Appendix B2.3.3-2: Review of Potential Noise and Vibration Effects to Bats

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Teck

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Subject: Review of Potential Noise and Vibration Effects to Bats

Dear Mr. Stroich:

1 INTRODUCTION

The environmental effects assessment for the Teck Coal Limited (Teck) Elkview Operations Baldy Ridge Extension (BRE) Project (the Project) identified interactions between Project activities and the environment to determine the residual effects of the Project on noise and vibration. Activities that use vehicles, other mobile equipment, or stationary machinery or processes are predicted to generate sound and/or vibration that would affect the environment outside the operational boundary of the Project (at magnitudes that vary across Project stages). Noise levels are predicted to range between 35.1 to 53.4 A-weighted decibels within a 5 kilometre (km) buffer around the Project and vibration levels have historically ranged between 0.30 to 1.43 millimetres per second (mm/s), up to 3.5 km from mine blasting and are predicted to increase to values as high as 8.1 mm/s within 0.5 km of the mine during future operations.

During Teck's recent regulatory application process for the Project, regulators requested that Teck conduct a review of potential effects to bats from noise and vibrations as an environmental risk that may result from expanding mine development. Matrix Solutions Inc. conducted a literature review and evaluation of potential effects to bats from noise and vibrations associated with mining developments. Overall, the review aims to help substantiate responses to stakeholder concerns and better understand the effects of noise and vibrations on bats.

2 BACKGROUND

Noise effects have been studied on wildlife for the past 20 years. However, there is less known about noise effects on bats compared to those known for many other wildlife species. For example, anthropogenic noise has been shown to reduce habitat availability (Bayne et al. 2008), potentially decreasing reproductive success (Habib et al. 2007; Swaddle and Page 2007), and increasing predation risk (Slabbekoorn and Ripmeester 2008) among songbird species. Specifically, chronic noise can reduce the efficacy of vocal communication among songbird individuals by interfering with call or song transmission which can reduce pairing success (Habib et al. 2007; Swaddle and Page 2007) and impair territory defense mechanisms (Brumm 2004). In addition, chronic noise can increase the vulnerability of songbirds to nest predation by masking predator warning calls (Yong 2008). Whether similar effects are experienced by bats is less well known.

Research indicates that noise effects on bats vary by species and their behaviors and habitat use patterns. However, the specific characteristics and thresholds of sound and vibration (e.g., amplitude, frequency, peak particle velocity) that influence bat behaviour are largely unknown. Similar to songbirds, noise could affect bats by interacting with or disrupting vocal communications among individuals and by masking foraging and predator calls. However, bats also rely on sound to move and forage (Altringham 2012) and noise effects are known to interact with these behaviours (Schaub et al. 2008; Siemers and Schaub 2011). In addition, noise effects may influence bat roosting and hibernating behaviours by disrupting torpor (Luo et al. 2014) and altering roost and hibernacula site use (Altringham 2012).

A review of the *British Columbia Species and Ecosystems Explorer* (BC CDC 2015) identified eight bat species with ranges overlapping the Elk Valley. A summary of the eight bat species, including their provincial and federal conservation status is provided in Table 1.

Table 1 Conservation Statuses and General Echolocation Frequencies of Eight Bat Species with Ranges overlapping the Elk Valley

Scientific Name	Common Name	General Echolocation Frequency*	Provincial Conservation Status	BC List	National Status (COSEWIC 2015)	National Status (SARA)
Eptesicus fuscus	Big brown bat	Low frequency	S5	Yellow	-	-
Lasionycteris noctivagans	Silver-haired bat	Low frequency	S4S5	Yellow	-	-
Lasiurus cinereus	Hoary bat	Low frequency	S4S5	Yellow	-	-
Myotis californicus	Californian myotis	High frequency	S4S5	Yellow	-	-
Myotis evotis	Long-eared myotis	High frequency	S5?	Yellow	-	-
Myotis lucifugus	Little brown myotis	High frequency	S4	Yellow	Endangered	Schedule 1 – Endangered
Myotis septentrionalis	Northern myotis	High frequency	S3S4	Blue	Endangered	Schedule 1 – Endangered
Myotis volans	Long-legged myotis	High frequency	S4S5	Yellow	-	-

*low frequency = <35 kilohertz; high frequency >35 kilohertz; BC = British Columbia; COSEWIC = Committee on the Status of Endangered Wildlife in Canada; SARA = Species at Risk Act

3 METHODS

A literature search was conducted to review available information on the potential effects of noise and vibration on bats. The search of historical information included sources from research journals, federal government reports, and technical reports. Initially, a review of bat behaviour was conducted to determine potential effects of noise and vibration on bats. Additional literature was then reviewed on potential noise and vibration effects on bats resulting from mining and other anthropogenic effects (e.g., highway traffic and forest clearing). The review is focussed and structured on noise and vibration effects to the following bat behaviours:

- effects to foraging, including access water;
- effects to daily and seasonal movements; and
- effects to roosting and hibernation.

