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CAPITAL POWER CORPORATION

Halkirk 2 Wind Power Project - Noise Impact Assessment

Submitted to:
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REPORT

Report Number: 1543760 / 3000 / 3002

Golder Associates

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1.0 INTRODUCTION

Capital Power Corporation (Capital Power) is proposing to develop the Halkirk 2 Wind Power Project ("the Project") in the County of Paintearth, approximately 12 kilometres (km) northeast of Halkirk, Alberta. The Project will be located within portions of Townships 39 and 40, Ranges 13, 14, and 15, W4M. The Project will consist of 74 Vestas V110 2.0-megawatt (MW) wind turbine generators and one electrical substation. The total installed nominal nameplate capacity of the Project will be 148 MW.

Power generating facilities in Alberta are regulated by the Alberta Utilities Commission (AUC). In particular, the AUC regulates power generating facilities through *Rule 007: Applications for Power Plants, Substations, Transmission Lines, Industrial System Designations, and Hydro Developments* (AUC 2016), which will hereafter be referred to as Rule 007, and through *Rule 012: Noise Control* (AUC 2013), which will hereafter be referred to as Rule 012. Rule 007 lays out general requirements for regulatory applications and Rule 012 provides specific methods and criteria for assessing potential environmental noise impacts.

Capital Power retained Golder Associates Ltd. (Golder) to complete a Noise Impact Assessment (NIA) for the Project. Golder conducted the Project NIA in accordance with guidance and methodology specified in Rule 012. The results of the Project NIA are summarized in this report.

The Project NIA report is structured as follows:

- Section 1 provides an introduction to the Project NIA;
- Section 2 presents a brief description of Project equipment and planned operations;
- Section 3 outlines the assessment approach used in the Project NIA, including a description of:
  - assessment cases considered in the Project NIA;
  - noise study area and relevant receptor locations;
  - applicable broadband and Low Frequency Noise (LFN) compliance criteria; and
  - methodology used to predict Project noise levels;
- Section 4 presents noise emissions values for sources considered in the Project NIA;
- Section 5 presents results for each assessment case, including a comparison of noise level predictions to Rule 012 compliance criteria;
- Section 6 summarizes and discusses results of the Project NIA;
- Appendix A describes field measurements and desktop calculation techniques used to establish noise emissions from third-party industrial facilities considered in the Project NIA;
- Appendix B presents a vendor-supplied data sheet, which contains one-third octave-band noise emissions for the Project wind turbine generators at various wind speeds;
- Appendix C presents a copy of the most recent noise assessment conducted for the Battle River Substation, which was used to develop noise emissions for the Project NIA;

- Appendix D presents a copy of a letter describing noise from the Tinchebray Substation, which was used to develop noise emissions for the Project NIA; and
- Appendix E presents a copy of the most recent noise assessment conducted for the Paintearth Coal Mine, which was used to develop noise emissions for the Project NIA.

2.0 PROJECT DESCRIPTION

The Project will consist of 74 Vestas V110 2.0-MW wind turbine generators and one electrical substation. The Project wind turbine generators will have a hub height of 95 metres (m). The Project wind turbine generators will operate for hub height wind speeds ranging from 3 to 20 metres per second (m/s). Blades equipped with serrated trailing edges (STE) will be installed on all Project wind turbine generators to reduce noise emissions (relative to standard blades). Depending on the time of day, individual Project wind turbine generators will operate in one of three different modes:

- Mode 0 STE, with a total sound power level of 106.0 A-weighted decibels (dBA);
- Mode 1 STE, with a total sound power level of 103.8 dBA; and
- Mode 2 STE, with a total sound power level of 100.6 dBA.

During the daytime period, defined by Rule 012 as 7 am to 10 pm (AUC 2013), all 74 Project wind turbine generators will operate in Mode 0 STE (106.0 dBA). During the nighttime period, defined by Rule 012 as 10 pm to 7 am (AUC 2013), two Project wind turbine generators will operate in Mode 0 STE (106.0 dBA), 70 Project wind turbine generators will operate in Mode 1 STE (103.8 dBA), and two Project wind turbine generators will operate in Mode 2 STE (100.6 dBA).

The major noise source associated with the Project substation will be a 167 megavolt-ampere (MVA) electrical transformer. Maximum noise emissions from the electrical transformer will occur when it operates in Oil Natural Air Forced 2nd-Stage Cooling (ONAF2) mode.

Table 1 presents locations and operating modes for Project noise sources. As required by Rule 012, the operating modes specified in Table 1 correspond to *"…the maximum noise emitted when the wind turbine operates under the planned maximum operating conditions for both the daytime and nighttime period"* (AUC 2013), where daytime is the period from 7 am to 10 pm and nighttime is the period from 10 pm to 7 am. A map showing the locations of Project noise sources is presented in Section 3.2 of this report. Additional detail on noise emissions from Project sources is provided in Section 4.2 and Appendix B of this report.

Table 1: Project Noise Source Locations and Operating Modes

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Source Operating Mode[a]	
		Easting [m]	Northing [m]	Daytime	Nighttime
H2SS	Project Substation (one 167 MVA transformer)	428789.95	5806450.98	ONAF2	ONAF2
T001B	Vestas V110 2.0 MW Wind Turbine Generator	424232.46	5808951.11	Mode 0 STE (106.0 dBA)	Mode 0 STE (106.0 dBA)
T002	Vestas V110 2.0 MW Wind Turbine Generator	425195.45	5808891.77	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T003C	Vestas V110 2.0 MW Wind Turbine Generator	426079.98	5808699.45	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T007	Vestas V110 2.0 MW Wind Turbine Generator	425068.55	5807825.44	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T008	Vestas V110 2.0 MW Wind Turbine Generator	425540.43	5807770.52	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T009A	Vestas V110 2.0 MW Wind Turbine Generator	426328.84	5807762.64	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T011B	Vestas V110 2.0 MW Wind Turbine Generator	426006.77	5806942.83	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T012C	Vestas V110 2.0 MW Wind Turbine Generator	426605.19	5806973.32	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T014A	Vestas V110 2.0 MW Wind Turbine Generator	426070.65	5805530.28	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T015A	Vestas V110 2.0 MW Wind Turbine Generator	426910.29	5805521.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T018B	Vestas V110 2.0 MW Wind Turbine Generator	427993.24	5804307.34	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T019A	Vestas V110 2.0 MW Wind Turbine Generator	427720.35	5805344.83	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T020	Vestas V110 2.0 MW Wind Turbine Generator	428287.74	5805247.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T021C	Vestas V110 2.0 MW Wind Turbine Generator	428574.37	5805466.93	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T022A	Vestas V110 2.0 MW Wind Turbine Generator	428557.71	5806008.75	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T025C	Vestas V110 2.0 MW Wind Turbine Generator	428596.39	5807689.48	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T026	Vestas V110 2.0 MW Wind Turbine Generator	428339.83	5808415.23	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T027B	Vestas V110 2.0 MW Wind Turbine Generator	428815.41	5808476.20	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T028A	Vestas V110 2.0 MW Wind Turbine Generator	429535.49	5808487.91	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T029B	Vestas V110 2.0 MW Wind Turbine Generator	429570.09	5809278.73	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T030B	Vestas V110 2.0 MW Wind Turbine Generator	428825.56	5809126.13	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T031B	Vestas V110 2.0 MW Wind Turbine Generator	427693.11	5809452.02	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)

Table 1: Project Noise Source Locations and Operating Modes

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Source Operating Mode[a]	
		Easting [m]	Northing [m]	Daytime	Nighttime
T033C	Vestas V110 2.0 MW Wind Turbine Generator	430447.87	5809232.43	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T034	Vestas V110 2.0 MW Wind Turbine Generator	430858.71	5809253.45	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T038B	Vestas V110 2.0 MW Wind Turbine Generator	430959.94	5808610.52	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T039B	Vestas V110 2.0 MW Wind Turbine Generator	431920.60	5808280.74	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T040A	Vestas V110 2.0 MW Wind Turbine Generator	432554.63	5808337.58	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T041C	Vestas V110 2.0 MW Wind Turbine Generator	432923.46	5808692.98	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T042	Vestas V110 2.0 MW Wind Turbine Generator	431260.75	5806965.12	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T047A	Vestas V110 2.0 MW Wind Turbine Generator	431557.24	5804732.03	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T049A	Vestas V110 2.0 MW Wind Turbine Generator	432468.57	5805515.83	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T051	Vestas V110 2.0 MW Wind Turbine Generator	434214.30	5803866.27	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T052B	Vestas V110 2.0 MW Wind Turbine Generator	434109.07	5805113.62	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T053B	Vestas V110 2.0 MW Wind Turbine Generator	435198.47	5804714.03	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T055A	Vestas V110 2.0 MW Wind Turbine Generator	434475.56	5805480.71	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T057A	Vestas V110 2.0 MW Wind Turbine Generator	434086.47	5807143.01	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T061A	Vestas V110 2.0 MW Wind Turbine Generator	433293.41	5808466.46	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T062A	Vestas V110 2.0 MW Wind Turbine Generator	433706.84	5808723.19	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T063A	Vestas V110 2.0 MW Wind Turbine Generator	434224.77	5808714.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T066	Vestas V110 2.0 MW Wind Turbine Generator	435963.06	5810742.06	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T067B	Vestas V110 2.0 MW Wind Turbine Generator	436507.88	5811015.99	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T069A	Vestas V110 2.0 MW Wind Turbine Generator	437388.20	5809456.30	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T073A	Vestas V110 2.0 MW Wind Turbine Generator	436805.43	5808380.02	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T078	Vestas V110 2.0 MW Wind Turbine Generator	436694.07	5806227.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T080A	Vestas V110 2.0 MW Wind Turbine Generator	435883.40	5804645.96	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)

Table 1: Project Noise Source Locations and Operating Modes

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Source Operating Mode[(a)]	
		Easting [m]	Northing [m]	Daytime	Nighttime
T084C	Vestas V110 2.0 MW Wind Turbine Generator	435349.86	5804267.27	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T085A	Vestas V110 2.0 MW Wind Turbine Generator	437631.11	5803645.14	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T086B	Vestas V110 2.0 MW Wind Turbine Generator	438223.89	5803805.22	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T088	Vestas V110 2.0 MW Wind Turbine Generator	439138.91	5803458.60	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T089C	Vestas V110 2.0 MW Wind Turbine Generator	439250.93	5803817.12	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T090	Vestas V110 2.0 MW Wind Turbine Generator	438346.00	5804578.00	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T091B	Vestas V110 2.0 MW Wind Turbine Generator	438978.89	5804402.99	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T092A	Vestas V110 2.0 MW Wind Turbine Generator	439358.25	5804983.47	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T094A	Vestas V110 2.0 MW Wind Turbine Generator	438473.41	5805407.47	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T100	Vestas V110 2.0 MW Wind Turbine Generator	441848.44	5806631.61	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T103	Vestas V110 2.0 MW Wind Turbine Generator	441454.00	5805005.96	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T106	Vestas V110 2.0 MW Wind Turbine Generator	436125.06	5809189.05	Mode 0 STE (106.0 dBA)	Mode 2 STE (100.6 dBA)
T114A	Vestas V110 2.0 MW Wind Turbine Generator	438612.56	5804192.98	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T115	Vestas V110 2.0 MW Wind Turbine Generator	438659.08	5803560.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T116	Vestas V110 2.0 MW Wind Turbine Generator	439860.08	5803937.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T117B	Vestas V110 2.0 MW Wind Turbine Generator	436667.64	5806693.97	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T118	Vestas V110 2.0 MW Wind Turbine Generator	436250.07	5807601.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T120	Vestas V110 2.0 MW Wind Turbine Generator	435832.08	5805482.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T128B	Vestas V110 2.0 MW Wind Turbine Generator	429539.92	5807194.33	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T130A	Vestas V110 2.0 MW Wind Turbine Generator	430908.48	5806648.39	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T132	Vestas V110 2.0 MW Wind Turbine Generator	429731.08	5808034.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T136A	Vestas V110 2.0 MW Wind Turbine Generator	426428.88	5808382.28	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T140	Vestas V110 2.0 MW Wind Turbine Generator	426771.09	5806344.04	Mode 0 STE (106.0 dBA)	Mode 2 STE (100.6 dBA)

Table 1: Project Noise Source Locations and Operating Modes

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Source Operating Mode[a]	
		Easting [m]	Northing [m]	Daytime	Nighttime
T142	Vestas V110 2.0 MW Wind Turbine Generator	425429.09	5808436.04	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T143	Vestas V110 2.0 MW Wind Turbine Generator	424517.10	5807939.03	Mode 0 STE (106.0 dBA)	Mode 0 STE (106.0 dBA)
T144A	Vestas V110 2.0 MW Wind Turbine Generator	426843.88	5805085.03	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T145	Vestas V110 2.0 MW Wind Turbine Generator	427922.09	5804870.05	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T146	Vestas V110 2.0 MW Wind Turbine Generator	425835.21	5806207.12	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)
T150	Vestas V110 2.0 MW Wind Turbine Generator	431595.76	5805573.98	Mode 0 STE (106.0 dBA)	Mode 1 STE (103.8 dBA)

(a) Planned operating mode corresponding to maximum noise emissions.

3.0 ASSESSMENT APPROACH

The purpose of the Project NIA was to assess potential environmental noise impacts from the Project within the context of regulatory requirements specified by Rule 012. Specific regulatory requirements are described in Section 3.3 of this report. In general, to demonstrate regulatory compliance, Rule 012 requires that cumulative noise levels at relevant receptors be compared to a mandated Permissible Sound Level (PSL) limit. Rule 012 considers relevant receptors to be *"…the most impacted dwelling(s) from the centre point of the tower of the closest wind turbine, or from the boundary of [the] substation"* (AUC 2013). Rule 012 indicates that cumulative noise levels should be calculated as the sum of:

- an assumed Ambient Sound Level (ASL) meant to represent the contribution of natural and non-industrial noise sources;
- the noise contribution from existing and approved industrial facilities in the area; and
- the noise contribution from the Project itself under *"…planned maximum operating conditions…"* (AUC 2013).

3.1 Assessment Cases

The Project NIA considered two assessment cases:

- the Baseline Case, which consists of cumulative noise levels associated with natural and non-industrial noise sources in combination with existing and approved industrial facilities; and
- the Application Case, which consists of cumulative noise levels associated with the Baseline Case in combination with the Project.

For both assessment cases, the cumulative noise level at each receptor was compared to the Rule 012 PSL. Noise contributions from existing and approved industrial facilities and noise contributions from the Project were predicted using a computer model developed in accordance with a widely-accepted calculation standard for the propagation of environmental noise (ISO 1996). Both the Baseline Case and Application Case modelled existing and approved industrial facilities under representative operating conditions. The Application Case modelled Project noise sources under *"…planned maximum operating conditions…"* (AUC 2013). Section 4.1 and Appendix A of this report provide additional detail on the existing and approved industrial facilities included in the Baseline Case. Section 2.0, Section 4.2, and Appendix B of this report provide additional detail on the Project noise sources included in the Application Case. Section 3.4 of this report presents additional detail on the computer modelling conducted for the Baseline Case and the Application Case.

