the equipment moves as its working thus creating moving 'point sources' of noise. In the longer term, the mine advances over a period of years thereby changing the distance between individual residences and the mining activities.

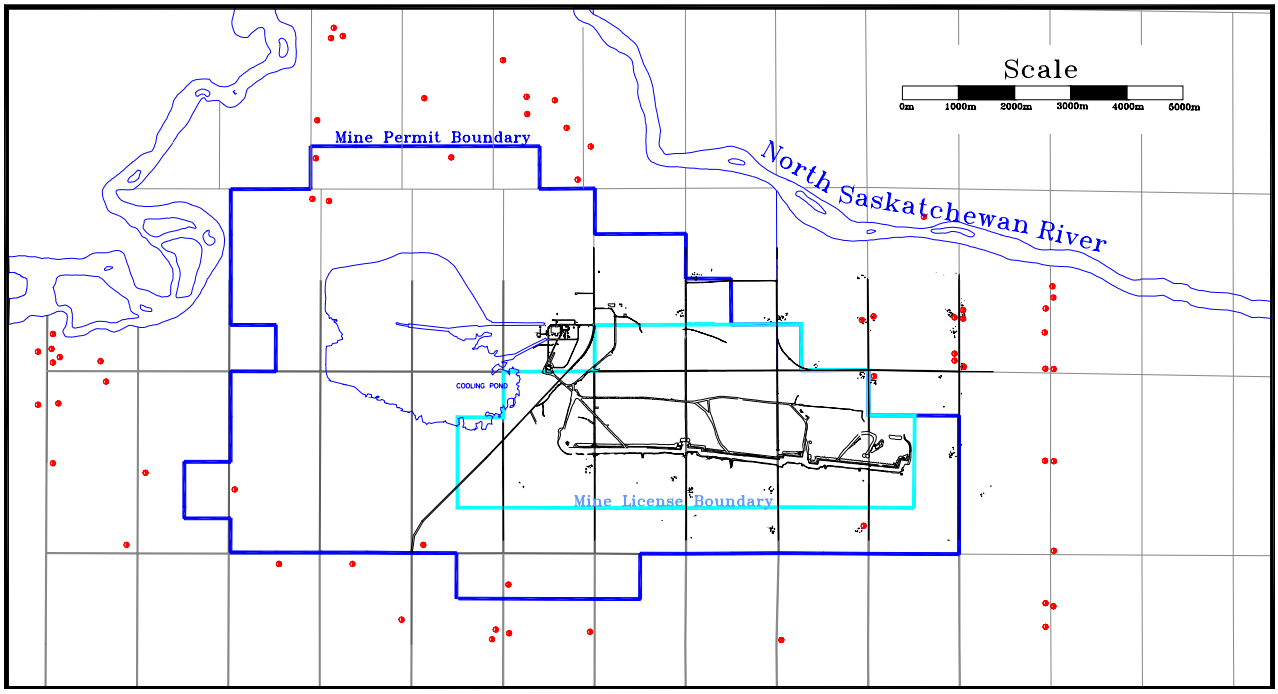

Figure 2: *Residence Location Map (residences indicated as red dots)*

2.1 Noise Measurements and Modelling

In order to determine what noise sources at the mine were significant, NSI commissioned Faszer Farquharson to conduct a noise impact assessment (NIA) of the mining operations to the surrounding community. One of the first steps in a NIA is to undertake detailed sound level

measurements of all the significant noise sources at the mine. Mining equipment is not the easiest type of equipment to measure because it is always moving. A combination of close-in measurements of various equipment components as well as further away sound propagation measurements were undertaken. The information obtained was reviewed and calculations undertaken to determine sound power levels of the equipment, some as a unit and some as various components of the units.

The sound power levels were used as input parameters for ENM, a sound propagation model along with the terrain and the location of the residences. Detailed mine plan information and locations of the equipment during mining were required as the bench heights with respect to the surrounding topography can create significant sound barriers.

The sound criteria used in a given jurisdiction must also be fully understood. Average sound levels as compared to statistical or peak sound levels can significantly change the sound power levels used in the model. The Alberta criteria, outlined in the EUB ID-99-8 Noise Control Directive are 50 and 40 dBA Leq, an energy average, for the daytime and nighttime periods respectively. Thus truck sound power levels were adjusted to reflect the mobility of the trucks in relation to the receivers and number of trips that would be completed during a typical nighttime shift.