4 RESULTS

4.1 Effects to Foraging

The eight bats species with ranges overlapping the Elk Valley are known to spend a significant portion of each night foraging for insects and accessing water. An individual bat consumes 40% to 100% of their body mass in insects per night (Kunz et al. 1995; Kurta et al. 1989) and short periods of water deprivation (i.e., 24 hours in little brown bats) can lead to mortality (Neuweiler 2000). Food and water requirements increase in pregnant or lactating bats (Kurta 1989). Foraging habitat can include any area that supports high numbers of night-flying insects such as pooled water, streams, or small ponds and lakes (Fenton 1983; Harvey et al. 1999). Due to high caloric and water demands, effects to bat foraging, such as increased time to travel to foraging sites or decreased foraging success, could decrease the health and survival of individuals.

The response of foraging bats to anthropogenic noise may vary based on the species of bat present and frequency and duration of noise. A study by Bunkley at al. (2015) looked at foraging levels of bat species, which echolocate using high frequency calls (>35 kilohertz [kHz]; Table 1) and low frequency calls (<35 kHz; Table 1) in response to well site and compressor site noise. There was a 70% reduction in activity in response to compressor site noise by bat species, which use low frequency calls. These species foraged for less time and were less successful at foraging in the presence of the compressor site noise. One species, the Mexican free-tailed bat, also exhibited lengthened echolocation call duration in response to the compressor site noise. There were no observed changes in activity in the high frequency bats in response to the various noise treatments.

Noise from both compressor and well sites are generally concentrated in frequencies between 1 and 20 kHz. As a result, the sound generated does not overlap with the frequency at which high frequency bats are echolocate (i.e., there is no interference between these sounds and echolocation calls). In addition, some species may not hear the sound being generated, as most bats can only perceive sounds between 15 and 90 kHz (Adams et al. 2000). This lack of overlap in frequencies and inability to actually perceive the additional noise may explain why higher frequency bats were not affected by the lower frequency noise. However, studies have also shown that some species will still shift echolocation frequencies in anthropogenic noise even when there is no frequency overlap (Hage et al. 2013; Hage and Metzer 2013). Therefore, it is possible that low frequency noises will affect low and high frequency bats.

Schaub et al. (2008) also looked at the effects of noise on foraging bats. Four different treatments were examined including the following:

- silence;
- traffic noise (frequency=0-50 kHz; main energy in 1 kHz-20 kHz range);
- wind/vegetation noise (frequency=0-85 kHz); and
- constant broadband noise (frequency=0-40 kHz).

Decreases in flight/foraging time and prey captures were greatest in the constant broadband noise environment. Activity levels also decreased in the wind/vegetation noise and traffic noise environments but to a lesser degree. The frequency range and constant duration of the noise could be contributing to the larger effects of the constant broadband noise.

Of the species present in the Elk Valley, two are considered low frequency bats (i.e., silver-haired and hoary bats) while the others are considered high frequency bats (Table 1). The effects of noise on different bat species will likely depend on frequencies generated by the Project; noise frequencies from the Project are expected to have the greatest effect on bat species that echolocate in frequencies that overlap those generated by the Project. Whether noise effects on foraging will impact bat populations is unknown and remains a data gap.

4.2 Effects to Daily and Seasonal Movements

The bat species present in the Elk Valley make both daily and seasonal movements. Daily movements occur as individuals move from daily roosts to foraging areas. Seasonal movements are conducted in response to cold temperatures and a lack of food availability during winter.

Daily movements depend on the distance between daily roosts and foraging areas which can vary among species. A study by Brigham (1991) indicated that big brown bats travel 1.8 kilometres (km) on average between daily roosts and foraging areas. Silver-haired bats have been recorded travelling between 0.1 and 3.4 km between roost sites and foraging sites (Campbell 1996). Hoary bats have been known to travel 20 km one-way between roosts and foraging sites (Barclay 1989).

Seasonal movements consist of either migrating to areas with suitable temperatures or hibernating. Silver-haired and hoary bats are generally expected to migrate into the United States (Cryan and Veilleux 2007). Other species present in the Project footprint are expected to hibernate, although to date, no large bat hibernacula have been found in British Columbia (Lausen 2014).

There is a lack of literature focussing specifically on the effects of noise on daily and seasonal movements for bats. However, similar to foraging, it is expected that additional noise present during daily and seasonal movements could increase the time needed to travel between suitable habitats and may lead to species using alternative, less optimal routes. These changes could increase food and water requirements and add stress to individual bats. Whether noise effects on daily and seasonal movements will impact bat populations is unknown and remains a data gap.