3.2 Noise Study Area and Receptors

Rule 012 regulates noise from a receptor perspective and considers relevant receptors to be *"…the most impacted dwelling(s) from the centre point of the tower of the closest wind turbine, or from the boundary of [the] substation"* (AUC 2013). Because Project noise sources will be spread across several townships and will be interspersed with third-party industrial facilities, it was not feasible to identify a single most impacted dwelling or even a small number of most impacted dwellings. Instead, the Project NIA established a 2 km buffer surrounding the lands Capital Power has optioned for the Project and assessed potential Project noise impacts at all occupied dwellings located within this buffer. A 2 km receptor buffer was selected based on the Rule 007 requirement that proponents consult with all residents living within 2 km of a proposed facility (AUC 2016). In other words, specific receptors for the Project NIA were selected such that discrete noise level predictions and assessment results would be available for all residents that Capital Power was required to consult as part of the AUC regulatory process for the Project.

In addition to AUC receptors corresponding to occupied dwellings, the Project NIA also assessed potential Project noise impacts at one dwelling location that may be developed in the future, one cabin with unknown occupancy status, and one campground. The potential future dwelling was included in the Project NIA at the request of the County of Paintearth. For the purposes of the Project NIA, it was necessary to estimate the approximate location of this potential future receptor, as there is currently no dwelling present on the site. The cabin and campground locations likely do not qualify as dwellings based on the Rule 012 definition but have been included in the Project NIA for information purposes.

Rule 012 does not specify receptor heights for use in noise assessments. However, Rule 012 does indicate that monitoring equipment should be deployed 1.5 m above ground when measuring noise levels associated with wind turbine generators, except in the case of a dwelling with a second storey bedroom. In the case of a second storey bedroom, Rule 012 indicates that monitoring equipment should be deployed 4.5 m above ground. For consistency with Rule 012 guidance on appropriate deployment locations for noise monitoring equipment, the Project NIA modelled receptors corresponding to one storey dwellings at 1.5 m above ground and modelled receptors corresponding to two storey dwellings at 4.5 m above ground. Where information about the height of existing dwellings was not available, the corresponding receptor was modelled at 4.5 m above ground, which is a conservative treatment of potential Project noise impacts.

Table 2 presents locations and heights for the 59 receptors considered in the Project NIA. For each receptor, Table 2 also identifies and provides the distance to the closest Project wind turbine generator. Figure 1 presents a map showing the noise study area, including the locations of receptors, Project noise sources, and third-party industrial facilities considered in the Project NIA. Section 4.1 and Appendix A of this report provide additional detail on existing and approved third-party industrial facilities considered in the Project NIA.

Table 2: Noise Receptors

Receptor Identification Code	Universal Transverse Mercator Coordinates [NAD 83, Zone 12]		Receptor Height [m]	Dwelling Description	Closest Wind Turbine Generator	Distance to Closest Wind Turbine Generator [m]
	Easting [m]	Northing [m]				
R004	426259.63	5811088.39	1.5	one-storey	T031B	2,175
R005	428877.21	5809891.20	1.5	one-storey	T030B	767
R007	436254.00	5809761.00	4.5	two-storey	T106	586
R008	437216.71	5811066.84	4.5	two-storey	T067B	711
R009	438528.00	5809729.00	4.5	two-storey	T069A	1,172
R010	426521.41	5809456.87	1.5	one-storey	T003C	877
R012	432216.07	5809496.38	1.5	one-storey	T041C	1,070
R014	433868.43	5809575.12	1.5	one-storey	T062A	867
R015	435455.96	5808121.74	1.5	one-storey	T118	950
R016	437199.39	5807239.86	1.5	one-storey	T117B	762
R017	438967.67	5808365.04	4.5	two-storey	T069A	1,920
R018	441287.16	5807897.27	4.5	two-storey	T100	1,385
R019	430550.42	5807816.36	1.5	one-storey	T132	848
R022	432469.14	5806576.97	1.5	one-storey	T049A	1,061
R024	433481.34	5806672.73	1.5	one-storey	T057A	766
R027	435464.66	5807071.04	1.5	one-storey	T118	948
R030	430545.63	5805796.52	1.5	one-storey	T130A	926
R031	430499.30	5804730.08	1.5	one-storey	T047A	1,058
R032	430790.81	5804776.67	1.5	one-storey	T047A	768
R033	432122.78	5804686.37	1.5	one-storey	T047A	567
R034	437024.21	5804528.79	4.5	two-storey	T085A	1,072
R036	437206.04	5805129.31	4.5	two-storey	T078	1,211
R040	442076.19	5809550.81	1.5	one-storey	T100	2,928
R042	432835.26	5806179.98	1.5	one-storey	T049A	759
R045	435466.57	5806363.09	1.5	one-storey	T120	954
R046	437164.01	5805860.29	1.5	one-storey	T078	596
R047	440345.24	5805582.77	4.5	two-storey	T092A	1,155
R048	442378.84	5803218.37	4.5	two-storey	T103	2,013
R049	431995.94	5804022.68	1.5	one-storey	T047A	834
R050	431936.55	5803901.67	4.5	two-storey	T047A	913
R051[(a)]	427615.97	5806494.12	1.5	one-storey	T140	858
R052	426965.82	5809986.80	1.5	one-storey	T031B	903
R053	427095.83	5804340.37	1.5	one-storey	T144A	786
R054[(a)]	430130.71	5806469.66	1.5	one-storey	T130A	798
R055	430829.60	5803517.79	4.5	two-storey	T047A	1,416
R056	433537.15	5806156.95	4.5	two-storey	T057A	1,129
R060	431839.61	5810081.86	4.5	two-storey	T034	1,284
R061	433781.26	5810148.49	4.5	two-storey	T062A	1,427
R063	437258.43	5802756.87	1.5	one-storey	T085A	963

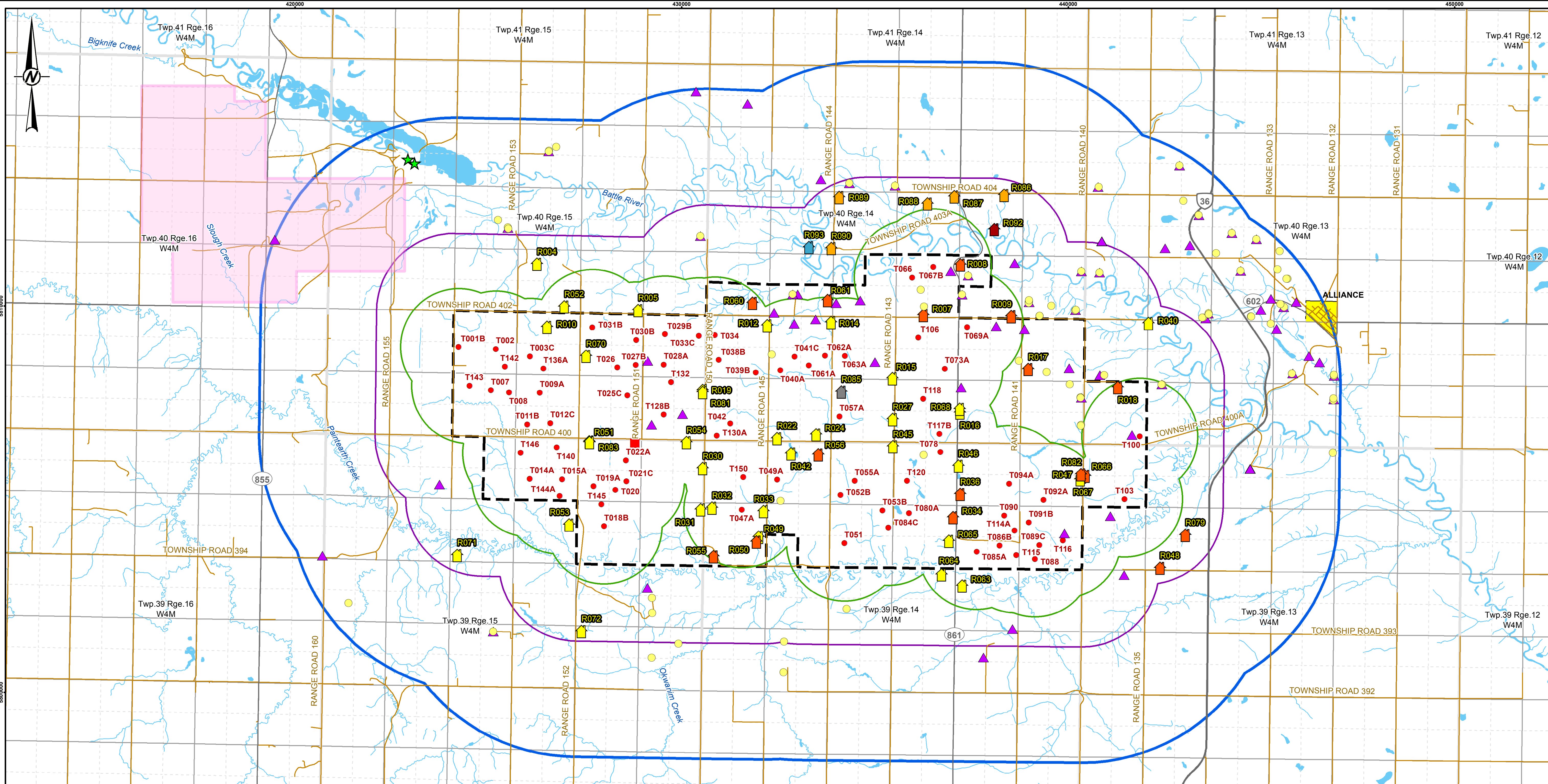
Table 2: Noise Receptors

Receptor Identification Code	Universal Transverse Mercator Coordinates [NAD 83, Zone 12]		Receptor Height [m]	Dwelling Description	Closest Wind Turbine Generator	Distance to Closest Wind Turbine Generator [m]
	Easting [m]	Northing [m]				
R064	436722.76	5803049.97	1.5	one-storey	T085A	1,086
R065	436917.79	5803921.65	1.5	one-storey	T085A	765
R066	440439.44	5805599.41	4.5	two-storey	T103	1,175
R067	440314.81	5805515.37	1.5	one-storey	T092A	1,094
R068	437198.27	5807332.78	1.5	one-storey	T117B	830
R070	427528.45	5808704.44	1.5	one-storey	T031B	765
R071	424197.37	5803552.52	1.5	one-storey	T014A	2,724
R072	427411.14	5801584.04	1.5	one-storey	T018B	2,785
R079	443030.59	5804075.08	4.5	two-storey	T103	1,831
R081	430548.95	5807767.48	1.5	one-storey	T132	860
R082	440335.19	5805638.59	4.5	two-storey	T092A	1,176
R083(a)	427618.48	5806472.76	1.5	one-storey	T140	857
R085	434136.20	5807783.40	1.5	potential future dwelling (location approximate)	T057A	642
R086	438348.00	5812873.00	4.5	two-storey (assumed)(b)	T067B	2,614
R087	437057.00	5812837.00	4.5	two-storey (assumed)(b)	T067B	1,902
R088	436361.00	5812653.00	4.5	two-storey (assumed)(b)	T067B	1,644
R089	434077.00	5812813.00	4.5	two-storey (assumed)(b)	T066	2,801
R090	433877.00	5811493.00	4.5	two-storey (assumed)(b)	T066	2,217
R092	438089.00	5811981.00	1.5	cabin(c)	T067B	1,852
R093	433295.00	5811522.00	1.5	campground(c)	T066	2,780

(a) This receptor is located within 1.5 km of the Project substation

(b) The height of this dwelling has not been definitively established. In the absence of dwelling-specific height data, it was modelled as a two-storey receptor for the sake of conservatism.

(c) This receptor may not meet the formal definition of a dwelling presented in Rule 012 (AUC 2013). This receptor is included in the NIA for information purposes only.



LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- POPULATED PLACE
- WATERBODY

0 2 4
1:100,000 KILOMETRES

REFERENCE(S)
1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
2. OIL AND GAS FACILITIES AND WELLS OBTAINED FROM IHS ENERGY INC. FOR MODEL REQUIREMENTS.
DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
NOISE STUDY AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1

3.3 Compliance Criteria

3.3.1 Broadband Noise

Rule 012 requires that broadband noise compliance be assessed by comparing cumulative noise levels to a mandated PSL limit. Cumulative noise levels include the contribution from natural and non-industrial sources, existing and approved industrial facilities, and the Project itself. The noise contribution from natural and non-industrial sources is characterized via an ASL value.

Appropriate PSL limits and ASL values for individual receptors are calculated using a desktop technique outlined in Rule 012. The Rule 012 calculation technique accounts for time of day, population density, and proximity to transportation infrastructure such as heavily-travelled roads and railways. All the receptors considered in the Project NIA are in areas with population density less than nine dwellings per quarter section and farther than 500 m from heavily-travelled roads and railways. As such, PSL limits and ASL values for a quiet rural environment are applicable for each receptor.

Table 3 presents Rule 012 PSL limits and ASL values applicable at each receptor considered in the Project NIA. Note that Rule 012 defines the daytime as the period between 7 am and 10 pm and the nighttime as the period between 10 pm and 7 am.

Table 3: Permissible Sound Levels and Ambient Sound Levels

Receptor Identification Code	Permissible Sound Level [dBA]		Ambient Sound Level [dBA]	
	Daytime	Nighttime	Daytime	Nighttime
R004	50	40	45	35
R005	50	40	45	35
R007	50	40	45	35
R008	50	40	45	35
R009	50	40	45	35
R010	50	40	45	35
R012	50	40	45	35
R014	50	40	45	35
R015	50	40	45	35
R016	50	40	45	35
R017	50	40	45	35
R018	50	40	45	35
R019	50	40	45	35
R022	50	40	45	35
R024	50	40	45	35
R027	50	40	45	35
R030	50	40	45	35
R031	50	40	45	35
R032	50	40	45	35
R033	50	40	45	35
R034	50	40	45	35
R036	50	40	45	35
R040	50	40	45	35

Table 3: Permissible Sound Levels and Ambient Sound Levels

Receptor Identification Code	Permissible Sound Level [dBA]		Ambient Sound Level [dBA]	
	Daytime	Nighttime	Daytime	Nighttime
R042	50	40	45	35
R045	50	40	45	35
R046	50	40	45	35
R047	50	40	45	35
R048	50	40	45	35
R049	50	40	45	35
R050	50	40	45	35
R051	50	40	45	35
R052	50	40	45	35
R053	50	40	45	35
R054	50	40	45	35
R055	50	40	45	35
R056	50	40	45	35
R060	50	40	45	35
R061	50	40	45	35
R063	50	40	45	35
R064	50	40	45	35
R065	50	40	45	35
R066	50	40	45	35
R067	50	40	45	35
R068	50	40	45	35
R070	50	40	45	35
R071	50	40	45	35
R072	50	40	45	35
R079	50	40	45	35
R081	50	40	45	35
R082	50	40	45	35
R083	50	40	45	35
R085	50	40	45	35
R086	50	40	45	35
R087	50	40	45	35
R088	50	40	45	35
R089	50	40	45	35
R090	50	40	45	35
R092	50	40	45	35
R093	50	40	45	35

3.3.2 Low Frequency Noise

LFN can be an issue even when broadband noise levels are otherwise acceptable. Consequently, Rule 012 requires a separate assessment of potential LFN impacts. Rule 012 indicates that a LFN issue exists if the following two conditions are met:

- the value of the cumulative noise level, expressed in C-weighted decibels (dBC), minus the value of the cumulative noise level, expressed in dBA, is greater than or equal to 20; and
- a clear tone is present in a one-third octave-band at or below 250 Hertz (Hz).

