Volume 2, Section 5 Snake Lake Reservoir Expansion Project Environmental Impact Assessment Noise

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On behalf of:

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Brooks, Alberta

Submitted by:

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Executive Summary

The Eastern Irrigation District is applying for approval under the *Environmental Protection and Enhancement Act* to construct the proposed Snake Lake Reservoir Expansion Project (the Project). The Project, located between Bassano and Brooks in Alberta, involves the construction of a roughly 8 km long, up to 20 m high dam to increase the storage capacity of the reservoir system from 19.25 million m^3 to 87.4 million m^3. This Environmental Impact Assessment section focuses on evaluating potential noise and vibration impacts during the construction phase, including activities such as clearing, grubbing, and berm construction. The assessment does not cover noise from operational phases as there are no major noise sources during this phase. This section follows the requirements of the Project's Final Terms of Reference (Volume 2, Appendix A) and focuses on the potential human health and well-being. It does not address the effects of noise or vibrations on wildlife.

The Noise Regional Study Area encompasses the Project footprint and the surrounding 6 km from the Project, with seven human receptors identified. This includes acreages, a feedlot, and a Hutterite Colony. Beyond 6 km, any noise generated by the Project is expected to attenuate to a level below the ambient noise level and baseline condition. Baseline noise levels were established based on a worst-case scenario of 35 Decibels A (dBA) (person's cumulative exposure to sound is over a 24-hour period).

Baseline vibration levels were assumed to be zero based on a worst-case scenario modelling approach. The vibration impact assessment modelled potential vibration levels during the most activity-intensive phase of construction, berm construction, using reference data and formulas developed and published by the United States Department of Transportation (2018) and the California Department of Transportation (2013). Noise levels were modelled during both the early works (clearing and grubbing) and the more intensive berm construction phase using iNoise software. The findings showed that noise levels at the receptors would remain below Health Canada's thresholds for adverse effects, with a negligible change in the percentage of "highly annoyed" human receptors. This change is substantially lower than the 6.5% criterion set by Health Canada.

To assess potential impacts of construction vibration, a worst-case scenario was modelled from the total number of planned units of civil construction equipment to be used during berm construction, and the worst-case available equipment vibration reference from the Federal Transport Administration. These parameters were used to calculate peak particle velocity (PPV) at each of the receptors near the construction site as were identified through the Noise Impact Assessment. Results were compared to a California Department of Transportation recommended threshold to prevent construction vibration annoyance in residential areas (Andrews et al., 2013).

Although the noise levels during construction are expected to be minimal, the report recommends maintaining noise abatement equipment on machinery and establishing a complaint response procedure to address potential noise concerns. No long-term monitoring will be necessary, as residual noise impacts during construction, reservoir filling, and operation are anticipated to be neutral.

In the worst-case scenario modelled, construction vibration propagation at the nearest receptor is projected to be 8% of the Guideline threshold of 0.2 mm/s PPV to prevent annoyance in residential areas. The impact of vibration generated during construction, filling, and operation for the Project are all considered to be neutral.

In conclusion, the noise and vibration generated by the Project will remain within regulatory limits, with no impacts on nearby residents.

Table of Contents

Figures

Tables

Abbreviations

BN	Baseline Noise
Caltrans	California Department of Transportation
GOA	Government of Alberta
GOC	Government of Canada
CN	Construction Noise
CPKC	Canadian Pacific Kansas City (Railway)
dB	Decibels
dBA	Decibels A *(Represents the A-weighting of noise which approximates the response of the human ear to audible noise frequencies)*
EIA	Environmental Impact Assessment
FTOR	Final Terms of Reference
ISO	International Organization for Standardization
Ldn	Day-Night Average Sound Level *(Reflects a person's cumulative exposure to sound over a 24-hour period)*
NIA	Noise Impact Assessment
NRSA	Noise Regional Study Area
%HA	Percent Highly Annoyed human receptors
PPV	Peak particle velocity
SLR	Snake Lake Reservoir
SPL	Sound pressure level
TCH	Trans-Canada Highway
ZOI	Zone of influence

5.1 INTRODUCTION

5.1.1 Background

The Snake Lake Reservoir (SLR) Expansion Project (the Project) is located 22 km southeast of Bassano and 19 km northwest of Brooks, Alberta. Siksika Nation is located 22 km northwest of the Project area.

The current SLR is located within Townships 19 and 20, Ranges 16 and 17, W4M and Townships 65 and 66 and Ranges 1 and 2, W4M. The Project will be an expansion east of the existing reservoir and will involve constructing a dam roughly 8 km long and up to 20 m high to form a new reservoir, increasing storage capacity for the combined reservoirs to 87.4 million m^3 (70,900 acre-feet). The Trans-Canada Highway (TCH; Highway 1) is approximately 2 km from the Project and the Canadian Pacific Kansas City (CPKC) rail line is adjacent to the northeast boundary of the site.

5.1.2 Purpose

5.1.2.1 Noise

Noise is considered to be any unwanted sound that has the potential to adversely affect human health and well being. The Project will generate noise during construction activities but is not expected to contribute to the existing environmental noise levels in the area during commissioning of flooding activities and normal dam operating conditions.

This assessment focuses exclusively on noise generated during dam construction activities and its potential impact on nearby residents by adding to the existing noise environment. The effects assessment focuses exclusively on human receptors; it does not address effects on wildlife or livestock. Prolonged noise exposure at 105 decibels (dB) has been observed to result in negative affects on livestock, such as a decrease in feed consumption and milk yield (Manci et al., 1988). Noise impacts for the Project are expected to be notably lower, with no more than 60 dB expected across most of the Noise Regional Study Area (NRSA), including anywhere livestock might be present. Therefore, no negative effects on livestock are expected. For a discussion on wildlife, see Volume 2, Section 11 (Wildlife and Wildife Habitat).

5.1.2.2 Vibration

Construction activities like soil compaction, excavation, and the operation of heavy machinery can generate ground-borne vibrations that may be felt by people and potentially cause slight movement in nearby structures. If these vibrations intensify, they could lead to structural damage in adjacent buildings. The strength of construction vibrations and their transmission from a site will depend on the type of construction activity, the distance from the source of energy, and the type of soil between the source and the receptor.

Construction activities generate two main types of vibrations. The first type, known as "continuous vibration," is produced by equipment or activities that typically emit lower energy levels over extended periods (Jones & Stokes Associates Inc., 2004). Examples of continuous vibration include:

- excavation equipment;
- static compaction equipment;
- track-mounted equipment;
- traffic on roads or haul roads;

- vibratory pile drivers;
- pile-extraction equipment; and
- vibratory compaction equipment.

The second type of vibration is "transient vibrations", which result from single or low-frequency impacts caused by construction activities and typically transmit high levels of energy. Examples of this type of vibration are:

- impact pile drivers;
- dynamic compaction; and
- blasting (not included in this study).

Both types of vibrations can annoy people. People are normally more sensitive to continuous vibrations than to transient vibrations. Therefore, in some circumstances, they may be more tolerant of higher levels of transient vibrations. There is also a greater potential for complaints the longer the duration of the vibration-producing activity.

This assessment focuses exclusively on vibration generated during dam construction activities and its potential effects on nearby residents. The effects assessment focuses exclusively on human receptors; it does not address effects on wildlife or livestock. See Volume 2, Section 11 (Wildlife and Wildlife Habitat) for a discussion on wildlife.