4.3 Effects to Daily Roosting and Hibernation

Bat species present in the Elk Valley generally roost daily, either in foliage or in tree cavities/under bark. The hoary bat is considered a foliage-roosting bat and it will roost in the leaves of both deciduous and coniferous trees (Menzel et al. 1998). Tree roosting species such as little brown bat and silver-haired bats use roosts consisting of partially decayed trees with small cavities or peeling bark found in mature forests (Caceres and Pybus 1997; Crampton and Barclay 1998). These species can also roost in caves. Tree roosting bats generally roost in colonies, and may be segregated by sex or age, depending on the current life requirements of individuals in the colony (Lacki et al. 2007).

Based on ambient temperature and reproductive condition, roosting bats may enter torpor to maintain energy reserves (Neuweiler 2000). Torpor includes reducing body temperature, which corresponds with a decrease in oxygen consumption, breathing rate, heart rate, and metabolic rate (Speakman and Thomas 2003; Geiser 2004; Altringham 2011). Harrison (1965) also found that little brown bats, which are generally considered high frequency bats, did not respond to frequencies above 40 kHz when in torpor. Bats in torpor can arouse spontaneously, regardless of ambient temperature. A study by Luo et al. (2014) found that the response of torpid bats to noise varied based on when the noise occurred (early morning compared to late day) and type of noise (silence, bird noise, traffic noise, and vegetation noise). Individuals were more sensitive to noise when it occurred closer to sunset (as opposed to noise that occurred earlier in the daily roosting period) and responded least to traffic noise and most to vegetation noise (i.e., noise of similar amplitude and frequency to vegetation rustling). The traffic noise and bird noise (i.e., playback of a dawn chorus of birds singing) were generally lower frequencies than the vegetation noise; therefore, it is possible that these noises are lower than the hearing range for the bats within the colony reducing their effect on individuals. In addition, Luo et al. (2014) found that torpid bats habituated to repeated and prolong noise disturbance (i.e., would no longer arouse when exposed to noise).

A report by the West Virginia Department of Environmental Protection (2006) looked at the potential effects of surface mine blasting on bat hibernaculum. Several other studies at active quarry sites were cited within this report. A winter bat study at Greer Lime Hellhole Cave found that bat populations in the cave increased from 2001 to 2005 while blasting vibration levels throughout the period ranged from 1.52 to 5.08 mm/sec. Additional work on bats hibernating in a limestone formation indicated that the peak particle velocity at the cave during blasting was at least 6.35 mm/sec. Monitoring of the site over a 10-year period indicated that there was no decrease in the bat population. As a result of the information found in the report, the authors indicated that hibernating bats can withstand underground vibration levels of 1.52 to 5.08 mm/sec without adverse effects. Additional work done by Besha (1984) and Myers (1975) on Indiana bats indicated that a seismic vibration of 2.54 and 0.5 mm/sec, respectively, did not disturb hibernating bats.

5 SUMMARY

There are limited studies on the effects that noise and vibration could have on bats. The research to date has primarily focussed on changes in bat activity and behaviour in response to different frequencies of noise and effects of vibrations generated by mine blasting on bat hibernacula. The key findings from this review identify the following:

- Noise effects to bats can vary depending on the degree of overlap between the frequency and volume of disturbance noises and the frequencies of echolocation used by individual bat species.

- Noise sources from well sites, compressor stations, traffic, wind/vegetation, and broadband noise have been documented to alter bat foraging and movement and echolocation behaviours.

- Studies monitoring population responses during periods of mine blasting show that vibration disturbances up to 6.35 mm/sec did not cause a population decrease to local bat populations. There is a lack of literature focussing on vibration levels greater than 6.35 mm/sec.

Results suggest that noise and vibrations from mining could affect bats by disrupting foraging, movement, and roosting behaviours. However, the degree to which noise and vibration disturbances contribute to bat demographics (the success of survival and recruitment for individuals) and population change is unknown.

Measuring and understanding the linkages between noise disturbances and animal behaviours and population demographics is a common data gap across many wildlife species including bats. For example, anthropogenic noise has been shown to reduce habitat availability (Bayne et al. 2008), potentially decrease reproductive success (Habib et al. 2007; Swaddle and Page 2007), and increase predation risk (Slabbekoorn and Ripmeester 2008) of songbirds. However, the resulting magnitude of demographic effects on songbird populations is unknown. Similarly, noise has been shown to effect mate selection in female treefrogs (*Hyla ebraccata*) in laboratory settings (Wollerman and Wiley 2002). However, the corresponding demographic effects on treefrogs are unknown. In addition, the responses of individual animal species can vary according to numerous factors, such as noise source, exposure levels and species auditory capabilities and behaviours (Shannon et al. 2015). Controlled research designs under laboratory settings are typically employed to understand and quantify the effects of noise disturbances on the behaviour and physiology of animals. In contrast, it is more difficult to directly link population and community level responses to noise because population level responses are typically measured under natural environmental settings (Kight and Swaddle 2011). As such, it is difficult to study and generalize noise effects on animal species, especially at a population level.

6 CLOSURE

Should you have any questions or requests for further information, please feel free to contact Jonah Keim at 780.504.8186.

Sincerely,

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