Rule 012 provides the following definition of a clear tone:

"For the one-third octave frequency bands between 20 to 250 Hz and below:

> *a) the linear sound level of one band must be at least 10 dB [decibels] or more above one of the adjacent bands within two one-third octave bandwidths*
>
> *b) there must be at least a five dB drop in level within two bandwidths on the opposite side of the frequency band exhibiting the high sound level"* (AUC 2013).

Rule 012 requires that both conditions – i.e., a dBC minus dBA difference greater than or equal to 20 **and** a clear tone at or below 250 Hz – be present for an LFN issue to exist. Satisfaction of one condition does not result in a LFN issue.

3.4 Noise Prediction Methodology

Computer noise models of existing and approved industrial facilities and the Project were developed using the CadnaA Version 4.6.155 software package. In accordance with Rule 012, CadnaA implements the noise propagation algorithm described in the International Organization for Standardization (ISO) 9613-2 technical standard (ISO 1996).

The computer models were used to calculate Baseline Case and Application Case cumulative noise levels at the receptors listed in Table 2. Inputs to the computer models consisted of source emissions in the form of octave-band sound power levels and environmental conditions – such as ground cover, temperature, humidity, and wind conditions – that are known to impact noise propagation. Noise source emissions for the Baseline Case and Application Case are discussed in detail in Section 4.1 and Section 4.2 of this report, respectively. A summary of environmental inputs to the computer models is provided in Table 4.

Table 4: Environmental Inputs to Computer Noise Models

Parameter	Model Setting	Description/Notes
Standard	ISO 9613-2 (ISO 1996)	Models treated noise sources, noise attenuation, and noise propagation in accordance with this standard.
Source Types	Point source; Area source	Point sources were used to model noise emissions from Project wind turbine generators, the Project substation, and most third-party industrial facilities. An area source was used to model noise emissions from the Paintearth Coal Mine, which is spatially distributed.
Ground Factor	0.0 – Wetlands 0.5 – Elsewhere	These values represent acoustic properties of the ground in accordance with ISO 9613-2. A value of 0.0 represents hard/reflective ground. A value of 1.0 represent porous/absorptive ground.
Temperature / Humidity	10 degrees Celsius / 70% relative humidity	These are typical default values for ISO 9613-2 intended to represent nighttime summer conditions.
Wind Conditions	1 m/s to 5 m/s from source to receptor	These represent default ISO 9613-2 wind conditions – moderate temperature inversion, wind from source to receptor 100% of the time.
Terrain	Terrain considered	Ground elevation contours at 5 m intervals were included in the models.

When calculating noise levels at receptors, the ISO 9613-2 algorithm used the environmental inputs listed in Table 4 to account for four noise attenuation mechanisms:

- geometric divergence;
- atmospheric absorption;
- ground absorption; and
- screening by barriers.

Geometric divergence accounts for the fact that a given noise source radiates a finite amount of acoustic energy and as this finite amount of energy propagates into the environment it is spread over a larger and larger area (i.e., the surface of an ever-expanding sphere). This geometric spreading means that the farther away a receptor is located from a source, the less energy will be received (i.e., the lower the observed noise level).

Atmospheric absorption accounts for the fact that acoustic energy associated with a given noise source is absorbed via interaction with molecules in the air through which it propagates. Attenuation effects associated with atmospheric absorption are most substantial at high frequencies, but can be important at lower frequencies for large propagation distances.

Ground absorption accounts for the fact that each time the acoustic energy emitted by a noise source interacts with the ground, some of it is absorbed. The amount of energy absorbed depends on the type of ground surface. During interactions with hard ground, very little energy is absorbed, but during interactions with porous ground, a substantial amount of energy is absorbed. Thus, if all other factors are held constant, observed noise levels associated with sources operating in an area of hard ground will be higher than observed noise levels associated with sources operating in an area of porous ground.

Screening by barriers accounts for the fact that a physical object (either terrain-based or anthropogenic) placed between a noise source and receptor can block acoustic energy and reduce observed noise levels at the receptor.

According to the ISO 9613-2 standard, the overall accuracy of the propagation algorithm used in the Project NIA computer models is ±3 dB for distances between source and receptor up to 1 km. The accuracy for propagation distances greater than 1 km is not stated in the standard. Model accuracy also depends on the accuracy of the noise emissions inputs, which is often ±2 dB for measured sources. Accounting for both these sources of uncertainty, the overall accuracy of the noise level predictions presented in the Project NIA is expected to be ±4 dB.

Several conservative assumptions regarding propagation conditions and Project operations were made to account for the level of uncertainty inherent in the noise level predictions. Each receptor was assumed to be downwind from each source 100% of the time. Because downwind conditions tend to enhance noise propagation, this assumption is conservative and likely overestimates the noise impact of the Project. Ground conditions in most of the modelling domain meet the definition of porous ground provided in ISO 9613-2: *"…ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land"* (ISO 1996). As such, for consistency with ISO 9613-2, a ground factor of 1.0 should be used in the computer models. Instead, the computer models used a substantially more reflective ground factor of 0.5 to represent conditions in the modelling domain. Because reflective ground tends to enhance noise propagation, this approach is conservative and likely overestimates the noise impact of the Project. The wind turbine generators and substation associated with the Project were modelled with maximum noise emissions 100% of the time. Because Project noise sources will often operate with less than maximum noise emissions, this modelling approach is conservative and likely overestimates the noise impact of the Project.

4.0 NOISE EMISSIONS

4.1 Baseline Case

Golder identified a total of 147 existing and approved third-party industrial facilities with the potential to influence cumulative noise levels at the receptors listed in Table 2. The Baseline Case of the Project NIA considered the noise contribution from each of these 147 existing and approved third-party industrial facilities.

Noise emissions for the 147 facilities considered in the Baseline Case of the Project NIA are presented in Table 5. Noise emissions are presented in the form of octave-band sound power levels, expressed in unweighted decibels (dBZ), and total sound power levels, expressed in dBA. Table 5 also provides a brief description and physical coordinates for each of the Baseline Case facilities.

Appendix A describes the procedure used to identify relevant Baseline Case facilities. Appendix A also describes field measurements and desktop calculation techniques used to estimate noise emissions from these facilities.

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
PEM	Paintearth Coal Mine	418901[(a)]	5812837[(a)]	127.8	128.4	128.6	129.9	126.7	125.2	122.0	116.0	111.1	129.9
BRPP	Electrical Facility - Battle River Power Plant	422923	5813799	133.0	132.0	128.1	122.4	114.5	108.8	101.7	96.7	89.4	118.3
207BO	Oil & Gas Facility - Battery	440021	5808387	117.6	121.1	112.4	106.0	107.4	106.9	105.7	103.4	100.2	112.4
121GO	Oil & Gas Facility - Gas Gathering System	443561	5809677	117.6	121.1	112.4	105.2	104.6	106.3	105.5	103.3	100.1	111.8
121GOA	Oil & Gas Facility - Gas Gathering System	443623	5809804	117.6	121.1	112.4	105.2	104.6	106.3	105.5	103.3	100.1	111.8
BRSS	Electrical Facility - Battle River Substation	423090	5813698	98.4	101.0	102.7	107.0	108.1	93.9	86.3	81.6	76.3	106.2
053BO	Oil & Gas Facility - Battery	434620	5810145	103.9	99.6	96.4	91.7	92.2	93.2	89.5	88.5	78.9	97.3
273SP	Oil & Gas Facility - Satellite	440818	5808210	103.9	99.6	96.4	91.7	92.2	93.2	89.5	88.5	78.9	97.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
011BO	Oil & Gas Facility - Battery	425125	5801575	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
018BO	Oil & Gas Facility - Battery	440188	5809894	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
043BO	Oil & Gas Facility - Battery	441645	5806664	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
046BO	Oil & Gas Facility - Battery	434998	5808547	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
057BO	Oil & Gas Facility - Battery	439898	5804118	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
068BO	Oil & Gas Facility - Battery	423732	5805380	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
071BO	Oil & Gas Facility - Battery	432387	5809825	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
072BP	Oil & Gas Facility - Battery	444703	5805788	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
074BO	Oil & Gas Facility - Battery	440864	5811672	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
075BO	Oil & Gas Facility - Battery	441090	5804563	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
092BO	Oil & Gas Facility - Battery	444867	5811727	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
110BO	Oil & Gas Facility - Battery	446497	5808545	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
111BO	Oil & Gas Facility - Battery	446225	5808710	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
114BO	Oil & Gas Facility - Battery	434341	5813176	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
115BO	Oil & Gas Facility - Battery	438133	5809476	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
117BO	Oil & Gas Facility - Battery	438865	5809399	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
122BO	Oil & Gas Facility - Battery	425506	5812025	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
126BP	Oil & Gas Facility - Battery	440768	5813083	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
130BP	Oil & Gas Facility - Battery	429112	5802706	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
141BO	Oil & Gas Facility - Battery	429222	5806928	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
149BO	Oil & Gas Facility - Battery	445804	5808254	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
151BO	Oil & Gas Facility - Battery	441446	5803035	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
156BO	Oil & Gas Facility - Battery	430484	5811814	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
158BP	Oil & Gas Facility - Battery	420705	5803536	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
160BO	Oil & Gas Facility - Battery	440338	5810898	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
172BP	Oil & Gas Facility - Battery	430372	5815555	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
174BO	Oil & Gas Facility - Battery	442876	5813637	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
181BO	Oil & Gas Facility - Battery	433602	5813282	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
190BO	Oil & Gas Facility - Battery	432875	5810298	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
192BP	Oil & Gas Facility - Battery	433997	5810073	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
200BP	Oil & Gas Facility - Battery	444708	5805788	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
201BO	Oil & Gas Facility - Battery	444461	5810910	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
214BP	Oil & Gas Facility - Battery	438553	5801639	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
227BO	Oil & Gas Facility - Battery	444233	5811891	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
228BP	Oil & Gas Facility - Battery	440868	5811679	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
229BO	Oil & Gas Facility - Battery	438610	5811106	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
248BO	Oil & Gas Facility - Battery	431705	5815238	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
255BO	Oil & Gas Facility - Battery	445389	5809408	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
261BO	Oil & Gas Facility - Battery	432997	5810299	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
265BO	Oil & Gas Facility - Battery	435517	5813116	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
272BO	Oil & Gas Facility - Battery	430019	5807205	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
275BO	Oil & Gas Facility - Battery	444703	5805788	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
281BO	Oil & Gas Facility - Battery	444980	5809899	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
283BO	Oil & Gas Facility - Battery	429120	5808583	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W324	Oil & Gas Well	439562	5810010	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W335	Oil & Gas Well	443492	5809701	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W336	Oil & Gas Well	443472	5809702	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W339	Oil & Gas Well	443637	5809810	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W342	Oil & Gas Well	438983	5810126	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W357	Oil & Gas Well	440930	5808209	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W358	Oil & Gas Well	436186	5810424	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3
W371	Oil & Gas Well	443636	5809790	100.9	96.6	93.4	88.7	89.2	90.2	86.5	85.5	75.9	94.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
095BO	Oil & Gas Facility - Battery	437226	5807892	93.3	91.2	89.3	82.7	86.0	87.3	82.9	77.3	70.4	90.5
241BO	Oil & Gas Facility - Battery	433461	5809656	95.7	94.8	94.3	86.3	87.3	83.9	81.2	75.1	69.2	89.3
244BO	Oil & Gas Facility - Battery	432911	5809540	104.8	97.4	90.1	83.3	84.2	80.3	74.5	73.3	67.8	85.7
W300	Oil & Gas Well	425250	5812231	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W301	Oil & Gas Well	425504	5812038	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W302	Oil & Gas Well	425521	5812002	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W303	Oil & Gas Well	426570	5814019	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W304	Oil & Gas Well	426759	5814126	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W305	Oil & Gas Well	426569	5814004	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W306	Oil & Gas Well	432563	5804961	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W307	Oil & Gas Well	429229	5800895	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W308	Oil & Gas Well	432651	5801316	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W309	Oil & Gas Well	432635	5800522	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
W310	Oil & Gas Well	429231	5802449	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W311	Oil & Gas Well	434267	5802162	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W312	Oil & Gas Well	429921	5801267	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W313	Oil & Gas Well	425125	5801575	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W314	Oil & Gas Well	446849	5806205	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W315	Oil & Gas Well	429238	5802057	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W316	Oil & Gas Well	421383	5802313	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W317	Oil & Gas Well	436264	5806148	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W318	Oil & Gas Well	442982	5812729	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W319	Oil & Gas Well	444233	5811891	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W320	Oil & Gas Well	443376	5812351	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W321	Oil & Gas Well	444461	5810910	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W322	Oil & Gas Well	442876	5813637	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W325	Oil & Gas Well	444867	5811727	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
W326	Oil & Gas Well	440338	5810898	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W328	Oil & Gas Well	446875	5808194	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W329	Oil & Gas Well	446876	5808219	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W330	Oil & Gas Well	446859	5807556	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W331	Oil & Gas Well	445413	5810949	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W332	Oil & Gas Well	442433	5807969	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W333	Oil & Gas Well	442413	5807969	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W334	Oil & Gas Well	445672	5810707	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W337	Oil & Gas Well	438983	5810106	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W338	Oil & Gas Well	439445	5808296	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W341	Oil & Gas Well	443823	5811370	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W343	Oil & Gas Well	440038	5807980	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W344	Oil & Gas Well	439260	5809751	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W345	Oil & Gas Well	440329	5806922	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
W346	Oil & Gas Well	437253	5810292	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W347	Oil & Gas Well	446860	5807606	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W349	Oil & Gas Well	438983	5810078	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W351	Oil & Gas Well	440318	5807642	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W352	Oil & Gas Well	445469	5811421	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W354	Oil & Gas Well	440811	5810869	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W355	Oil & Gas Well	440179	5809886	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W356	Oil & Gas Well	432334	5808751	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W359	Oil & Gas Well	440318	5807622	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W360	Oil & Gas Well	437412	5810782	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W361	Oil & Gas Well	440198	5809902	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W362	Oil & Gas Well	440329	5806902	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W363	Oil & Gas Well	445785	5808249	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W364	Oil & Gas Well	438984	5810146	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
W365	Oil & Gas Well	445646	5810707	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W366	Oil & Gas Well	438724	5808580	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W367	Oil & Gas Well	439260	5809751	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W369	Oil & Gas Well	440788	5813083	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W370	Oil & Gas Well	436271	5809982	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W373	Oil & Gas Well	435517	5813116	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W374	Oil & Gas Well	432875	5810298	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W379	Oil & Gas Well	430484	5811814	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W380	Oil & Gas Well	434341	5813176	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W383	Oil & Gas Well	445582	5809968	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W384	Oil & Gas Well	445487	5810044	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W385	Oil & Gas Well	444728	5809728	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W386	Oil & Gas Well	444734	5809726	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3
W387	Oil & Gas Well	445239	5809541	91.6	88.1	85.1	80.5	81.6	80.0	78.6	74.9	69.8	85.3