5.1.3 Project Setting

A detailed description of the Project setting is found in the Overview Section (Volume 1, Section 2). The Project is located within the Dry Mixedgrass Natural Subregion in the Grassland Natural Region of Alberta (Government of Alberta [GOA], 2006). Droughts occur every few years and are defined by a prolonged reduction in precipitation and/or a sustained water deficit when evapotranspiration exceeds precipitation. Most of the Project area consists of native grassland, which has been used for livestock grazing. Wetlands are also located within this area.

5.1.4 Regulatory Context

5.1.4.1 Noise

The assessment was completed in accordance with guidance provided by the Health Canada publication *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Government of Canada [GOC], 2017). The Health Canada Guideline is a methodology for assessing human health risks stemming from environmental noise impacts, with a focus on standardized evaluation approaches to ensure comprehensive risk characterization.

Although the Project is provincially regulated and falls under the jurisdiction of the Province of Alberta, the Canadian Environmental Impact Assessment (EIA) Guidelines were deemed an appropriate framework for this assessment, in addition to the Guide to Preparing Environmental Impact Assessment Reports in Alberta (GOA, 2013). By using the federal and provincial guides, the assessment provides a more comprehensive evaluation of the Project's potential noise impacts to human health, and ensures that the Project is developed in a responsible and sustainable manner. This is the same approach taken by Stantec (2018) for the *Springbank Off-Stream Reservoir Project Assessment of Potential Effects on Acoustic Environment*.

The assessment was also performed in accordance with the requirements in the Final Terms of Reference (FTOR) for the Project, which excluded the requirement for assessing noise impacts on wildlife, and requires instead a discussion of strategies to reduce sensory disturbance effects (Volume 2, Appendix A). For further details, see Volume 2, Section 11 (Wildlife and Wildlife Habitat).

5.1.4.2 Vibration

There are currently no Provincial or Canadian Federal guidelines for assessment of construction activity generated specifically for vibration and effects on humans. In Canada and the United States, construction noise and/or vibration are specifically regulated by government authorities in only three regions: the City of Toronto (Ontario), the City of New York, and the State of California (Busch, 2017).

Toronto's vibration bylaw enacted May 27, 2008, requires that construction equipment is assessed for vibration concerns within a "zone of influence" (ZOI) which is defined as a radius away from construction activity where the vibration amplitudes are excessive. Within the ZOI, the bylaw defines excessive construction vibrations as peak particle velocity (PPV) of 8 mm/s below a frequency of 4 Hz, 15 mm/s from 4 to 10 Hz, and 25 mm/s for a frequency range above 10 Hz.

The most stringent vibration levels to prevent human annoyance during construction are based on thresholds for human comfort and nuisance. These thresholds are designed to minimize disturbances to nearby residents or workers, and are often specified in terms of PPV, with guidelines on acceptable levels to avoid discomfort.

The following vibration guidelines are more stringent than the regulations noted above and aim to avoid substantial disturbance to people living near construction sites.

1. United States (Federal Transit Administration Guidelines): These Guidelines for construction vibration (often applied in urban and transit-related projects) recommend the following vibration limits to prevent human annoyance (John A. Volpe National Transportations Systems Center, 2018):
    - For residential areas:
        - 0.2 - 0.3 mm/s PPV is the threshold for preventing disturbance during construction activities.
    - For sensitive buildings (e.g., hospitals, schools):
        - 0.1 mm/s PPV is considered acceptable to avoid discomfort.
2. California (State Guidelines): The California Department of Transportation (Caltrans) guidelines for construction vibrations also aim to avoid human annoyance. They suggest:
    - 0.2 mm/s PPV be used as a threshold to prevent significant annoyance in residential areas.

The Caltrans guideline limit of 0.2 mm/s PPV was used in this assessment to determine potential for annoyance due to vibration from the Project. There are no sensitive buildings in close proximity to the Project, therefore a 0.1 mm/s was not deemed necessary. The assessment was also performed in accordance with the requirements in the FTOR for the Project (see Volume 2, Appendix A) which excluded the requirement for assessing vibration impact on wildlife.

5.2 STUDY AREA

Baseline conditions and potential Project effects were assessed by examining indicators in the Regional Study Area. The study area for the Noise Impact Assessment (NIA) – the NRSA – includes all areas within 6 km of the Project area and its noise sources (see Appendix C1, Figure C1-1). There are currently seven human receptors, including five residential receptors (acreages and farmsteads, including Antelope Creek Ranch), a Hutterite colony, and a feedlot, within the NRSA that have been included in this assessment. All other receptors are beyond 6 km from the nearest Project noise sources and have been excluded due to the neutral impact on more distant receptors from the Project area.

A single study area was deemed sufficient for this NIA, because of the localized nature of the proposed Project. The Project's potential noise impacts are not expected to extend beyond the local area, and the relevant environmental receptors and stakeholders are primarily located within this area. Using a single study area allows for a more focused and detailed assessment of the potential environmental impacts on local stakeholders, while still ensuring that the potential impacts are adequately assessed and mitigated.

5.3 ISSUE SCOPING

Scoping for this EIA is a process that included (Table 5-1):

- identifying the Project activities that may alter or remove the resources or indicators;
- developing a list of resources or indicators for each discipline;
- identifying the risks, issues, or concerns regarding these effects; and
- determining what assessments to include (i.e., ones where high effects are likely), and which to exclude (i.e., where effects are likely to be negligible or trivial).

Noise and soil vibration will be generated during construction activities but are not expected during reservoir filling or normal operations. Therefore, this assessment only addresses construction noise (CN) activities and generated soil vibration activities in comparison to the Baseline Case. This assessment only considers daytime Project noise and vibration generation and assumes that construction activities will only take place during normal daytime hours (7 am to 7 pm). Actual Project schedules will depend on the parties responsible for construction and site conditions (e.g., storms and other weather challenges), so night work is possible. However, since the assessment was based on all equipment running simultaneously, it should still be a worst-case scenario compared to a day- and night-shift with partial equipment run during each.

Based on the screening exercise, and in line with requirements in the Project FTOR, the *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (GOC, 2017), and the *California Department of Transportation Guidelines for Construction Vibrations* (2013), the following indicators are selected for assessment of noise and vibration:

- day-night average sound level (Ldn) which reflects what a person's cumulative exposure to sound is over a 24-hour period (decibels A [dBA]);
- expected percent highly annoyed human receptors (%HA); and
- expected vibration compared to accepted standard of 0.2 mm/s PPV for residences near construction.

Table 5-1: Issue scoping for noise and vibration resources

Project Activities and Risks	Resources	Indicators or Measures	Potential Issues	Screening[1]
• Clearing and Grubbing of vegetation and topsoil in the new reservoir area • Berm Construction • Reclamation and planting / establishment of new vegetation communities in outer berm areas	• Noise and vibration levels to receptor	• Expected %HA[2] and Ldn[3] • Expected vibration compared to accepted standard 0.2 mm/s peak particle velocity for residences near construction	• Change in noise and vibration levels to receptor	• Project construction may result in temporary increases to noise and/or vibration levels

1. Determine if the issue is unlikely to occur, or if relevant data is not sufficient for assessment.
2. Percent Highly Annoyed human receptors
3. Day-Night Average Sound Level

5.4 BASELINE

The description of baseline sound and vibration levels was estimated based on the characteristics of the NRSA. A desktop analysis was conducted to determine the acoustic and vibration environment baseline at identified receptors.

5.4.1 Methods

5.4.1.1 Receptor Locations

All existing and reasonably anticipated human receptor locations within the NRSA have been included in this assessment. Through a desktop analysis, a list of receptors was created for evaluating the Project effects.