The results of the model are presented both in detail in octave band sound pressure levels as well as overall dBA sound levels order ranked by sound level from highest to lowest at the receiver locations (see Tables 2, 3, and 4). The following order ranked tables are extracted from the NIA report.

Table 2: *Order Ranked Sound Pressure Levels (Residence 1, Year 1999 Night Shift)*

Source	Source Sound Level Contribution (dBA)
Electric Shovel Ventilation	38.6
Marion 8750 Dragline Bleed Tubes	34.7
Komatsu Dozer	32.5
510 Haul Trucks	32.1
Marion 8750 Dragline Inlet Air House	31.0
Electric Shovel Mechanical Noise	28.8
Genesee Power Plant	28.4-
Marion 8750 Dragline Ventilation	24.4
Caterpillar D11 Dozer	23.5
Marion 8750 Dragline House	23.5
Marion 8750 Dragline Vent Fan Casing	20.9
Elk Point Telfordville Gas Plant	14.8
Facility Sum	**39.5**

Table 3: *Order Ranked Sound Pressure Levels (Residence 2, Year 2004 Night Shift)*

Source	Source Sound Level Contribution (dBA)
Marion 8750 Dragline Bleed Tubes	39.2
Marion 8750 Dragline Inlet Air House	34.7
Komatsu Dozer	32.1
Electric Shovel Ventilation	28.5
Catepillar 992 Front End Loader	27.1
Genesee Power Plant	26.5
Marion 8750 Dragline Vent Fan Casing	24.5
510 Haul Trucks	24.4
Electric Shovel Mechanical Noise	23.7
Marion 8750 Dragline House	21.0
Catepillar D11 Dozer	21.0
Marion 8750 Ventilation	20.2
Elk Point Telfordville Gas Plant	14.6
Facility Sum	**41.9**

Table 4: *Order Ranked Sound Pressure Levels (Residence 5, Year 2009 Night Shift)*

Source	Source Sound Level Contribution (dBA)
Genesee Power Plant	32.2
Marion 8750 Dragline Bleed Tubes	31.0
510 Haul Trucks	28.3
Marion 8750 Dragline Inlet Air House	27.0
Electric Shovel Ventilation	23.7
Komatsu Dozer	22.7
Marion 8750 Dragline House	22.5
Electric Shovel Mechanical Noise	20.1
Marion 8750 Dragline Vent Fan Casing	17.4
Caterpillar D11 Dozer	14.4
Marion 8750 Ventilation	13.5
Facility Sum	**37.4**

The significant noise sources can be readily seen from the tables, however different sources have different rankings at the three residences. In this case, the one residence that had a predicted sound level over 40 dBA was to be purchased before that year of mining, thus there was no exceedance of criteria.

Based on the sound propagation results indicating no exceedance of the criteria, we were able to make a decision to attack the coal haul truck mufflers rather than the highest order ranked source. This decision was based on the haul trucks landing in the top three most significant noise sources source as well as being flagged by the residences as having a high annoyance factor. If there had been an exceedance of the criteria it may have been necessary to attack another source along with the truck mufflers such as the dragline ventilation fans or shovel ventilation fans in order to reduce the overall sound level to meet the criteria.

The noise measurements had indicated that the engine exhaust was the most significant source on the haul trucks and thus this source would receive noise control. Other sources that had been measured were the engine casing noise and radiator fan.

The next step was designing a muffler for the trucks that would provide the required noise attenuation, fit the chassis of the truck and not exceed the engine back pressure requirements.

An NSI muffler design that had proved successful for large stationary engines was modified into a duel exhaust design and squished and squeezed to fit the available space under the box of the truck. One unit was manufactured for test purposes. This unit was connected to the existing exhaust outlets using flexible hose. This test was very successful indicating a high attenuation level and low pressure drop (see Figure 3). The next step was to install the unit in the truck and undertake a trial period. This again proved successful and the all three trucks have had the mufflers installed.

Figure 3: *Muffler Test Configuration*

The actual attenuation results were not indicative of the performance of the muffler by itself. To obtain more definitive data, a test was conducted that isolated the exhaust noise from the rest of the truck noise. This was accomplished by parking the truck in the workshop, closing the shop doors and running the exhaust out of the shop with flexible pipe.