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
026SP	Oil & Gas Facility - Satellite	446868	5807585	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
032SP	Oil & Gas Facility - Satellite	438985	5810095	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
037SP	Oil & Gas Facility - Satellite	445239	5810186	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
062SP	Oil & Gas Facility - Satellite	437253	5810292	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
067SP	Oil & Gas Facility - Satellite	442423	5807969	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
089SP	Oil & Gas Facility - Satellite	437411	5810789	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
105SP	Oil & Gas Facility - Satellite	443381	5812351	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
106SP	Oil & Gas Facility - Satellite	440336	5807628	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
116SP	Oil & Gas Facility - Satellite	442504	5811494	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
147SP	Oil & Gas Facility - Satellite	445568	5809974	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8

Table 5: Baseline Case Noise Emissions

Source Identification Code	Source Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]		Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		Easting [m]	Northing [m]	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
150SO	Oil & Gas Facility - Satellite	436960	5810902	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
165SP	Oil & Gas Facility - Satellite	437802	5800901	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
170SP	Oil & Gas Facility - Satellite	419471	5811717	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
189SP	Oil & Gas Facility - Satellite	443144	5811574	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
217SP	Oil & Gas Facility - Satellite	440811	5810869	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
226SP	Oil & Gas Facility - Satellite	426557	5814005	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
243SP	Oil & Gas Facility - Satellite	446880	5808194	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8
270SP	Oil & Gas Facility - Satellite	445892	5810102	88.7	86.7	95.1	77.3	76.5	80.2	74.4	74.8	71.5	84.8

(a) Approximate centre point of the spatially-distributed area source used to represent this facility

4.2 Application Case

Project noise sources consist of 74 Vestas V110 2.0-MW wind turbine generators and one electrical substation. In accordance with Rule 012, all Project noise sources were modelled using *"…the maximum noise emitted when the wind turbine operates under the planned maximum operating conditions for both the daytime and nighttime period"* (AUC 2013).

As discussed in Section 2.0 of the Project NIA report, all 74 Project wind turbine generators will operate in Mode 0 STE during the daytime period. During the nighttime period, two wind turbine generators (T001B and T143) will operate in Mode 0 STE, two wind turbine generators (T106 and T140) will operate in Mode 2 STE, and the other 70 wind turbine generators will operate in Mode 1 STE. For each of the relevant operating modes, Table 6 presents total noise emissions from the Project wind turbine generators as a function of hub height wind speeds. Table 6 shows that maximum noise emissions from the Project wind turbine generators will occur for hub height wind speeds between 10 m/s and 20 m/s. In particular, noise emissions reach a maximum for a wind speed of 10 m/s; total noise emissions remain constant at this maximum level for wind speeds up to 20 m/s (i.e., the cut-out wind speed for the V110).

Table 6: Noise Emissions from Project Wind Turbine Generators (Vestas V110 2.0 MW) as a Function of Hub Height Wind Speed

Hub Height Wind Speed [m/s]	Total Sound Power Level [dBA]		
	Mode 0 STE	Mode 1 STE	Mode 2 STE
3	95.3	95.3	95.1
4	95.8	95.9	95.6
5	96.9	97.0	96.6
6	100.7	101.0	99.1
7	102.3	102.3	100.5
8	104.5	103.5	100.6
9	106.0	103.7	100.6
10	106.0	103.8	100.6
11	106.0	103.8	100.6
12	106.0	103.8	100.6
13	106.0	103.8	100.6
14	106.0	103.8	100.6
15	106.0	103.8	100.6
16	106.0	103.8	100.6
17	106.0	103.8	100.6
18	106.0	103.8	100.6
19	106.0	103.8	100.6
20	106.0	103.8	100.6

Although total noise emissions from the Project wind turbine generators are constant for wind speeds from 10 to 20 m/s, there are changes to emissions spectra as wind speed increases. To fully characterize potential noise impacts from the Project, the Application Case of the Project NIA modelled noise emissions from the wind turbine generators for every integer wind speed from 10 up to 20 m/s. Noise emissions from the Project wind turbine generators are presented in Table 7. Noise emissions in Table 7 are presented in the form of octave-band sound power levels, expressed in dBZ, and total sound power levels, expressed in dBA. The noise emissions data presented in Table 7 were calculated directly from one-third octave-band noise specifications provided by the turbine vendor (see Appendix B).

As discussed in Section 2.0 of the Project NIA, maximum noise emissions from the Project substation will occur when the 167 MVA transformer operates in ONAF2 mode. Noise emissions for the Project substation in ONAF2 mode are presented in Table 8. Noise emissions in Table 8 are presented in the form of octave-band sound power levels, expressed in dBZ, and total sound power levels, expressed in dBA. Noise emissions data presented in Table 8 were calculated using noise specifications supplied by a potential vendor for the Project transformer, augmented by spectral data from a widely-accepted acoustics handbook (Crocker 2007). The noise emissions data presented in Table 8 include a 5 dB penalty added to the base emissions to account for the potentially-tonal nature of the transformer noise (ISO 2003).

Table 7: Noise Emissions for Project Wind Turbine Generators (Vestas V110 2.0 MW)

Operating Mode	Hub Height Wind Speed [m/s]	Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
Mode 0 STE	10	116.5	113.7	109.5	105.5	102.2	100.2	98.6	94.9	82.4	106.0
	11	117.4	114.4	109.4	104.9	101.8	100.5	98.8	95.2	82.6	106.0
	12	118.1	114.8	109.2	104.4	101.4	100.6	98.9	95.4	82.6	106.0
	13	118.7	115.2	109.2	104.1	101.2	100.8	99.1	95.7	82.7	106.0
	14	119.1	115.5	109.0	103.8	100.9	100.9	99.1	95.8	82.8	106.0
	15	119.5	115.8	108.9	103.4	100.7	101.0	99.2	95.9	82.8	106.0
	16	119.7	116.0	108.8	103.1	100.5	101.0	99.2	95.9	82.8	106.0
	17	120.1	116.2	108.7	102.8	100.2	101.1	99.3	96.0	82.8	106.0
	18	120.3	116.4	108.7	102.6	100.1	101.1	99.3	96.1	82.8	106.0
	19	120.6	116.6	108.6	102.4	99.9	101.2	99.4	96.1	82.9	106.0
	20	120.7	116.7	108.4	102.1	99.7	101.2	99.4	96.1	82.8	106.0
Mode 1 STE	10	114.2	111.9	107.5	103.6	100.2	97.8	96.4	92.8	80.2	103.8
	11	115.2	112.4	107.3	102.9	99.7	98.2	96.6	93.1	80.4	103.8
	12	115.8	112.8	107.1	102.4	99.3	98.4	96.7	93.3	80.4	103.8
	13	116.4	113.2	106.9	102.0	99.0	98.5	96.8	93.4	80.4	103.8
	14	116.8	113.4	106.8	101.6	98.7	98.6	96.9	93.6	80.5	103.8
	15	117.3	113.8	106.8	101.3	98.6	98.7	97.0	93.7	80.6	103.8
	16	117.5	113.9	106.6	100.9	98.3	98.7	97.0	93.8	80.6	103.8
	17	117.9	114.3	106.5	100.7	98.1	98.8	97.1	93.9	80.6	103.8
	18	118.1	114.4	106.5	100.5	97.9	98.9	97.2	94.0	80.7	103.8
	19	118.3	114.6	106.4	100.2	97.7	98.9	97.1	93.9	80.6	103.8
	20	118.6	114.8	106.3	100.0	97.6	99.0	97.2	94.0	80.7	103.8
Mode 2 STE	10	112.0	109.9	104.1	99.9	96.5	94.7	93.3	90.0	77.1	100.6
	11	112.7	110.4	103.9	99.4	96.2	94.9	93.4	90.2	77.2	100.6
	12	113.2	110.7	103.8	99.0	95.9	95.0	93.5	90.4	77.2	100.6
	13	113.7	111.1	103.7	98.6	95.6	95.1	93.7	90.5	77.2	100.6
	14	114.1	111.4	103.6	98.2	95.4	95.2	93.7	90.7	77.3	100.6
	15	114.6	111.7	103.5	98.0	95.1	95.3	93.8	90.8	77.3	100.6

Table 7: Noise Emissions for Project Wind Turbine Generators (Vestas V110 2.0 MW)

Operating Mode	Hub Height Wind Speed [m/s]	Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
	16	114.9	111.9	103.4	97.7	94.9	95.4	93.9	90.9	77.4	100.6
	17	115.2	112.2	103.4	97.4	94.8	95.5	93.9	91.0	77.4	100.6
	18	115.5	112.4	103.3	97.1	94.6	95.6	94.0	91.1	77.4	100.6
	19	115.7	112.5	103.1	96.9	94.4	95.6	94.0	91.1	77.4	100.6
	20	115.8	112.6	103.1	96.7	94.2	95.6	94.0	91.1	77.4	100.6

Table 8: Noise Emissions for Project Substation

Operating Mode	Octave-Band Sound Power Level [dBZ]									Total Sound Power Level [dBA]
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
ONAF2	96.2	102.2	104.2	99.2	99.2	93.2	88.2	83.2	76.2	99.6

As discussed in Section 3.3.2 of this report, Rule 012 sets out a two-part test for LFN issues. The second part of the LFN test requires the presence of a clear tone in a one-third octave-band at or below 250 Hz. Rule 012 sets out a specific procedure for testing for a clear tone. If there is no such tone, then no LFN issues can exist.

The Rule 012 procedure for identifying a clear tone was applied to the vendor-supplied one-third octave-band noise emissions specifications reproduced in Appendix B. Based on the Rule 012 definition, the V110 2.0 MW noise emissions do not include a clear tone at or below 250 Hz for any of the relevant operating modes (i.e., Mode 0 STE, Mode 1 STE, and Mode 2 STE). As such, Project noise sources cannot produce LFN issues, regardless of the outcome of the first part of the LFN test. In other words, even if the difference between dBC and dBA noise levels were found to be greater than 20, the absence of a clear tone in the Project noise emissions precludes the presence of a Project-related LFN issue.

5.0 ASSESSMENT RESULTS

5.1 Baseline Case

5.1.1 Broadband Noise

As discussed in Section 3.1 of this report, Baseline Case cumulative noise levels were calculated by summing the contribution from natural and non-industrial sources with the contribution from the 147 existing and approved industrial facilities listed in Table 5. The noise contribution from natural and non-industrial sources was characterized using Rule 012 ASL values (see Table 3) and the noise contribution from existing and approved industrial facilities was characterized using a computer model.

Baseline Case cumulative noise levels for the daytime period are presented in Table 9. Baseline Case cumulative noise levels for the nighttime period are presented in Table 10. Figure 2 presents Baseline Case cumulative noise level contours for the daytime period at a height of 1.5 m above ground (i.e., corresponding to the receptor height for a one-storey dwelling). Figure 3 presents Baseline Case cumulative noise level contours for the daytime period at a height of 4.5 m above ground (i.e., corresponding to the receptor height for a two-storey dwelling). Figure 4 presents Baseline Case cumulative noise level contours for the nighttime period at a height of 1.5 m above ground. Figure 5 presents Baseline Case cumulative noise level contours for the nighttime period at a height of 4.5 m above ground.

Table 9: Baseline Case Cumulative Noise Levels – Daytime

Receptor Identification Code	Ambient Sound Level [dBA]	Existing and Approved Industrial Facilities [dBA]	Baseline Case Cumulative Noise Level [dBA]
R004	45	32	45
R005	45	12	45
R007	45	30	45
R008	45	28	45
R009	45	35	45
R010	45	14	45
R012	45	32	45
R014	45	30	45
R015	45	26	45
R016	45	24	45
R017	45	38	46

Table 9: Baseline Case Cumulative Noise Levels – Daytime

Receptor Identification Code	Ambient Sound Level [dBA]	Existing and Approved Industrial Facilities [dBA]	Baseline Case Cumulative Noise Level [dBA]
R018	45	37	46
R019	45	23	45
R022	45	12	45
R024	45	13	45
R027	45	16	45
R030	45	16	45
R031	45	8	45
R032	45	7	45
R033	45	19	45
R034	45	19	45
R036	45	15	45
R040	45	29	45
R042	45	12	45
R045	45	19	45
R046	45	16	45
R047	45	24	45
R048	45	16	45
R049	45	7	45
R050	45	7	45
R051	45	10	45
R052	45	14	45
R053	45	8	45
R054	45	24	45
R055	45	8	45
R056	45	13	45
R060	45	22	45
R061	45	37	46
R063	45	9	45
R064	45	6	45
R065	45	8	45
R066	45	24	45
R067	45	23	45
R068	45	25	45
R070	45	15	45
R071	45	9	45
R072	45	11	45
R079	45	12	45
R081	45	24	45
R082	45	24	45
R083	45	10	45
R085	45	20	45