Seven human receptor locations were identified in the NRSA (i.e., within 6 km of the proposed construction site; Table 5-2; Appendix C1, Figure C1-2). The receptors are a combination of residences/acreages/farmsteads, a small community, and a feedlot. There are no receptors with heightened sensitivity as defined by the Health Canada Guidline (GOC, 2017), such as schools or other public buildings, within the area. There are several oil and gas production facilities in the area, which were not considered human receptors, nor emitters (Appendix C1, Figure C1-1). The receptors and distance from the Project area are listed in Table 5-2 below. Note that Receptors 1 (acreage) and 5 (Antelope Creek Ranch) are adjacent to one another, and therefore combined into one polygon and assessed together (see Appendix C1, Figure C1-2).

Table 5-2: Acoustic receptors and distance to Project area

Receptor Number	Description	Distance from Project Area (km)
1	Acreage	4.88
2	Acreage	3.50
3	Acreage	4.64
4	Acreage	5.44
5	Antelope Creek Ranch	5.11
6	Lathom Hutterite Colony	5.75
7	Snake Lake Feedlot	4.80

Note: Receptors 1 and 5 are located in the same area (see Appendix C1, Figure C1-2).

5.4.1.2 Baseline Levels

Baseline Noise (BN) levels for identified receptors were determined based on Health Canada's Guideline for estimating the most stringent and worst-case scenario for evaluating Project noise impact (GOC, 2017). Receptors identified near the the Project area were considered to be residing in a "quiet rural area" with the greatest expectation of "peace and quiet".

Baseline vibration levels for identified receptors are assumed to be zero.

5.4.2 Results

The acoustic environment in the NRSA is characterized as a rural environment, with a combination of natural environment and human activities including vehicle and rail traffic. The TCH is a busy four-lane divided highway and the CPKC railway averages approximately 20 trains per day; both enter the NRSA (see Appendix C1, Figure C1-1).

Health Canada considers a quiet rural area to have Ldn of 45 dBA because of human-made sounds, where "dBA" represents the A-weighting of noise which approximates the response of the human ear to audible noise frequencies. Ldn reflects a person's cumulative exposure to sound over a 24-hour period.

Health Canada's most conservative approach guidance for performing an NIA is to assume an Ldn baseline of 35 dBA in rural areas, which has been adopted for this assessment (GOC, 2017). This sets the basis for a worst-case scenario evaluation as the BN level is higher at some identified receptors because of nearby highway traffic noise from the heavily travelled TCH and rolling train noise from the CPKC railway that runs through the NRSA. For example, Receptor 4 is less than 150 m and Receptor 3 is less than 70 m from the TCH, which would increase their BN level above 45 dBA.

The oil and gas facilities in the area were not expected to generate appreciable operational noise and were not considered to contribute to receptor BN level in this assessment.

5.5 IMPACT ASSESSMENT

Project noise and vibration impacts were assessed by comparing baseline conditions (Baseline Case) to Project conditions in a Project Case, including a full construction (maximum impact scenario), and a future operations scenario, for assessing residual impacts.

5.5.1 Methods

For a full description of the EIA Approach, including the assessment methods and EIA criteria, see Volume 2, Section 2. This section discusses how the Application Case for noise and vibrations was assessed.

5.5.1.1 Noise Modelling

CN levels were modelled using iNoise V2024.1 Noise Prediction Software produced by DGMR Software (DGMR Software, 2024). The software models noise levels for receptors in the environment based on the International Organization for Standardization (ISO) standard *9613 Acoustics – Attenuation of Sound Propagation Outdoors*. This Standard specifies "an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources" (ISO, 2024). The method predicts the sound that would be equal to continuous A-weighting of noise under meteorological conditions that are advantageous to sound carrying across the landscape (ISO, 2024). Calculations using this standard meet the guidelines recommended by Health Canada.

CN levels at receptors were modelled using the software and calculations were based on the following parameters:

- calculation method: ISO 9613;
- noise receptor height: 1.5 m;
- no meteorological correction (worst-case scenario);
- temperature: 20°C;
- air humidity: 70%;
- air pressure: 101.325 kPa;
- general method ground attenuation of 0.70 (Compacted soft ground);
    - The Project area and NRSA are mostly native grassland, with numerous wetlands. This is consistent with the compacted soft ground parameter setting in the model.
- fetching radius: 6 km;
- no barriers between noise sources and receptors; and
- only daytime noise levels modelled as it is unlikely any work performed at night.

Overall noise prediction accuracy depends on the accuracy of noise source data and scenarios related to sound propagation over terrain. Topography was not included in the noise model and was assumed to be flat which is a very conservative scenario. The assessment model assumed that downwind conditions exist 100% of the time and that all expected equipment for the two phases of construction were operating at 100% and simultaneously. These conditions are extremely improbable, hence the model predictions are conservative.

A total of seven receptor locations were modelled based on the initial and peak CN production levels (Table 5-2; see Appendix C1, Figure C1-2). Two models were assessed based on the stages of construction for comparison to the baseline: Construction Early Works (Clearing and Grubbing) and Berm Construction.

Construction Early Works

Clearing and Grubbing includes the following activities:

- mowing, stockpiling and removing grassy thatch and woody materials;
- gathering surface boulders and materials unsuitable for use; and
- stripping topsoil.

Table 5-3 lists the type of equipment and quantity expected to be needed for clearing and grubbing the site.

Table 5-3: Anticipated equipment needed for clearing and grubbing

Equipment	Example	Number Needed
Excavator/Grabber Large	CAT Large Excavator 352	12
Excavator/Grabber: Medium	CAT Medium Excavator 330	4
Excavator/Grabber: Mini	Kubota KX030-4 Series Mini-Excavator	2
Dump truck: Medium	30-ton Kenworth T470H	4
Chainsaws	-	2
Tractor mower	-	2
Electrical generator	-	1

Berm Construction

Berm Construction includes the following activities:

- clay application and compaction;
- trucking sand, gravel, rip rap materials;
- deeper soil excavation from the reservoir area;
- berm build up; and
- building collection ditches.

Berm Construction is expected to use the most equipment and generate the most CN. Equipment used will include excavators, bulldozers, dump trucks, earth movers, reclamation equipment, lighting, generating, and pumps. Table 5-4 lists the type of equipment and quantity expected to be needed for berm construction.

Table 5-4: Anticipated equipment needed for berm construction used for modelling

Equipment	Example	Number Needed
Excavator/Grabber Large	CAT Large Excavator 352	12
Excavator/Grabber: Medium	CAT Medium Excavator 330	4
Excavator/Grabber: Mini	Kubota KX030-4 Series Mini-Excavator	2
Front Bucket Loader Small	CAT Small Wheel Loaders 930M	1
Front Bucket Loader Medium	CAT Medium Wheel Loaders 950	4
Front Bucket Loader Large	CAT Large Wheel Loaders 988K	4
Earth Movers/Scrapers Small	CAT Grader 14H	2
Earth Movers/Scrapers Medium	Medium: Cat 16H Grader	4
Earth Movers/Scrapers Large	CAT Open Bowl Scraper 637 (i.e., buggies)	8
Bulldozer Large	CAT D10	6
Bulldozer medium	CAT D6	6
Bulldozer small	CAT D2	2
Compactor: Large	CAT Soil Compactor 825K	6
Compactor: Small	CAT CS54B Smooth Drum Vibratory Soil Compactor	2
Dump truck: Large	CAT Three Axle Articulated Trucks 725	8

Equipment	Example	Number Needed
Dump truck: Medium	30-ton Kenworth T470H	4
Dump truck: Small	12-ton International Workstar	2

Sound Level for Noise Sources Modelled

The iNoise software includes reference sound power level by frequency (Octave Band) for common construction equipment. This data is used to calculate the noise emission from the Project area for individual sources and collectively modelled for propagation from the Project area to the identified receptors. Table 5-5 lists the sound power level in dBA for the equipment noise sources used in the noise impact model without any reductions from silencers.