The before and after octave band and overall sound power level results for a truck pass-by including all truck sources and just the engine exhaust source are indicated in Figures 4 and 5. Subjectively, the muffler has drastically reduced the engine "bark" that was heard by the surrounding residences and very positive comments have be received regarding the reduced coal haul truck noise levels.

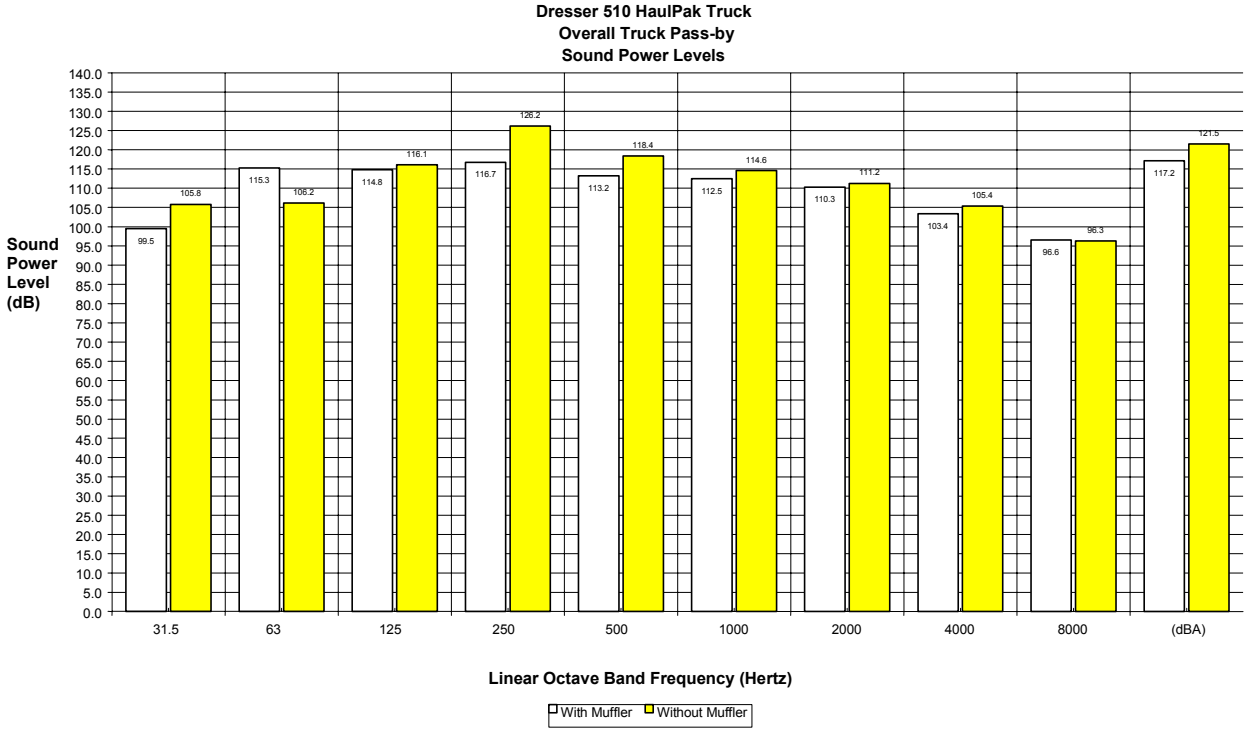

Figure 4: *Total Truck Sources*

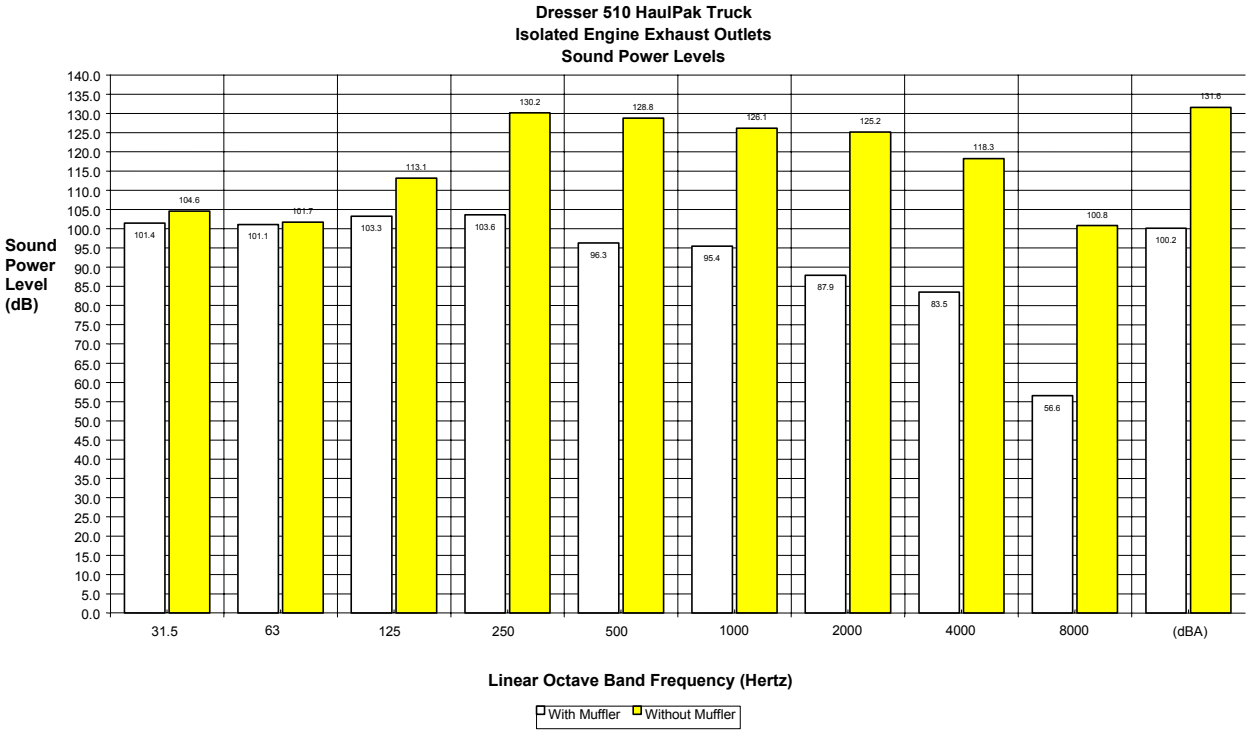

Figure 5: *Engine Exhaust Source Only*

In the end, the muffler reduced the engine exhaust noise by 36 dB and eliminated the "engine exhaust throb". This translates to an 80 percent reduction in the level of engine exhaust noise as each 10 dBA reduction in sound power level equates to a 50% reduction in audible noise.

3 MINING INTO THE FUTURE

EPCOR is currently expanding the output capacity of the Genesee Generating Station from 800 MW (gross) to 1295 MW (gross). The expansion means an increase of greater than 50% output in the capacity of the mine. The mine expansion would be accomplished through the addition of a truck and shovel fleet. The increased material volume that would have to be moved combined with the changes in overburden geometry make it impractical to make up production requirements with a third dragline. Overburden depth increases up to as much as 50 metres above nominal dragline pad in certain areas while it is as little as 4 metres in others. The bleed tubes and house pressurization fans of the 8200 dragline have had noise control installed. Further noise control programs being considered for the post-expansion era include:

- Bleed Tubes on the 8750 dragline,
- House Pressurization Fans on the 8750 dragline, and the waste shovel,
- the exhaust noise of the waste haul trucks,
- the engine compartment noise on all haul trucks, and
- noise generated by the dozers, both engine and undercarriage.

4 SUMMARY

The entire 150 ton haul truck fleet has been fitted with the new muffler as of March, 2001. The muffler has reduced engine noise by 36 dB and eliminated the "engine exhaust throb". This translates to an 80 percent reduction in the level of engine exhaust noise. One local resident, who was particularly concerned about the ambient noise generated by the mine, contacted us in April of 2002. He asked if all our haul trucks had been fitted with the new mufflers as he could no longer hear the truck noise that he had previously. He thanked us for taking meaningful steps towards dealing with the amount of ambient noise being generated and now considers the mine a "good neighbour", sensitive to public concerns. Genesee Operations is continuing its work to understand and mitigate potential noise concerns both for neighboring residents and our employees. Our goal is to meet or exceed current regulatory guidelines for both ambient and occupational noise classes. Under our newly established ISO 14001:1996 Environmental Management System, we have developed a framework to define noise strategies. The strategies include testing for ambient noise every five years and occupational noise every three years.