Table 9: Baseline Case Cumulative Noise Levels – Daytime

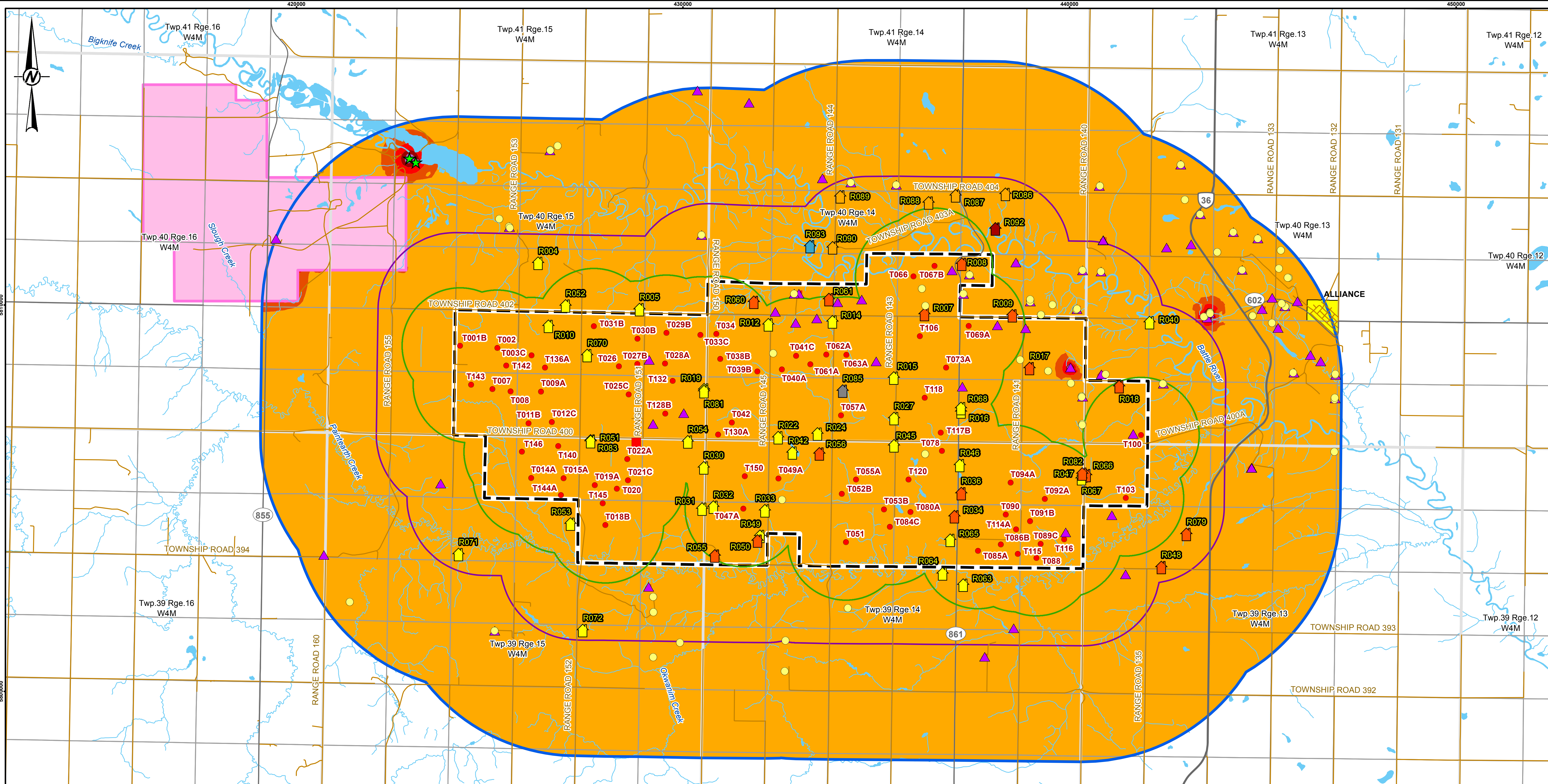
Receptor Identification Code	Ambient Sound Level [dBA]	Existing and Approved Industrial Facilities [dBA]	Baseline Case Cumulative Noise Level [dBA]
R086	45	21	45
R087	45	19	45
R088	45	23	45
R089	45	28	45
R090	45	21	45
R092	45	22	45
R093	45	18	45

Table 10: Baseline Case Cumulative Noise Levels – Nighttime

Receptor Identification Code	Ambient Sound Level [dBA]	Existing and Approved Industrial Facilities [dBA]	Baseline Case Cumulative Noise Level [dBA]
R004	35	32	37
R005	35	12	35
R007	35	30	36
R008	35	28	36
R009	35	35	38
R010	35	14	35
R012	35	32	37
R014	35	30	36
R015	35	26	36
R016	35	24	35
R017	35	38	40
R018	35	37	39
R019	35	23	35
R022	35	12	35
R024	35	13	35
R027	35	16	35
R030	35	16	35
R031	35	8	35
R032	35	7	35
R033	35	19	35
R034	35	19	35
R036	35	15	35
R040	35	29	36
R042	35	12	35
R045	35	19	35
R046	35	16	35
R047	35	24	35
R048	35	16	35
R049	35	7	35

Table 10: Baseline Case Cumulative Noise Levels – Nighttime

Receptor Identification Code	Ambient Sound Level [dBA]	Existing and Approved Industrial Facilities [dBA]	Baseline Case Cumulative Noise Level [dBA]
R050	35	7	35
R051	35	10	35
R052	35	14	35
R053	35	8	35
R054	35	24	35
R055	35	8	35
R056	35	13	35
R060	35	22	35
R061	35	37	39
R063	35	9	35
R064	35	6	35
R065	35	8	35
R066	35	24	35
R067	35	23	35
R068	35	25	35
R070	35	15	35
R071	35	9	35
R072	35	11	35
R079	35	12	35
R081	35	24	35
R082	35	24	35
R083	35	10	35
R085	35	20	35
R086	35	21	35
R087	35	19	35
R088	35	23	35
R089	35	28	36
R090	35	21	35
R092	35	22	35
R093	35	18	35



LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)
- 65 - 70 dB(A)
- > 70 dB(A)

0 2 4
1:100,000 KILOMETRES

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

PROJECT
HALKIRK 2 WIND PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

TITLE
BASELINE CASE NOISE LEVELS
RECEPTOR HEIGHT 1.5 m - DAYTIME

PROJECT NO.	CONTROL	REV.	FIGURE
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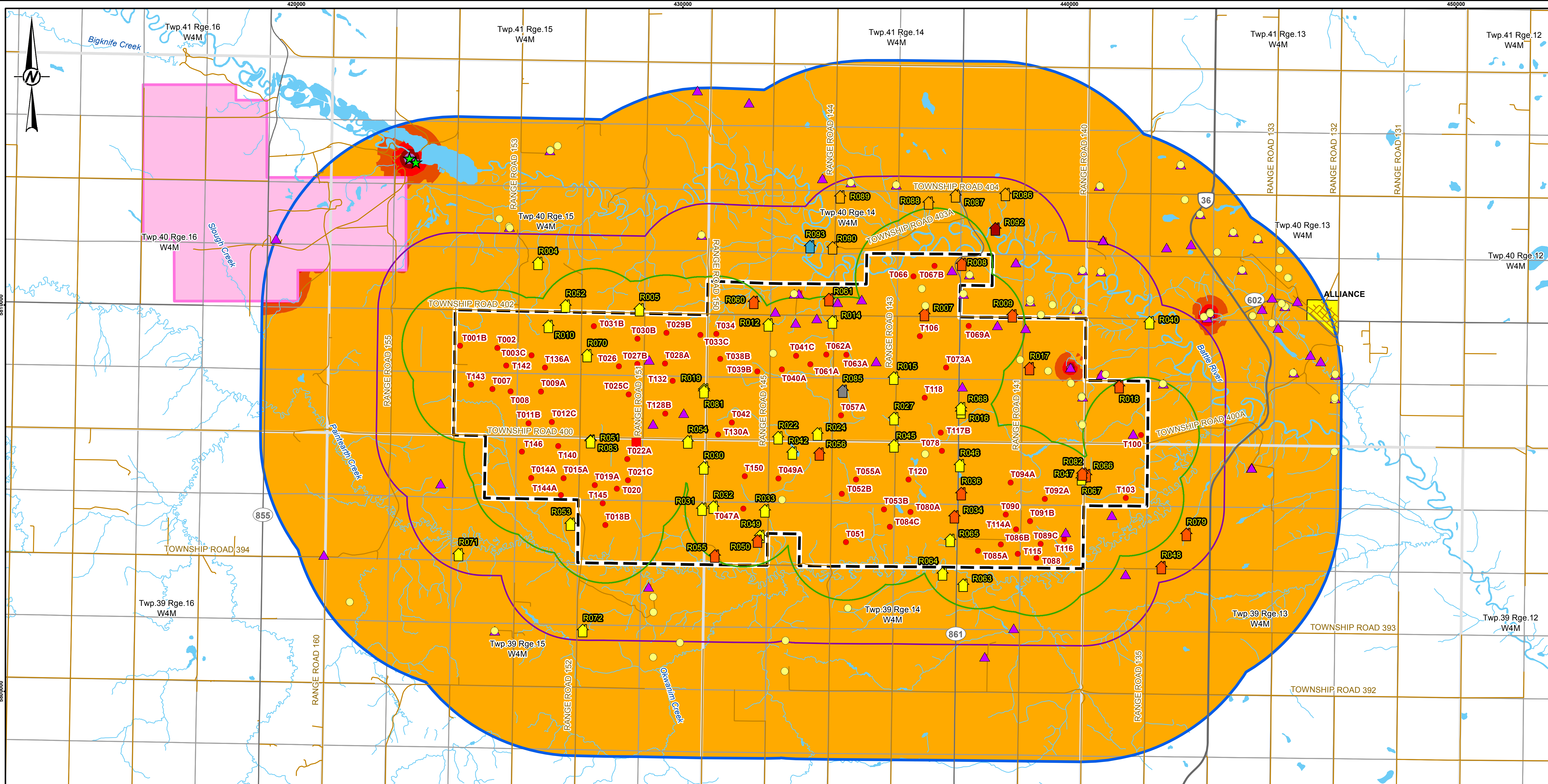

LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)
- 65 - 70 dB(A)
- > 70 dB(A)

0 2 4
1:100,000 KILOMETRES

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

PROJECT
HALKIRK 2 WIND PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

TITLE
BASELINE CASE NOISE LEVELS
RECEPTOR HEIGHT 4.5 m - DAYTIME

PROJECT NO.	CONTROL	REV.	FIGURE
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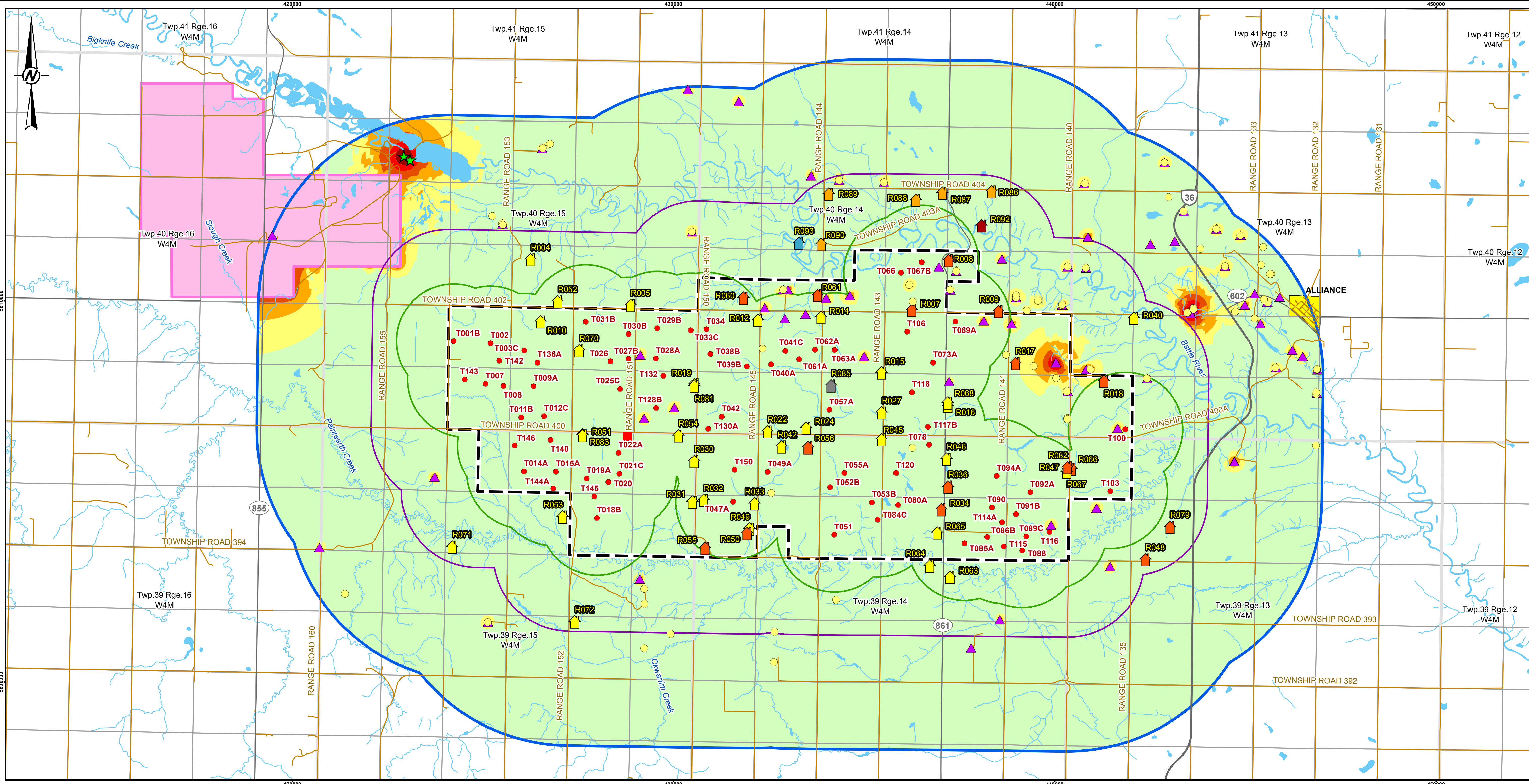

LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 35 - 40 dB(A)
- 40 - 45 dB(A)
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)

0 2 4
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DATUM: NAD83 PROJECTION: UTM ZONE 12

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PROJECT
HALKIRK 2 WIND PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