The noise models were created with the assumption that all planned heavy construction equipment used for each phase would be operating at the same time, even though actual impacts are expected to be much lower. Equipment used for clearing and grubbing was modelled as being spread out across the Project area, while equipment used for berm construction was modelled with the assumption it would all be operating on the perimeter of the site, along the berm, which would create a worst-case scenario for noise impact on the identified nearby receptors.

Table 5-5: Sound power level (dBA[1]) by octave band for noise sources modelled

Source Description	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Total dBA
Articulated dump truck similar to CAT 725	89.8	101.9	99.4	103.8	104.0	100.2	94.0	87.9	109.4
30 ton	87.8	90.9	98.4	103.8	107.0	113.2	98.0	86.9	114.8
Electrical Generator	81.8	85.9	76.4	78.8	81.0	77.2	74.0	63.9	89.4
Cat 352 Excavator - 49,000kg	80.8	92.9	102.4	103.8	105.0	104.2	99.0	88.9	110.4
Wheeled Loader (41 T)	93.8	102.9	105.4	109.8	112.0	114.2	106.0	103.9	118.0
Lighting generator	70.8	80.9	86.4	84.8	87.0	89.2	85.0	79.9	94.2
Wheeled Loader (100-200kw)	93.8	102.9	105.4	109.8	112.0	114.2	106.0	103.9	118.1
Cat D10 equivalent	81.8	95.9	95.4	101.8	107.0	110.2	98.0	85.9	112.6
Cat D6 equivalent	83.8	99.9	100.4	104.8	103.0	101.2	92.0	83.9	109.4
Cat 330 Excavator - 30,000kg	78.8	96.9	89.4	97.8	98.0	97.2	92.0	83.9	104.0
Kubota 3,000kg	75.8	81.9	87.4	91.8	92.0	91.2	87.0	76.9	97.6
Earth Mover/Scraper (small, medium and large)	89.8	98.9	102.4	103.8	112.0	107.2	103.0	91.9	114.5
Small Dump Truck	87.8	90.9	98.4	103.8	107.0	113.2	98.0	86.9	114.8
Cat D2 equivalent	75.8	94.9	97.4	98.8	102.0	99.2	96.0	88.9	106.5
Soil compactor like CAT 825	71.8	89.9	98.4	96.8	105.0	97.2	95.0	88.9	107.3
Vibratory Soil compactor like CAT CS54B	91.8	93.9	92.4	96.8	98.0	94.2	88.0	80.9	103.0

1. Decibels A

5.5.1.2 Assessing %HA

CN was assessed as operational noise according to the Health Canada Guidance document (GOC, 2017). This approach allowed for a calculation of the change in expected %HA due to CN at each identified receptor in accordance with ISO 1996-1:2003 to determine Project noise impact on receptors (ISO, 2003). Noise annoyance is the degree of annoyance that is measured by a subject's response to a social survey questionnaire on noise annoyance according to ISO/TS Standard 15666:2021. Modelled construction A-weighted noise levels (i.e., dBA) at each receptor were added to the BN levels averaged over a 24-hour period at each receptor. The difference in noise level from the baseline was used to calculate an expected %HA at each receptor. The Health Canada Guideline for using change in %HA as an indicator of NIA for long-term noise should not exceed 6.5% (GOC, 2017).

Total sound pressure (noise) levels at each receptor were calculated using the BN level of 35 dBA and the calculated CN level at each receptor using the software model.

The resultant sound pressure level (SPL) at each receptor was added logarithmically. The total sound pressure level at each receptor was calculated using the following formula:

$$\boldsymbol{Total\,SPL} = \mathbf{10} \cdot \boldsymbol{LOG}\mathbf{10}[\mathbf{10}\boldsymbol{SPL}\mathbf{1}/\mathbf{10} + \mathbf{10}\boldsymbol{SPL}\mathbf{2}/\mathbf{10} + \mathbf{10}\boldsymbol{SPL}\mathbf{3}/\mathbf{10}\ldots + \mathbf{10}\boldsymbol{SPLn}/\mathbf{10}]\ (\boldsymbol{dBA})$$

The calculation of %HA values caused by Project noise used a BN level of 35 dBA. The total sound pressure for each receptor was calculated using the formula noted above to determine total SPL at each receptor during clearing and grubbing and berm construction phases for comparison.

The %HA for baseline and total noise during construction was calculated using the following equation:

$$\%\boldsymbol{HA} = \mathbf{100}\,/\,[\mathbf{1} + \boldsymbol{e}(\mathbf{10.4} - \mathbf{0.132} * \boldsymbol{Ldn})]$$

The change in %HA for Project construction is calculated by subtracting %HA (baseline) from %HA (baseline and construction).

5.5.1.3 Vibration Modelling

Construction vibration levels were modelled using the United States Federal Transit Administration formula to estimate the potential construction vibration levels at given distances from a source (John A. Volpe National Transportations Systems Center, 2018). The formula is used to calculate the PPV at various distances from the vibration source.

A review of the existing literature reveals that information on vibration source levels from general construction equipment is limited. The most detailed compilation of vibration source amplitudes can be found in the *Transit Noise and Vibration Impact Assessment* (Hanson et al., 2006), which provides vibration source amplitudes at a distance of 25 feet for various types of construction equipment. A summary of this data relevant to this Project is presented in Table 5-6.

Table 5-6: Reference vibration source amplitudes

Equipment	Reference PPV[1] at 25ft (in/sec)
Vibratory Roller	0.210
Large Bulldozer	0.089
Loaded Trucks	0.076
Small bulldozer	0.003

1. Peak particle velocity

The formula below is used to estimate the vibration PPV at distance from a source.

$$PPVEquipment = (PPVRef\ (25/D)n\ ) * (25.4\ mm/sec)$$

Where:

PPV_{Ref} = Reference PPV at 25 ft (from Table 5-6).

D = Distance from equipment to the receiver in feet.

n = The value related to the vibration attenuation rate through ground (see Table 5-7).

Table 5-7 below summarizes the four different classifications of soil for use with this model.

Table 5-7: Soil vibration attenuation

Soil Class	Description of Soil Material	Suggested Value of "n"
Class I	Weak or soft soils: lossy soils, dry or partially saturated peat and muck, mud, loose beach sand, dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, topsoil (shovel penetrates easily)	1.4
Class II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock (can dig with a shovel)	1.3
Class III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock (cannot dig with a shovel, need a pick to break up)	1.1
Class IV	Hard, competent rock: bedrock, freshly exposed hard rock (difficult to break with a hammer)	1.0

(Jones & Stokes Associates Inc., 2004)

Soils in the Project Area are modelled using Class II criteria since it is possible to dig with a shovel/hand auger and soil types are mostly silty-loam, loam-clay, and similar.

Example Calculation:

If the PPV_{Ref} for a specific piece of equipment (e.g., a vibratory roller) and the distance D to the point of measurement is known, the above formula can be used to estimate the expected PPV at that point.

For instance, let's assume:

- The PPV_{Ref} constant for a specific activity (e.g. use of a vibratory roller) is 0.21
- The distance from the source is 50 feet (15.24 meters). The value in feet is used in the calculation.
- The exponent n is 1.3 for Class II soils

Using the formula:

$$PPVEquipment = (PPVRef\ (25/D)^{n}\ ) * (25.4\ mm/sec)$$

This means the PPV (vibration) at a distance of 50 ft (15.24 meters) would be approximately 2.17 mm/s.

To calculate vibration from multiple pieces of construction equipment, contributions of each individual piece of equipment must be accounted for and combined appropriately. Since vibration sources may overlap, the total vibration at a specific location is calculated using a root sum square method. The vibrations from different sources may not be directly additive but instead combine in a way that depends on their phase.

The calculation for predicted total vibration from multiple pieces of construction equipment is as follows:

1. Identify the PPV of each piece of equipment at the receptor distance using the formula noted above.
2. Combine the individual PPVs for each piece of equipment using the root sum square method to get the total vibration using the following formula:

$$\boldsymbol{PPVTotal} = (((\boldsymbol{PPV}\mathbf{12}) + (\boldsymbol{PPV}\mathbf{22}) + (\boldsymbol{PPV}\mathbf{32}) + \cdots + (\boldsymbol{PPV}\mathbf{12}))\mathbf{1/2}) * \mathbf{25.4}\ \boldsymbol{mm/sec}$$

By using this method, the total vibration at a location caused by multiple pieces of construction equipment can be calculated, thereby assessing potential impacts on structures and nearby residents.

5.5.2 Impact Assessment Results (Application Case)

Construction activities were divided into a Clearing and Grubbing and a Berm Construction phase. Modelling for noise and vibration impact during Clearing and Grubbing was assumed to have all 27 planned units of heavy construction equipment operating at the same time and dispersed throughout the Project area, to capture the worst-case scenario from a noise perspective. See Table 5-3 and Table 5-4 for a list of equipment that is expected to be used during this phase of construction.

5.5.2.1 Expected Noise During Clearing and Grubbing

Expected noise to be detected during the Clearing and Grubbing phase ranged from 0 dBA Ldn at the Lathom Hutterite Colony (Receptor 6) and farthest acreage (Receptor 5), up to 16 dBA Ldn at the acreage located closest to (i.e., 3.5 km from) the Project area (Receptor 2; Table 5-8).

Appendix C1, Figure C1-3 shows the expected noise contours across the studied area from construction activities during clearing and grubbing activities and included each receptor and the modelled noise level at each during this construction phase. As demonstrated here, while CN within the Project area is expected to be mostly over 40 dBA, with CN between 50-80 dBA close to point sources, the remainder of the NRSA should experience CN at or below 40 dBA.

Table 5-8: Acoustic receptors and construction noise modelled during clearing and grubbing

Receptor Number	Description	Construction Noise (dBA[1] Ldn[2])
1	Acreage	8
2	Acreage	16
3	Acreage	7
4	Acreage	0
5	Antelope Creek Ranch	8
6	Lathom Hutterite Colony	0
7	Snake Lake Feedlot	10

1. Decibels A
2. Day-Night Average Sound Level

5.5.2.2 Expected Noise during Berm Construction

Modelling for noise generated during Berm Construction assumed that all 79 units of heavy construction equipment would be operating at the same time along the Project area perimeter. See Table 5-4 for a list of equipment that is expected to be used during this phase of construction.

Expected noise contours from construction activities during Berm Construction activities (see Appendix C1, Figure C1-4) indicate that noise during this phase will remain under 40 dBA for the majority of the NRSA, outside of the Project area. The area surrounding the Project boundary is expected to experience CN between 40-60 dBA, and over 60 dBA at point sources (see Appendix C1, Figure C1-4). CN at the receptors is predicted to range from 15 dBA at the Lathom Hutterite Colony (R6), to 32 dBA at the acreage located closest to the Project Area (R2; Table 5-9).

Table 5-9: Acoustic receptors and construction noise modelled during berm construction

Receptor Number	Description	Construction Noise (dBA[1])
1	Acreage	31
2	Acreage	32
3	Acreage	31
4	Acreage	25
5	Antelope Creek Ranch	31
6	Lathom Hutterite Colony	15
7	Snake Lake Feedlot	26

1. Decibels A

5.5.2.3 Noise Results Summary

Table 5-10 below summarizes the impact assessment modelling calculations for noise impact to receptors near the proposed Project area.

Table 5-10: Baseline berm construction noise levels and percent annoyance for each receptor

Receptor Number	Description	Baseline Noise (BN) Level (dBA[1])	Construction Noise (CN) at Receptor (dBA)	Total Sound pressure level (SPL) at Receptor (BN + CN) (dBA)	%HA[2] at Baseline	%HA During Project	Change in %HA During Project
1	Acreage	35	22	35.2	0.31	0.32	0.01
2	Acreage	35	23	35.3	0.31	0.32	0.01
3	Acreage	35	22	35.2	0.31	0.32	0.01
4	Acreage	35	16	35.1	0.31	0.31	0.00
5	Antelope Creek Ranch	35	22	35.2	0.31	0.32	0.01
6	Lathom Hutterite Colony	35	4	35	0.31	0.31	0.00
7	Snake Lake Feedlot	35	18	35.1	0.31	0.31	0.00

1. Decibels A
2. Percent Highly Annoyed human receptors

The %HA calculated for the worst-case noise generating scenario (Berm Construction) is significantly lower than the Health Canada criterion level of 6.5% (GOC, 2017), for every receptor within the NRSA. The highest calculated change in %HA is 0.01% change in the anticipated receptor noise annoyance level, for Receptors 1, 2, 3 and 5 (Table 5-10). Overall, noise emissions are expected to be low during all phases of construction.

The calculations used in the model for this NIA assumed every receptor is downwind (i.e., no meterological effect) from the construction site, to estimate the worst-case scenario. Nonetheless, a ground absorption factor of 0.7 was used in the model. This factor assumes the ground will absorb some sound energy as it propagates. However, a period of low moisture could result in greater propagation of noise as soil could become harder and vegetation foliage reduced, thereby reducing the amount of noise absorbed by soil and vegetation. As a result, a worst-case scenario for zero absorption of noise by the ground and its cover was also calculated using the iNoise software for the worst-case construction period (Berm Construction). The results of those calculations are summarized in Table 5-11 below, and illustrated in Appendix C1, Figure C1-5.

Table 5-11: Baseline berm construction noise levels and percent annoyance for each receptor with worst-case ground absorption calculation

Receptor Number	Description	Baseline Noise (BN) Level (dBA[1])	Construction Noise (CN) at Receptor (dBA)	Total Sound pressure level (SPL) at Receptor (BN + CN) (dBA)	%HA[2] at Baseline	%HA During Project	Change in %HA During Project
1	Acreage	35	31	36.5	0.31	0.38	0.07
2	Acreage	35	32	36.8	0.31	0.39	0.08
3	Acreage	35	31	36.5	0.31	0.38	0.07
4	Acreage	35	25	35.4	0.31	0.32	0.01
5	Antelope Creek Ranch	35	31	36.5	0.31	0.38	0.07
6	Lathom Hutterite Colony	35	15	35	0.31	0.31	0.00
7	Snake Lake Feedlot	35	26	35.5	0.31	0.33	0.02

1. Decibels A
2. Percent Highly Annoyed human receptors

In this worst-case scenario, with maximum noise propagation due to no sound absorption from the ground or any foliage, the highest %HA calculated would be a change of only 0.08% from the base condition. This is also well below the Health Canada criterion level of 6.5% (GOC, 2017).

5.5.2.4 Vibration Results Summary

Table 5-12 below summarizes the impact assessment modelling calculations for vibration impact to receptors near the proposed Project site.