TITLE
BASELINE CASE NOISE LEVELS
RECEPTOR HEIGHT 1.5 m - NIGHTTIME

PROJECT NO.	CONTROL	REV.	FIGURE
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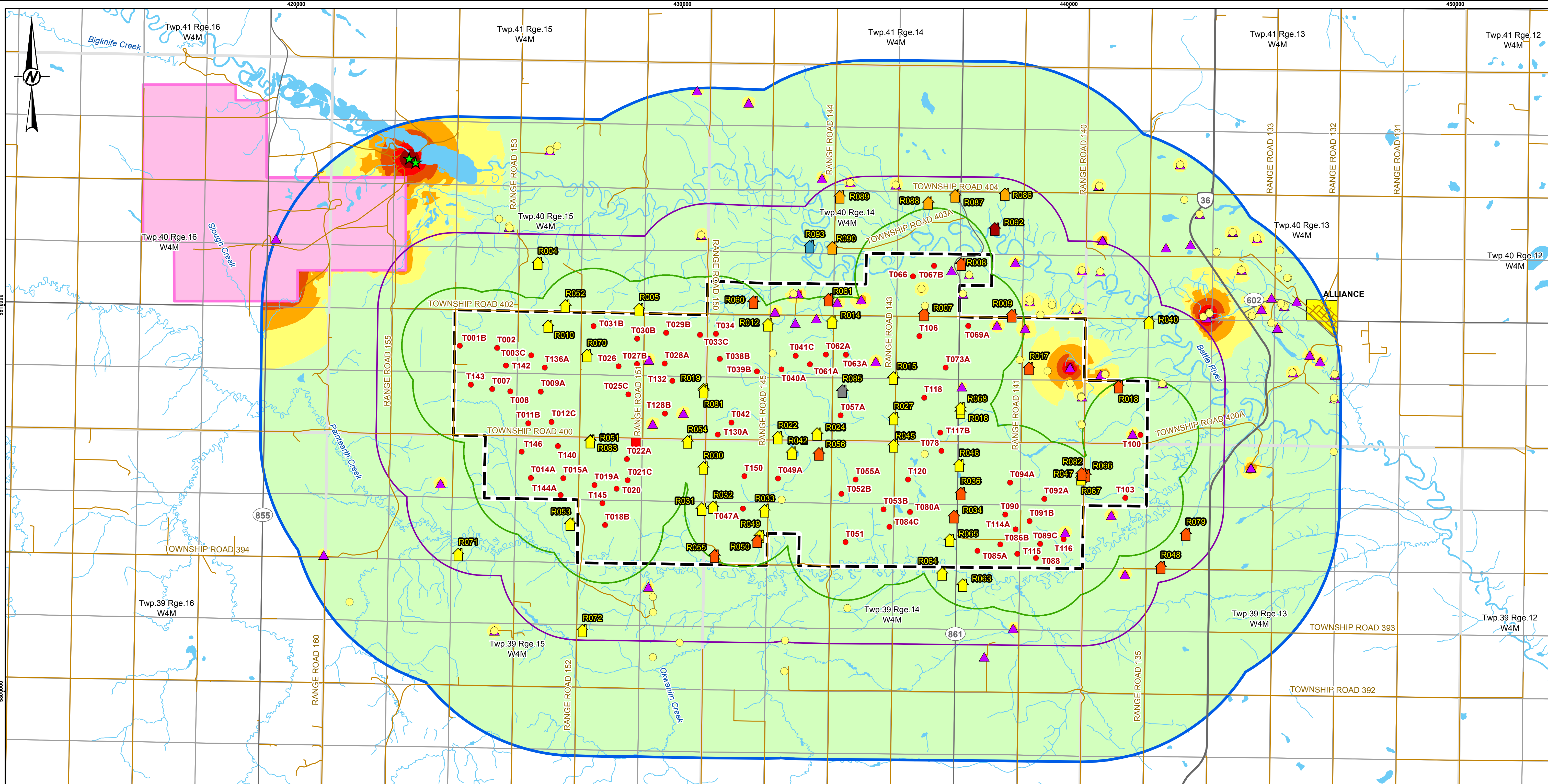

LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 35 - 40 dB(A)
- 40 - 45 dB(A)
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)

0 2 4
1:100,000 KILOMETRES

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
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CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
BASELINE CASE NOISE LEVELS RECEPTOR HEIGHT 4.5 m - NIGHTTIME

PROJECT NO.	CONTROL	REV.	FIGURE
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Table 9 shows that Baseline Case cumulative noise levels at receptors are predicted to range between 45 dBA and 46 dBA during the daytime period. There are no receptors at which Baseline Case cumulative noise levels are predicted to exceed the daytime PSL of 50 dBA, which is applicable at all receptors (see Table 3). In other words, Baseline Case cumulative noise levels are predicted to comply with Rule 012 during the daytime period.

Table 10 shows that Baseline Case cumulative noise levels at receptors are predicted to range between 35 dBA and 40 dBA during the nighttime period. There are no receptors at which Baseline Case cumulative noise levels are predicted to exceed the nighttime PSL of 40 dBA, which is applicable at all receptors (see Table 3). In other words, Baseline Case cumulative noise levels are predicted to comply with Rule 012 during the nighttime period.

5.1.2 Low Frequency Noise

As discussed in Section 3.3.2 of this report, Rule 012 sets out a two-part test for LFN issues. The first part of the LFN test compares noise levels expressed in dBA to noise levels expressed in dBC. It is understood that the first part of the LFN test should be applied to cumulative noise levels – i.e., noise levels that include the contribution from natural and non-industrial sources and from industrial facilities – but Rule 012 does not provide ASL values in dBC. Therefore, when applying the first part of the LFN test, it is necessary to omit the noise contribution from natural and non-industrial sources. In the case of the Baseline Case for the Project NIA, this meant applying the first part of the LFN test to the noise contribution from the 147 existing and approved industrial facilities listed in Table 5.

Table 11 presents a Baseline Case LFN analysis based on the first part of two-part LFN test and omitting the contribution from natural and non-industrial sources. Because the 147 existing and approved facilities considered in the Baseline Case are assumed to operate continuously 24 hours per day, there is no need to conduct separate LFN analyses for the daytime and nighttime periods.

Table 11: Baseline Case Low Frequency Noise Analysis

Receptor Identification Code	Existing and Approved Industrial Facilities [dBA]	Existing and Approved Industrial Facilities [dBC]	Difference: dBC minus dBA	Rule 012 LFN Threshold	Potential for LFN Issue
R004	32	55	23	20	yes
R005	12	27	15	20	no
R007	30	43	13	20	no
R008	28	42	14	20	no
R009	35	52	17	20	no
R010	14	30	16	20	no
R012	32	46	14	20	no
R014	30	43	13	20	no
R015	26	41	15	20	no
R016	24	39	15	20	no
R017	38	56	18	20	no
R018	37	54	17	20	no
R019	23	38	15	20	no
R022	12	33	21	20	yes
R024	13	34	21	20	yes
R027	16	34	18	20	no

Table 11: Baseline Case Low Frequency Noise Analysis

Receptor Identification Code	Existing and Approved Industrial Facilities [dBA]	Existing and Approved Industrial Facilities [dBC]	Difference: dBC minus dBA	Rule 012 LFN Threshold	Potential for LFN Issue
R030	16	33	17	20	no
R031	8	24	16	20	no
R032	7	23	16	20	no
R033	19	34	15	20	no
R034	19	42	23	20	yes
R036	15	35	20	20	yes
R040	29	46	17	20	no
R042	12	33	21	20	yes
R045	19	42	23	20	yes
R046	16	36	20	20	yes
R047	24	40	16	20	no
R048	16	28	12	20	no
R049	7	23	16	20	no
R050	7	22	15	20	no
R051	10	24	14	20	no
R052	14	30	16	20	no
R053	8	27	19	20	no
R054	24	38	14	20	no
R055	8	23	15	20	no
R056	13	33	20	20	yes
R060	22	34	12	20	no
R061	37	49	12	20	no
R063	9	23	14	20	no
R064	6	22	16	20	no
R065	8	27	19	20	no
R066	24	40	16	20	no
R067	23	40	17	20	no
R068	25	39	14	20	no
R070	15	33	18	20	no
R071	9	23	14	20	no
R072	11	29	18	20	no
R079	12	27	15	20	no
R081	24	39	15	20	no
R082	24	41	17	20	no
R083	10	24	14	20	no
R085	20	37	17	20	no
R086	21	43	22	20	yes
R087	19	38	19	20	no
R088	23	39	16	20	no
R089	28	42	14	20	no

Table 11: Baseline Case Low Frequency Noise Analysis

Receptor Identification Code	Existing and Approved Industrial Facilities [dBA]	Existing and Approved Industrial Facilities [dBC]	Difference: dBC minus dBA	Rule 012 LFN Threshold	Potential for LFN Issue
R090	21	36	15	20	no
R092	22	38	16	20	no
R093	18	32	14	20	no

Results from Table 11 suggest that the difference between Baseline Case noise levels expressed in dBA and dBC is greater than or equal to 20 for 10 receptors. At these 10 receptors, there is a potential for Baseline Case LFN issues based on the first part of the Rule 012 LFN test. However, it is likely that the difference between Baseline Case dBA and dBC noise levels would be reduced if ASL values were included in the LFN analysis. In addition, the first part of the LFN test only identifies potential LFN issues. As discussed in Section 3.3.2 of this report, both the first part and the second part of the Rule 012 LFN test must be satisfied for a LFN issue to exist. Based on field measurements conducted in the vicinity of the Project (see Appendix A), there is no reason to expect a clear tone satisfying the second part of the LFN test to be present in the Baseline Case environment. Therefore, according to Rule 012 criteria, it is unlikely that a Baseline Case LFN issue exists for any of the receptors considered in the Project NIA.

5.2 Application Case

5.2.1 Broadband Noise

As discussed in Section 3.2 of this report, Application Case cumulative noise levels were calculated by summing the contribution from natural and non-industrial sources, the contribution from existing and approved industrial facilities, and the contribution from the Project itself under planned maximum operating conditions. The noise contribution from natural and non-industrial sources was characterized using Rule 012 ASL values (see Table 3). Noise contributions from existing and approved industrial facilities and from the Project itself were characterized using computer models.

Application Case cumulative noise levels for the daytime period are presented in Table 12. Application Case cumulative noise levels for the nighttime period are presented in Table 13. As discussed in Section 4.2 of this report, Application Case cumulative noise levels are presented for hub height wind speeds ranging from 10 m/s up to 20 m/s. Table 14 summarizes the data from Table 12 and Table 13 by presenting the maximum daytime and nighttime Application Case cumulative noise level for each receptor across all relevant hub height wind speeds.

Table 12: Application Case Cumulative Noise Levels – Daytime

Receptor Identification Code	ASL [dBA]	Existing and Approved Industrial Facilities [dBA]	Project Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]											Application Case Cumulative Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]										
			10	11	12	13	14	15	16	17	18	19	20	10	11	12	13	14	15	16	17	18	19	20
R004	45	32	30	30	30	30	30	30	30	30	30	30	30	45	45	45	45	45	45	45	45	45	45	45
R005	45	12	39	39	39	39	39	39	39	39	39	39	39	46	46	46	46	46	46	46	46	46	46	46
R007	45	30	41	41	41	41	41	41	41	41	41	41	40	47	47	47	47	47	47	47	47	47	47	46
R008	45	28	38	38	38	38	38	38	38	37	37	37	37	46	46	46	46	46	46	46	46	46	46	46
R009	45	35	33	33	33	33	33	33	33	33	33	33	33	46	46	46	46	46	46	46	46	46	46	46
R010	45	14	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R012	45	32	38	38	37	37	37	37	37	37	37	37	37	46	46	46	46	46	46	46	46	46	46	46
R014	45	30	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R015	45	26	37	37	37	37	37	37	37	37	37	37	37	46	46	46	46	46	46	46	46	46	46	46
R016	45	24	39	39	39	39	39	39	39	39	39	39	39	46	46	46	46	46	46	46	46	46	46	46
R017	45	38	32	32	32	32	32	32	32	32	32	32	31	46	46	46	46	46	46	46	46	46	46	46
R018	45	37	31	31	31	31	31	31	30	30	30	30	30	46	46	46	46	46	46	46	46	46	46	46
R019	45	23	40	40	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R022	45	12	37	37	37	37	37	37	37	37	37	37	37	46	46	46	46	46	46	46	46	46	46	46
R024	45	13	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R027	45	16	38	38	37	37	37	37	37	37	37	37	37	46	46	46	46	46	46	46	46	46	46	46
R030	45	16	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R031	45	8	36	36	36	36	36	36	36	36	36	36	35	46	46	46	46	46	46	46	46	46	46	45
R032	45	7	37	37	37	37	37	37	37	37	37	37	37	46	46	46	46	46	46	46	46	46	46	46
R033	45	19	41	41	40	41	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R034	45	19	40	40	39	39	39	39	39	39	39	39	39	46	46	46	46	46	46	46	46	46	46	46
R036	45	15	39	39	39	39	39	39	39	39	39	39	39	46	46	46	46	46	46	46	46	46	46	46
R040	45	29	16	15	15	15	15	15	15	15	15	15	14	45	45	45	45	45	45	45	45	45	45	45
R042	45	12	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R045	45	19	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R046	45	16	40	40	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R047	45	24	37	37	37	37	37	37	37	37	37	37	36	46	46	46	46	46	46	46	46	46	46	46
R048	45	16	29	28	28	28	28	28	28	28	28	28	28	45	45	45	45	45	45	45	45	45	45	45
R049	45	7	36	36	36	36	36	36	36	36	36	36	36	46	46	46	46	46	46	46	46	46	46	46

Table 12: Application Case Cumulative Noise Levels – Daytime

Receptor Identification Code	ASL [dBA]	Existing and Approved Industrial Facilities [dBA]	Project Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]											Application Case Cumulative Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]										
			10	11	12	13	14	15	16	17	18	19	20	10	11	12	13	14	15	16	17	18	19	20
R050	45	7	36	36	36	36	36	36	36	36	36	36	35	46	46	46	46	46	46	46	46	46	46	45
R051	45	10	41	41	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R052	45	14	36	36	36	36	36	36	36	36	36	36	36	46	46	46	46	46	46	46	46	46	46	46
R053	45	8	40	40	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R054	45	24	39	39	39	39	39	39	39	39	39	39	39	46	46	46	46	46	46	46	46	46	46	46
R055	45	8	32	32	31	31	31	31	31	31	31	31	31	45	45	45	45	45	45	45	45	45	45	45
R056	45	13	39	39	39	39	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R060	45	22	35	35	35	35	35	35	35	35	35	35	34	45	45	45	45	45	45	45	45	45	45	45
R061	45	37	36	36	35	35	35	35	35	35	35	35	35	46	46	46	46	46	46	46	46	46	46	46
R063	45	9	36	36	36	36	36	36	36	36	36	36	36	46	46	46	46	46	46	46	46	46	46	46
R064	45	6	35	35	35	35	35	35	35	35	35	35	35	45	45	45	45	45	45	45	45	45	45	45
R065	45	8	39	39	39	39	39	39	38	38	38	39	38	46	46	46	46	46	46	46	46	46	46	46
R066	45	24	37	37	37	37	37	37	37	37	36	36	36	46	46	46	46	46	46	46	46	46	46	46
R067	45	23	36	36	36	36	36	36	36	36	36	36	36	46	46	46	46	46	46	46	46	46	46	46
R068	45	25	38	38	38	38	38	38	38	38	38	38	38	46	46	46	46	46	46	46	46	46	46	46
R070	45	15	40	40	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R071	45	9	27	27	26	26	26	26	26	26	26	26	26	45	45	45	45	45	45	45	45	45	45	45
R072	45	11	26	26	25	26	25	25	25	25	26	26	26	45	45	45	45	45	45	45	45	45	45	45
R079	45	12	27	27	27	27	27	27	27	27	27	27	27	45	45	45	45	45	45	45	45	45	45	45
R081	45	24	40	40	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R082	45	24	37	37	37	37	37	36	36	36	36	36	36	46	46	46	46	46	46	46	46	46	46	46
R083	45	10	41	41	40	41	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R085	45	20	40	40	40	40	40	40	40	40	40	40	40	46	46	46	46	46	46	46	46	46	46	46
R086	45	21	25	25	25	25	25	24	24	24	24	24	24	45	45	45	45	45	45	45	45	45	45	45
R087	45	19	28	28	28	28	28	27	27	27	27	27	27	45	45	45	45	45	45	45	45	45	45	45
R088	45	23	30	30	30	30	30	29	29	29	29	29	29	45	45	45	45	45	45	45	45	45	45	45
R089	45	28	26	26	26	26	26	26	26	26	26	26	26	45	45	45	45	45	45	45	45	45	45	45
R090	45	21	30	30	29	29	29	29	29	29	29	29	29	45	45	45	45	45	45	45	45	45	45	45
R092	45	22	27	27	27	27	27	27	27	27	27	27	27	45	45	45	45	45	45	45	45	45	45	45