Berm Construction is expected to use the most equipment and generate the most construction soil vibration. Equipment used will include excavators, bulldozers, dump trucks, earth movers, reclamation equipment, lighting, generators, and pumps. In total it is estimated that 77 pieces of equipment will be required for berm construction, as noted in Table 5-4.

Only "continuous vibrations" produced by equipment that emit lower energy levels over extended periods were used in this model. There is not expected to be any "transient vibrations", generated from single or low-rate impacts during reservoir construction activities. Examples of both of these activities are listed in Section 5.1.2.2, of this document.

A worst-case scenario was modelled using the total number of planned units of civil equipment to be used during berm construction (77), and the worst-case available reference from the Federal Transport Administration for vibration (vibratory roller @ 0.21 in/sec or 5.334 mm/sec PPV). These parameters were used to calculate PPV at each of the closest receptors to the construction site identified in the NIA. These results were compared to the recommended threshold of 0.2 mm/s PPV to prevent vibration annoyance in residential areas. The results of these calculations are in Table 5-12 below.

Table 5-12: Impact assessment modelling calculations for vibration impact to receptors

Receptor Number	Description	Distance from Project Area (km)	Total peak particle velocity (PPV) (mm/sec)	Target PPV (mm/sec)	PPV % of Target at Receptor
1	Acreage	4.86	0.011	0.2	6
2	Acreage	3.50	0.016	0.2	8
3	Acreage	4.55	0.012	0.2	6
4	Acreage	5.22	0.010	0.2	5
5	Antelope Creek Ranch	4.86	0.011	0.2	6
6	Lathom Hutterite Colony	5.93	0.008	0.2	4
7	Snake Lake Feedlot	4.32	0.012	0.2	6

In this extreme worst-case scenario, vibration propagation at the nearest receptor is projected to be significantly below the lowest guideline threshold of 0.2 mm/s PPV to prevent annoyance in residential areas, and in fact even well below the more conservative 0.1 mm/s PPV guideline for sensitive buildings, discussed earlier (see Section 5.1.4.2).

5.6 RESIDUAL IMPACT

Table 5-13 characterizes the residual environmental effects on environmental noise and vibration during the three Project phases: construction, filling and operation. No residual Project effects are expected during any of the three phases.

Table 5-13: Project residual effects on noise and vibration during the Project phases

Impact Description	Direction	Key Criteria			Modifiers		Residual Impact Rating
		Magnitude	Geographical Extent	Duration	Confidence	Ecological and Social Context	
Construction							
Noise levels for receptors	Neutral	[redacted]					Neutral
Vibration levels for receptors	Neutral	[redacted]					Neutral
Filling							
No impacts were assessed at this stage.							
Operation							
No impacts were assessed at this stage.							

5.7 CUMULATIVE EFFECTS ASSESSMENT

Cumulative Effects Assessment was not completed since the impact of noise and vibration generated during all Project phases are all considered to be neutral.

5.8 MONITORING

No noise or vibration monitoring will be required during Project construction or operation of the completed reservoir as the noise and vibration impact from construction and operation is considered to be neutral according to the Health Canada Guideline (2017) and non-detectable for the receptors within the NRSA.

5.8.1 Complaint Resolution

Based on the above assessment, noise and vibration complaints aren't anticipated as a result of the Project. However, if any residents have noise or vibration complaints, they can contact the Eastern Irrigation District, who will follow their standard complaint resolution process.

5.9 CONCLUSIONS

None of seven receptors in the NRSA (i.e., within 6 km of the Project area) are expected to experience noise and vibration levels during construction that exceed the Health Canada limits (without any additional mitigation measures). The impact of noise and vibrations generated during construction, filling and operations and vibration guidelines for residences for the Project are all considered to be neutral. However, it is recommended that machinery and factory-supplied noise-abatement equipment (e.g., mufflers) be maintained in good working order during construction and that a complaint response procedure be implemented to address noise complaints, should they arise.

5.10 REFERENCES

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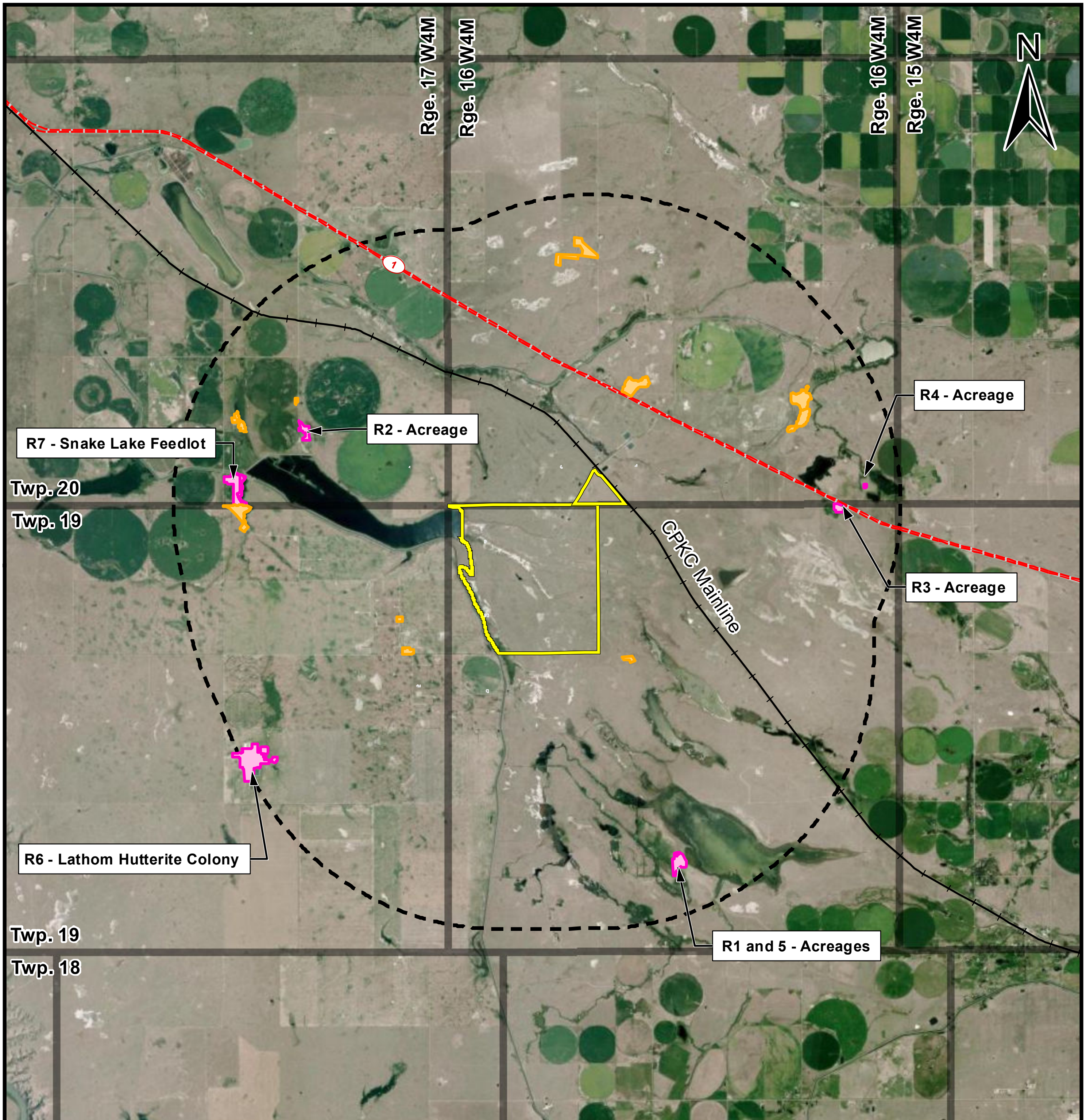
Appendix C

Appendices

Figures

Appendix C1: Figures



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Approved:	WB	Revision:	0
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CAD Survey		Revision:	0

Data Sources:
Imagery: ESRI. Date: 07/10/2021.
ATS Grid: AltaLIS 2007.
Noise Contours produced by PMO Global Services

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Noise Regional Study Area
- Settlement - Potential Noise Receptor
- Industrial Facility - Potential Noise Effector
- Highway
- Railway

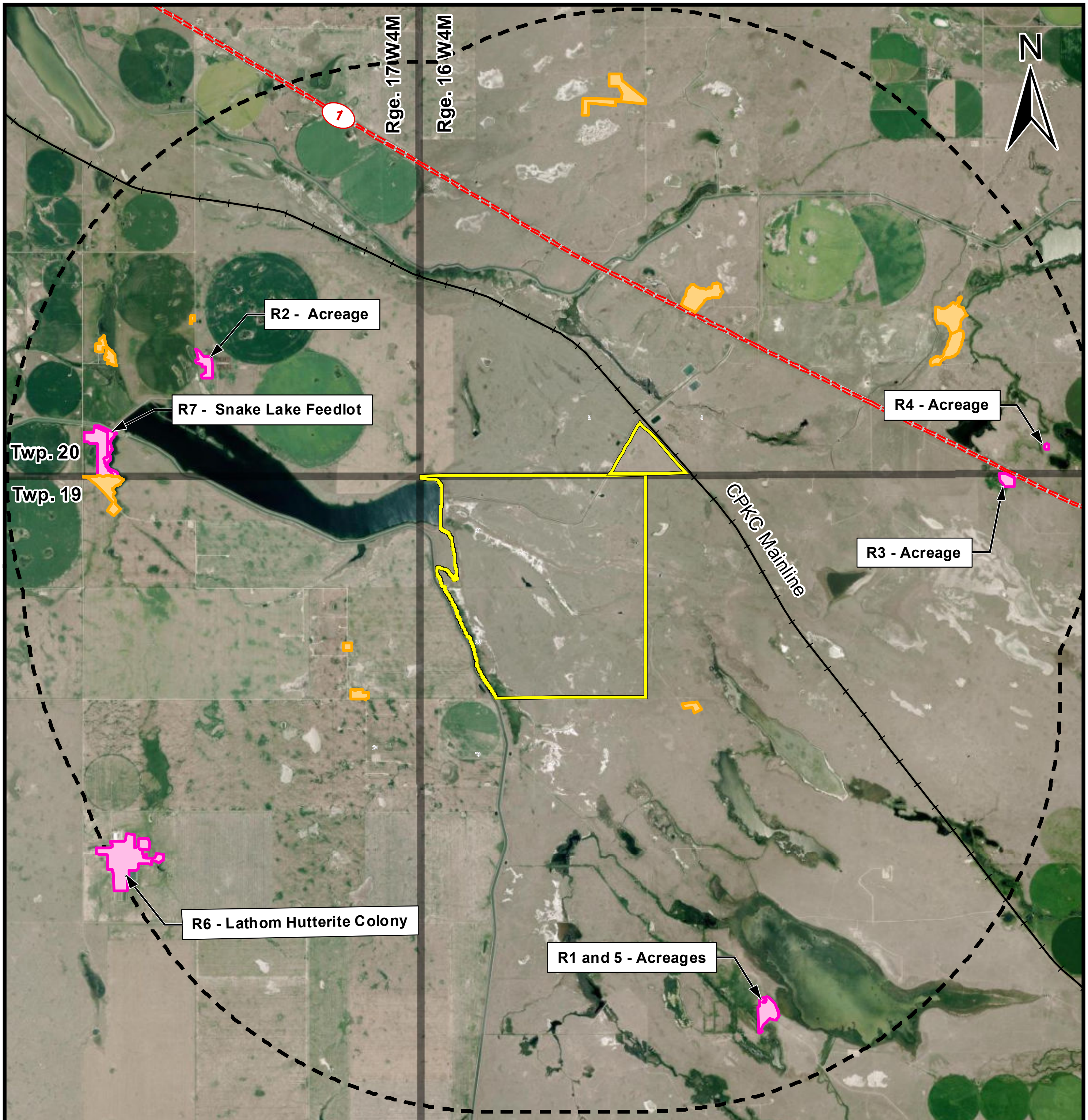
EID

Noise Regional Study Area (NRSA)

March 2025

REF.: AARES21-127 (Noise)

Figure C1-1



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Approved:	WB	*Revision:*	0
Route Source:		*Date:* Feb 21, 2024	
CAD Survey		*Revision:*	0

Data Sources:
Imagery: ESRI. Date: 07/10/2021.
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Legend

- Snake Lake Reservoir Expansion Project Area
- Noise Regional Study Area
- Settlement - Potential Noise Receptor
- Industrial Facility - Potential Noise Effector
- Highway
- Railway

EID

Potential Noise Receptors and Effectors Near the Snake Lake Reservoir Expansion Project Area

March 2025

REF.: AARES21-127 (Noise)

Figure C1-2

SCALE: 1:80,000

Km

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Route Source:		Date: Feb 21, 2024	
CAD Survey		Revision:	0

Data Sources:
Imagery: ESRI. Date: 07/10/2021.
ATS Grid: AltaLIS 2007.
Noise Contours produced by PMO Global Services

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Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Noise Regional Study Area
- Noise Receptor
- Highway
- Railway
- Point Source

dB(A) Level

- 0 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80

EID

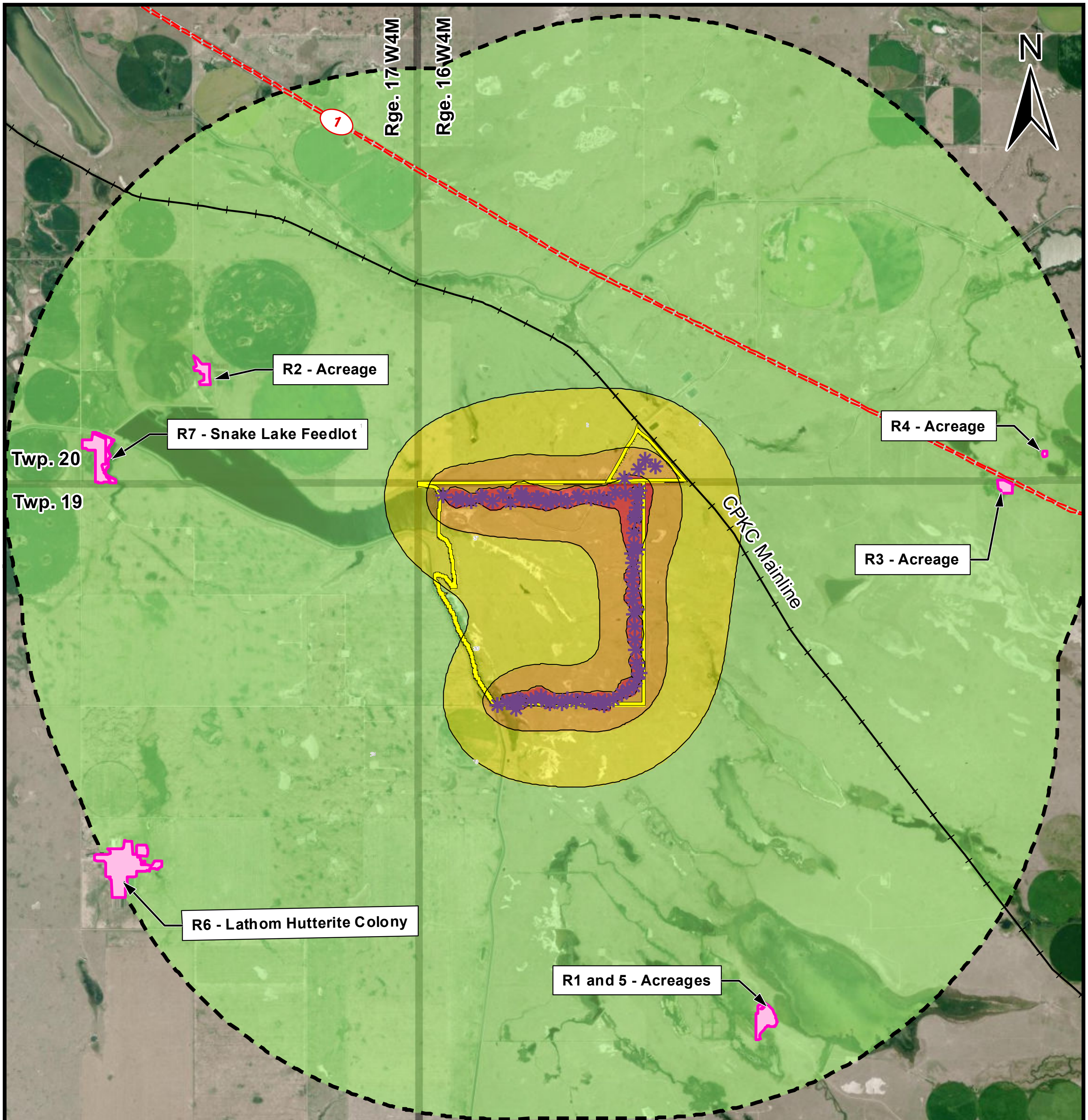
Clearing and Grubbing Noise Sources and Receptors with Expected Noise Contours

March 2025

REF.: AARES21-127 (Noise)

Figure C1-3

Map Location: Y:\01_GISProject\AARES_21\AARES21_127 (5653)\Noise\AARES21_127_FigC1-3 Clearing_Grubbing.mxd



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Drafted:	JNB	Date: Mar 28, 2025	
Approved:	WB	Revision:	0
Route Source:		Date: Feb 21, 2024	
CAD Survey		Revision:	0

Data Sources:
Imagery: ESRI. Date: 07/10/2021.
ATS Grid: AltaLIS 2007.
Noise Contours produced by PMO Global Services

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

Snake Lake Reservoir Expansion Project Area
Noise Regional Study Area
Noise Receptor
Highway
Railway
Point Source

dB(A) Level

0 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
> 90

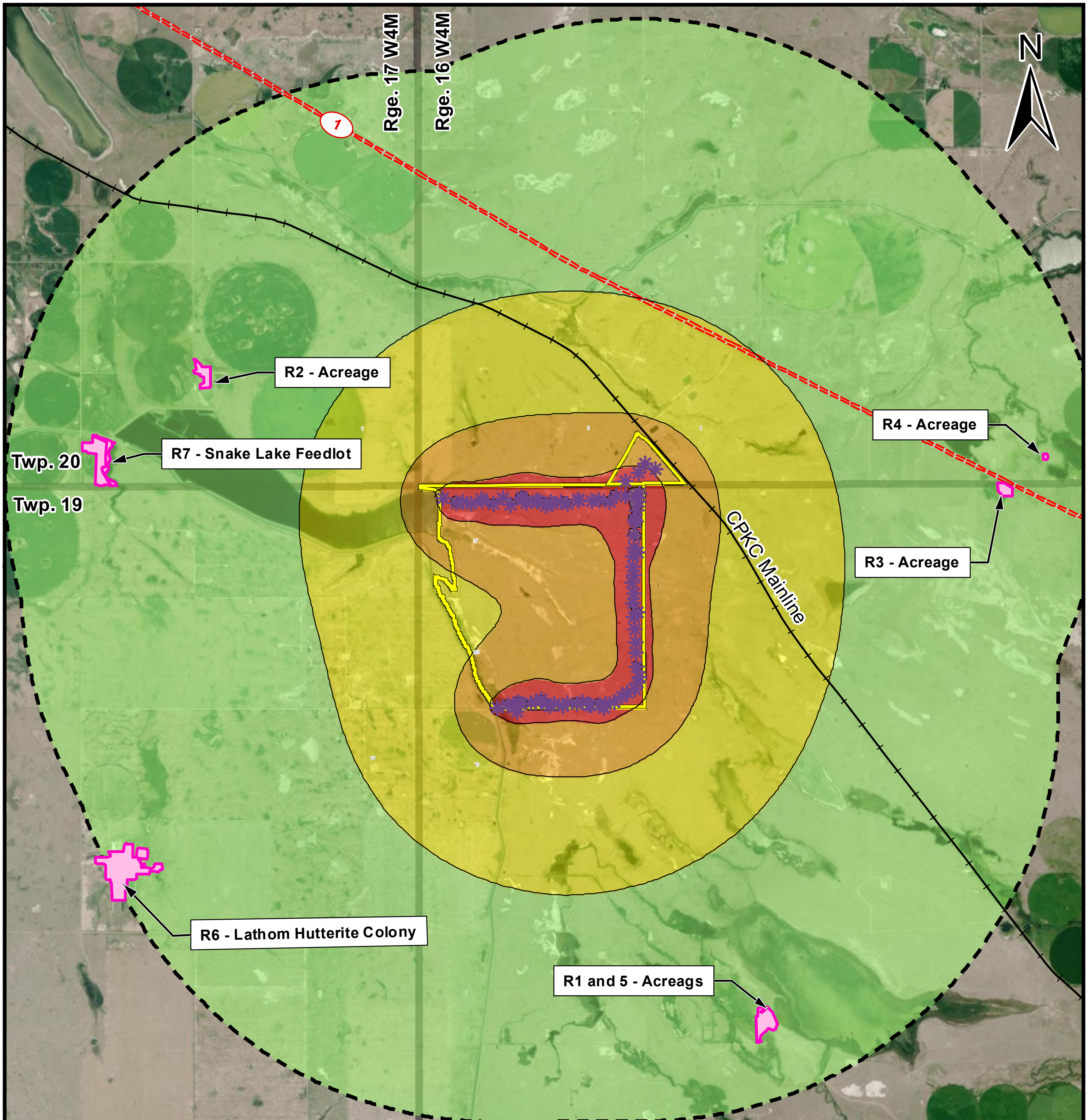
EID

Berm Construction Noise Sources and Receptors with Expected Noise Contours

March 2025

REF.: AARES21-127 (Noise)

Figure C1-4



SCALE: 1:80,000

Km

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Drafted:	JNB	Date: Mar 28, 2025	
Approved:	WB	Revision:	0
Route Source:		Date: Feb 21, 2024	
CAD Survey		Revision:	0

Data Sources:
Imagery: ESRI. Date: 07/10/2021.
ATS Grid: AltaLIS 2007.
Noise Contours produced by PMO Global Services

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Noise Regional Study Area
- Noise Receptor
- Highway
- Railway
- Point Source

dB(A) Level

- 0 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- > 90

Noise Sources and Receptors with Expected Noise Contours in a Worst-Case Zero Absorption Scenario

March 2025

REF.: AARES21-127 (Noise)

Figure C1-5