Table 12: Application Case Cumulative Noise Levels – Daytime

Receptor Identification Code	ASL [dBA]	Existing and Approved Industrial Facilities [dBA]	Project Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]											Application Case Cumulative Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]										
			10	11	12	13	14	15	16	17	18	19	20	10	11	12	13	14	15	16	17	18	19	20
R093	45	18	27	27	26	26	26	26	26	26	26	26	26	45	45	45	45	45	45	45	45	45	45	45

Table 13: Application Case Cumulative Noise Levels – Nighttime

Receptor Identification Code	ASL [dBA]	Existing and Approved Industrial Facilities [dBA]	Project Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]											Application Case Cumulative Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]										
			10	11	12	13	14	15	16	17	18	19	20	10	11	12	13	14	15	16	17	18	19	20
R004	35	32	29	29	28	28	28	28	28	28	28	28	28	37	37	37	37	37	37	37	37	37	37	37
R005	35	12	37	37	37	37	37	37	37	37	37	37	37	39	39	39	39	39	39	39	39	39	39	39
R007	35	30	37	37	37	37	37	37	37	37	37	37	37	40	40	40	40	40	40	40	40	40	40	40
R008	35	28	36	36	35	35	35	35	35	35	35	35	35	39	39	38	38	38	38	38	38	38	38	38
R009	35	35	31	31	31	31	31	31	30	30	30	30	30	39	39	39	39	39	39	39	39	39	39	39
R010	35	14	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R012	35	32	35	35	35	35	35	35	35	35	35	35	35	39	39	39	39	39	39	39	39	39	39	39
R014	35	30	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R015	35	26	35	35	35	35	35	35	35	35	35	35	35	38	38	38	38	38	38	38	38	38	38	38
R016	35	24	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R017	35	38	30	30	30	30	29	29	29	29	29	29	29	40	40	40	40	40	40	40	40	40	40	40
R018	35	37	29	29	29	29	28	28	28	28	28	28	28	40	40	40	40	39	39	39	39	39	39	39
R019	35	23	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40
R022	35	12	35	35	35	35	35	35	35	35	35	35	35	38	38	38	38	38	38	38	38	38	38	38
R024	35	13	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R027	35	16	35	35	35	35	35	35	35	35	35	35	35	38	38	38	38	38	38	38	38	38	38	38
R030	35	16	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R031	35	8	34	33	33	33	33	33	33	33	33	33	33	38	37	37	37	37	37	37	37	37	37	37
R032	35	7	35	35	35	35	35	35	35	35	35	35	35	38	38	38	38	38	38	38	38	38	38	38
R033	35	19	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40

Table 13: Application Case Cumulative Noise Levels – Nighttime

Receptor Identification Code	ASL [dBA]	Existing and Approved Industrial Facilities [dBA]	Project Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]											Application Case Cumulative Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]										
			10	11	12	13	14	15	16	17	18	19	20	10	11	12	13	14	15	16	17	18	19	20
R034	35	19	38	37	37	37	37	37	37	37	37	37	37	40	39	39	39	39	39	39	39	39	39	39
R036	35	15	37	37	37	37	37	37	37	37	37	37	37	39	39	39	39	39	39	39	39	39	39	39
R040	35	29	14	13	13	13	13	13	13	13	12	12	12	36	36	36	36	36	36	36	36	36	36	36
R042	35	12	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R045	35	19	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R046	35	16	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40
R047	35	24	35	35	35	35	35	35	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R048	35	16	27	26	26	26	26	26	26	26	26	26	26	36	36	36	36	36	36	36	36	36	36	36
R049	35	7	34	34	34	34	34	34	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R050	35	7	34	34	34	34	34	34	33	33	33	33	33	38	38	38	38	38	38	37	37	37	37	37
R051	35	10	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40
R052	35	14	34	34	34	34	34	34	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R053	35	8	38	38	38	37	37	37	37	37	37	37	37	40	40	40	39	39	39	39	39	39	39	39
R054	35	24	37	37	37	37	37	37	37	37	37	37	37	39	39	39	39	39	39	39	39	39	39	39
R055	35	8	30	29	29	29	29	29	29	29	29	29	29	36	36	36	36	36	36	36	36	36	36	36
R056	35	13	37	37	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R060	35	22	33	33	33	33	33	33	32	32	32	32	32	37	37	37	37	37	37	37	37	37	37	37
R061	35	37	34	33	33	33	33	33	33	33	33	33	33	40	40	40	40	40	40	40	40	40	40	40
R063	35	9	34	34	34	34	34	34	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R064	35	6	33	33	33	33	32	33	32	32	32	32	32	37	37	37	37	37	37	37	37	37	37	37
R065	35	8	37	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R066	35	24	35	35	35	35	35	35	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R067	35	23	34	34	34	34	34	34	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R068	35	25	36	36	36	36	36	36	36	36	36	36	36	39	39	39	39	39	39	39	39	39	39	39
R070	35	15	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40
R071	35	9	25	24	24	24	24	24	24	24	24	24	24	35	35	35	35	35	35	35	35	35	35	35
R072	35	11	23	23	23	23	23	23	23	23	23	23	23	35	35	35	35	35	35	35	35	35	35	35
R079	35	12	25	25	25	25	25	25	25	25	25	24	24	35	35	35	35	35	35	35	35	35	35	35
R081	35	24	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40

Table 13: Application Case Cumulative Noise Levels – Nighttime

Receptor Identification Code	ASL [dBA]	Existing and Approved Industrial Facilities [dBA]	Project Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]											Application Case Cumulative Noise Level [dBA] as a Function of Hub Height Wind Speed [m/s]										
			10	11	12	13	14	15	16	17	18	19	20	10	11	12	13	14	15	16	17	18	19	20
R082	35	24	35	35	35	34	34	34	34	34	34	34	34	38	38	38	38	38	38	38	38	38	38	38
R083	35	10	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40
R085	35	20	38	38	38	38	38	38	38	38	38	38	38	40	40	40	40	40	40	40	40	40	40	40
R086	35	21	23	22	22	22	22	22	22	22	22	22	22	35	35	35	35	35	35	35	35	35	35	35
R087	35	19	26	26	25	25	25	25	25	25	25	25	25	36	36	36	36	36	36	36	36	36	36	36
R088	35	23	28	28	27	27	27	27	27	27	27	27	27	36	36	36	36	36	36	36	36	36	36	36
R089	35	28	24	24	24	24	24	24	24	24	24	23	24	36	36	36	36	36	36	36	36	36	36	36
R090	35	21	28	27	27	27	27	27	27	27	27	27	27	36	36	36	36	36	36	36	36	36	36	36
R092	35	22	25	25	25	24	24	24	24	24	24	24	24	36	36	36	36	36	36	36	36	36	36	36
R093	35	18	25	24	24	24	24	24	24	24	24	24	24	35	35	35	35	35	35	35	35	35	35	35

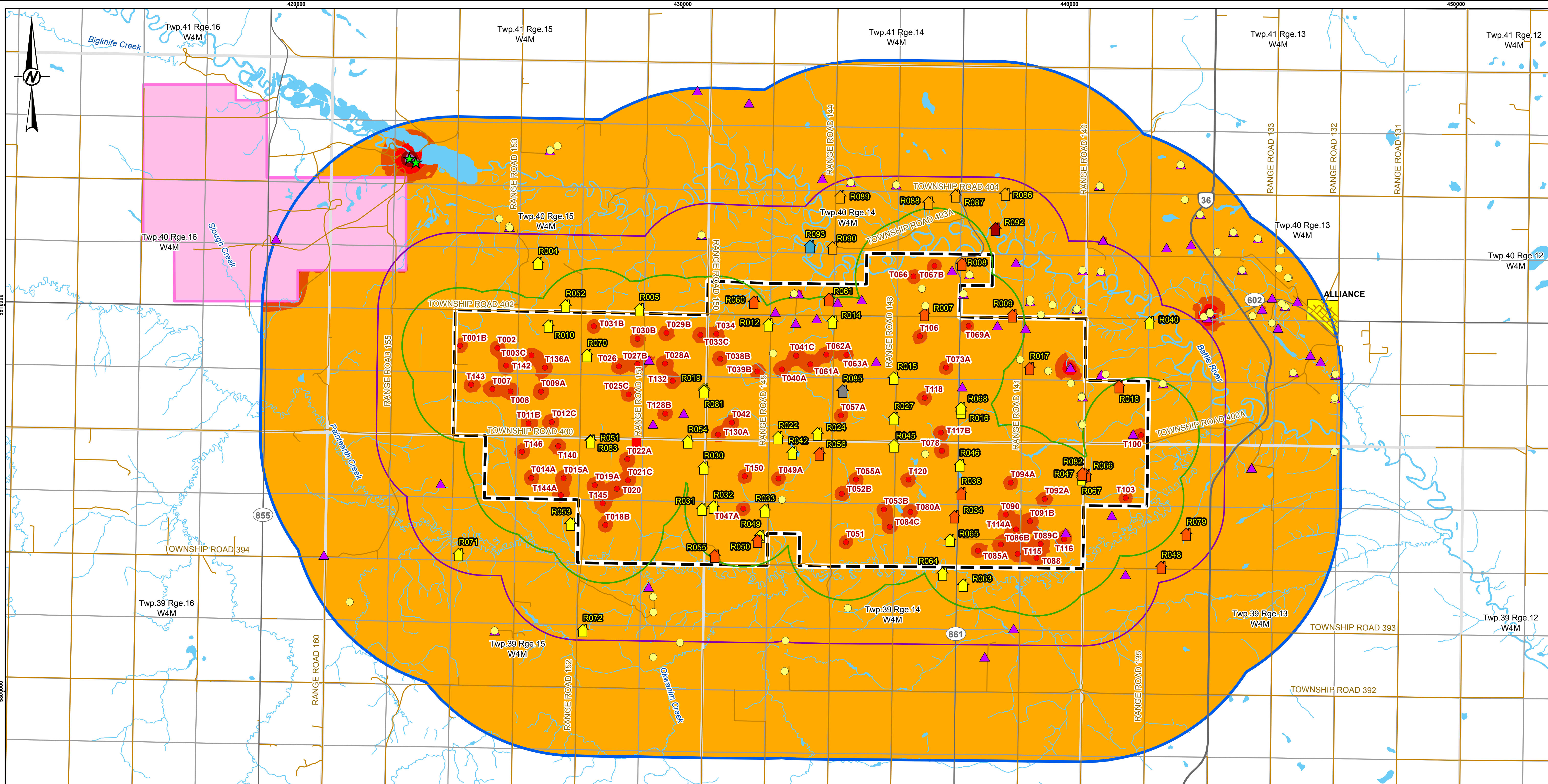
Table 14: Application Case Cumulative Noise Levels – Summary

Receptor Identification Code	Maximum Application Case Cumulative Noise Level [dBA]	
	Daytime	Nighttime
R004	45	37
R005	46	39
R007	47	40
R008	46	39
R009	46	39
R010	46	39
R012	46	39
R014	46	39
R015	46	38
R016	46	39
R017	46	40
R018	46	40
R019	46	40
R022	46	38
R024	46	39
R027	46	38
R030	46	39
R031	46	38
R032	46	38
R033	46	40
R034	46	40
R036	46	39
R040	45	36
R042	46	39
R045	46	39
R046	46	40
R047	46	38
R048	45	36
R049	46	38
R050	46	38
R051	46	40
R052	46	38
R053	46	40
R054	46	39
R055	45	36
R056	46	39
R060	45	37
R061	46	40
R063	46	38
R064	45	37
R065	46	39

Table 14: Application Case Cumulative Noise Levels – Summary

Receptor Identification Code	Maximum Application Case Cumulative Noise Level [dBA]	
	Daytime	Nighttime
R066	46	38
R067	46	38
R068	46	39
R070	46	40
R071	45	35
R072	45	35
R079	45	35
R081	46	40
R082	46	38
R083	46	40
R085	46	40
R086	45	35
R087	45	36
R088	45	36
R089	45	36
R090	45	36
R092	45	36
R093	45	35

Figure 6 presents Application Case cumulative noise level contours for the daytime period at a height of 1.5 m above ground (i.e., corresponding to the receptor height for a one-storey dwelling). Figure 7 presents Application Case cumulative noise level contours for the daytime period at a height of 4.5 m above ground (i.e., corresponding to the receptor height for a two-storey dwelling). Figure 8 presents Application Case cumulative noise level contours for the nighttime period at a height of 1.5 m above ground. Figure 9 presents Application Case cumulative noise level contours for the nighttime period at a height of 4.5 m above ground. The Application Case cumulative noise levels contours presented in the figures below all correspond to a hub height wind speed of 20 m/s, but the contours are generally representative of all hub height wind speeds between 10 and 20 m/s.



LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)
- 65 - 70 dB(A)
- > 70 dB(A)

0 2 4
1:100,000 KILOMETRES

CLIENT
Capital Power

CONSULTANT
Golder Associates

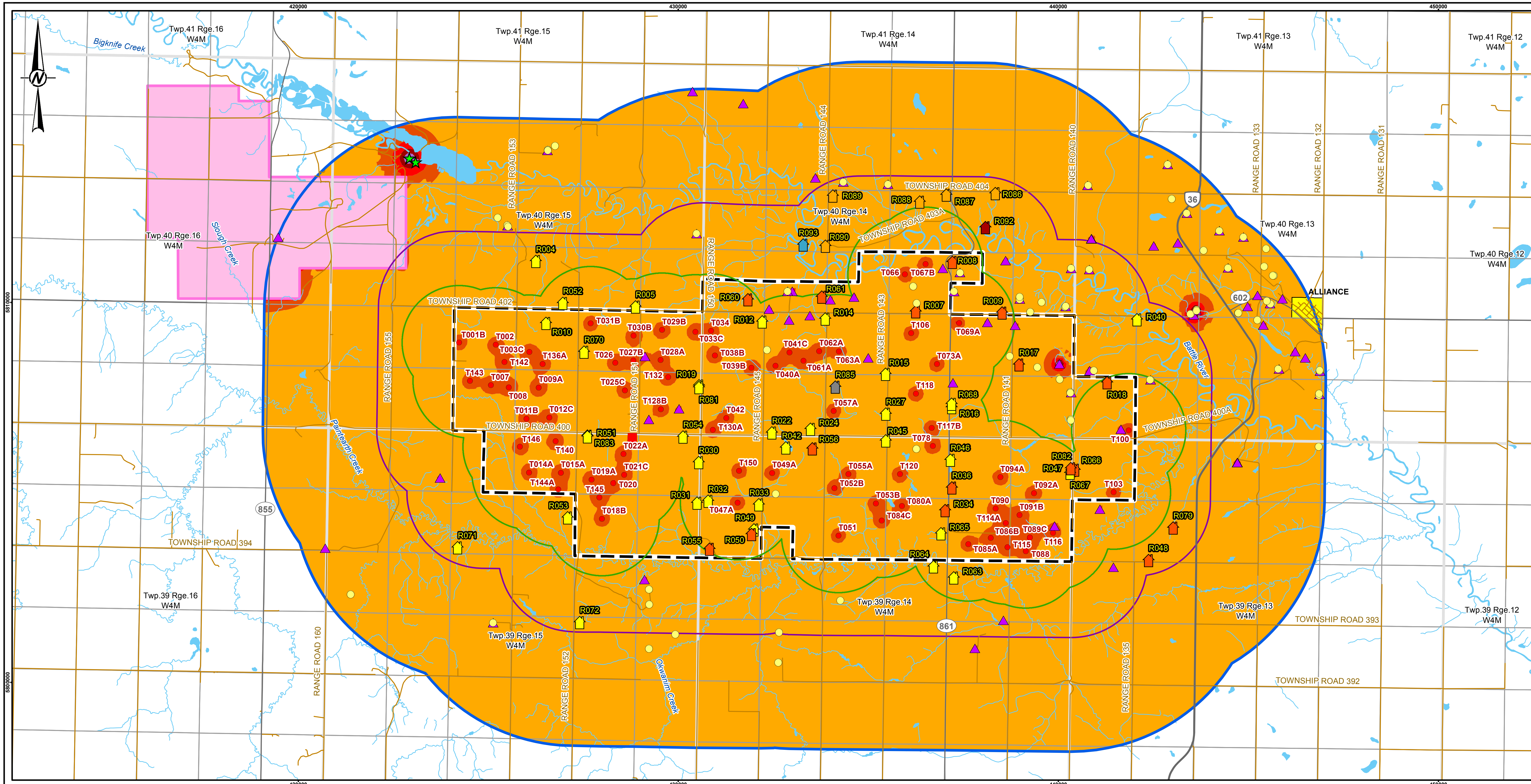
YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

REFERENCE(S)
1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
2. OIL AND GAS FACILITIES AND WELLS OBTAINED FROM IHS ENERGY INC. FOR MODEL REQUIREMENTS.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
APPLICATION CASE NOISE LEVELS RECEPTOR HEIGHT 1.5 m - DAYTIME

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	6



LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)
- 65 - 70 dB(A)
- > 70 dB(A)

0 2 4
1:100,000 KILOMETRES

CLIENT
Capital Power

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

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DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
APPLICATION CASE NOISE LEVELS RECEPTOR HEIGHT 4.5 m - DAYTIME

PROJECT NO.	CONTROL	REV.	FIGURE
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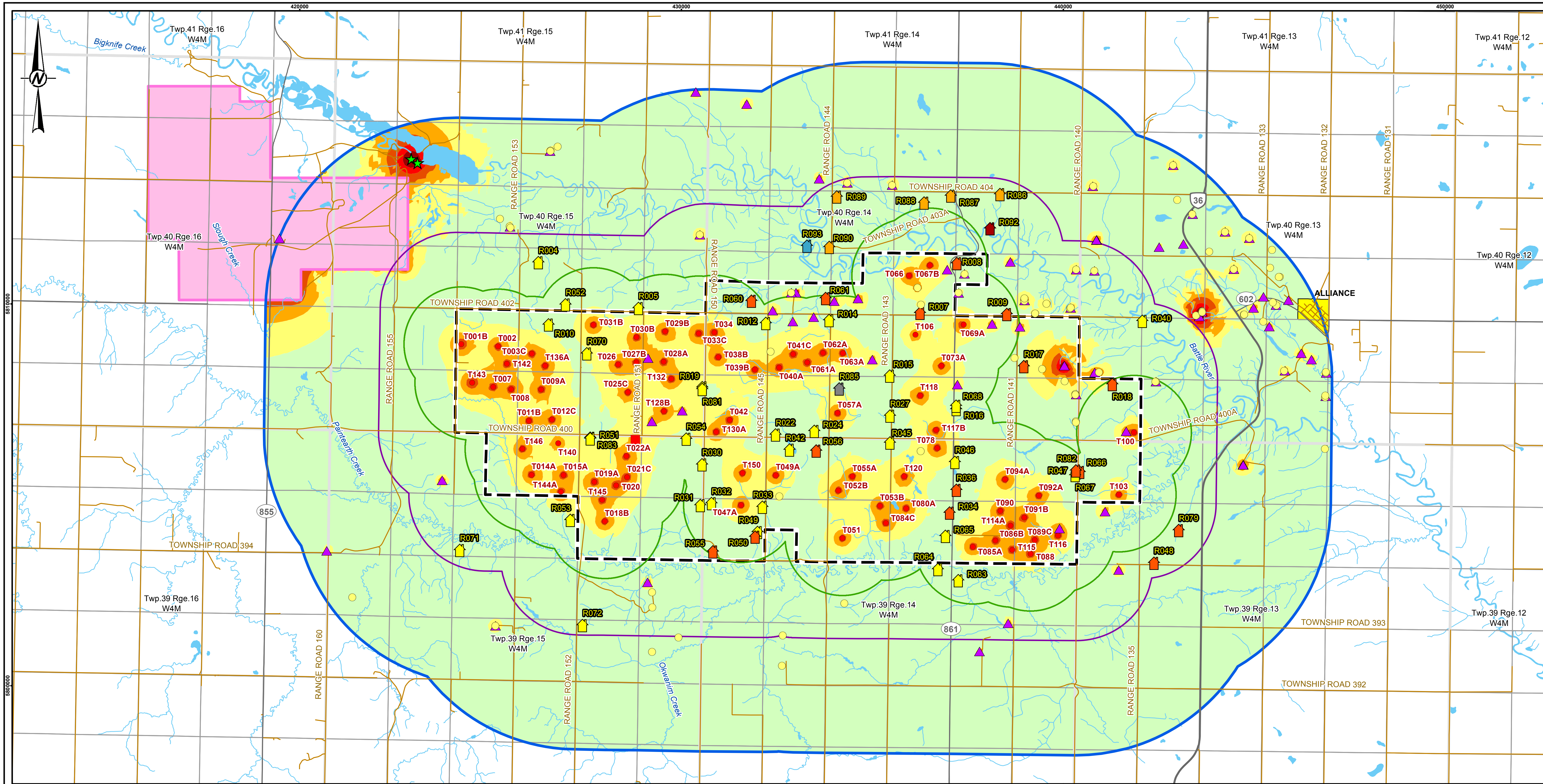

LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 35 - 40 dB(A)
- 40 - 45 dB(A)
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)

0 2 4

1:100,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-04-05
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2. OIL AND GAS FACILITIES AND WELLS OBTAINED FROM IHS ENERGY INC. FOR MODEL REQUIREMENTS.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
APPLICATION CASE NOISE LEVELS
RECEPTOR HEIGHT 1.5 m - NIGHTTIME

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	8

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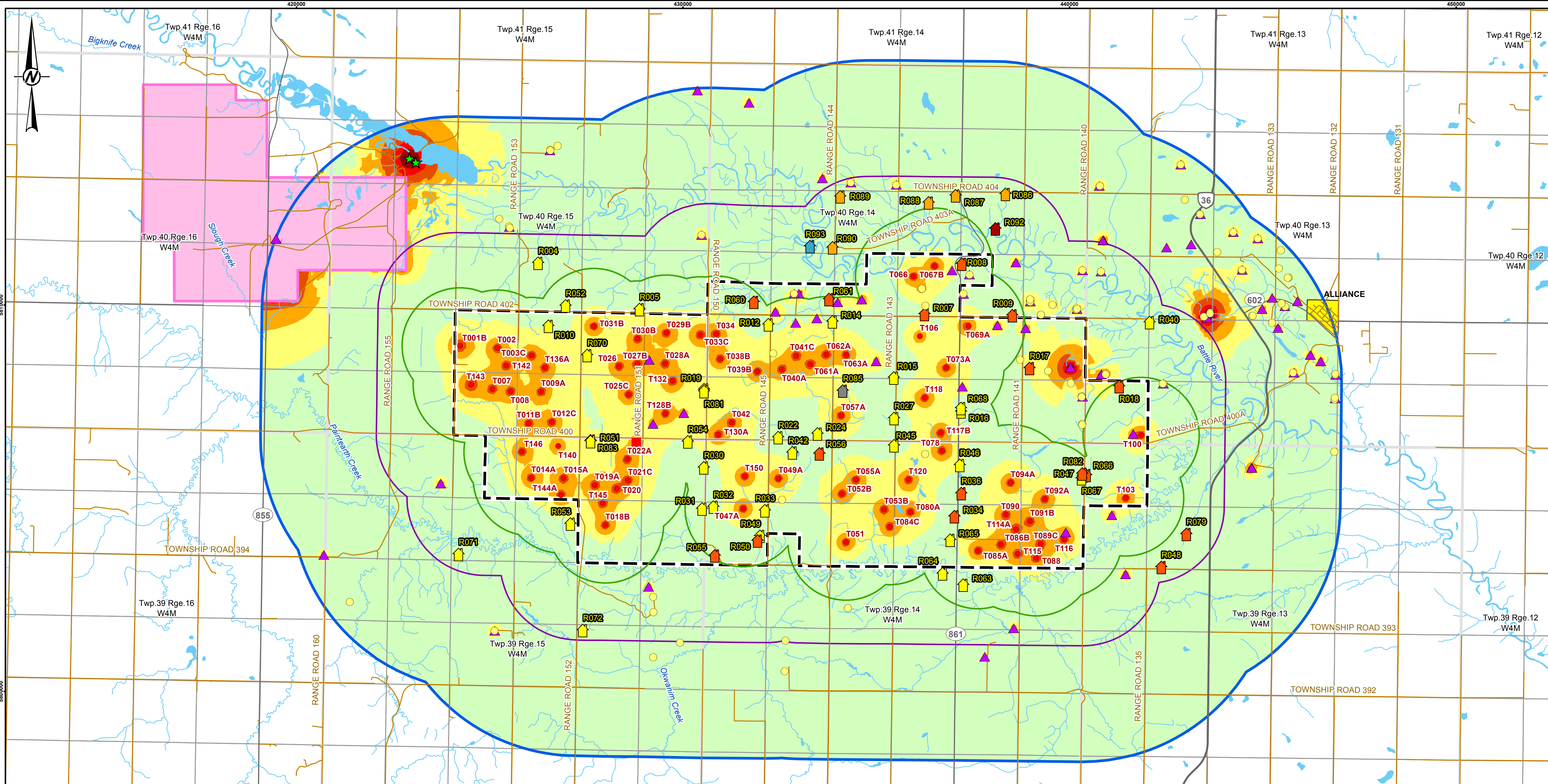

LEGEND

THIRD PARTY NOISE SOURCES
- ELECTRICAL FACILITY
- OIL & GAS FACILITY
- OIL & GAS WELL
- PAINTEARTH MINE

PROJECT NOISE SOURCES
- TURBINE
- SUBSTATION

DWELLING TYPES
- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- INDEFINITE WATERCOURSE
- POPULATED PLACE
- WATERBODY

NOISE CONTOUR
- 35 - 40 dB(A)
- 40 - 45 dB(A)
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)

0 2 4
1:100,000 KILOMETRES

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

PROJECT
HALKIRK 2 WIND PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-05
DESIGNED	VY
PREPARED	SK
REVIEWED	VY
APPROVED	AF

TITLE
APPLICATION CASE NOISE LEVELS
RECEPTOR HEIGHT 4.5 m - NIGHTTIME

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	9

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Table 12 and Table 14 show that Application Case cumulative noise levels at receptors are predicted to range between 45 dBA and 47 dBA during the daytime period. There are no receptors at which Application Case cumulative noise levels are predicted to exceed the daytime PSL of 50 dBA, which is applicable at all receptors (see Table 3). In other words, Application Case cumulative noise levels are predicted to comply with Rule 012 during the daytime period.

Table 13 and Table 14 show that Application Case cumulative noise levels at receptors are predicted to range between 35 dBA and 40 dBA during the nighttime period. There are no receptors at which Application Case cumulative noise levels are predicted to exceed the nighttime PSL of 40 dBA, which is applicable at all receptors (see Table 3). In other words, Application Case cumulative noise levels are predicted to comply with Rule 012 during the nighttime period.

5.2.2 Low Frequency Noise

As discussed in Section 4.2 of this report, there are no clear tones in the noise emissions spectra of the Project wind turbine generators that satisfy the second part of the Rule 012 LFN test. As such, the Project cannot produce LFN issues, regardless of the outcome of the first part of the LFN test. In other words, even if the difference between dBC and dBA noise levels is greater than 20, the absence of a clear tone in the Project noise emissions precludes the presence of a Project-related LFN issue.

Notwithstanding the fact that the Project cannot produce LFN issues, Application Case LFN analyses were conducted for hub height wind speeds ranging from 10 m/s up to 20 m/s based on the first part of the Rule 012 LFN test. Table 15 and Table 16 present the maximum difference between dBA and dBC noise levels for each receptor across all relevant hub height wind speeds. Natural and non-industrial sources must be omitted from the LFN analysis because Rule 012 does not provide ASL values in dBC.

Table 15: Application Case Low Frequency Noise Analysis – Daytime

Receptor Identification Code	A-Weighted Noise Levels [dBA]			C-Weighted Noise Levels			Maximum Difference (All Wind Speeds): dBC minus dBA	Rule 012 LFN Threshold
	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level		
R004	32	30	34	55	55	58	24	20
R005	12	39	39	27	61	61	22	20
R007	30	40	40	43	60	60	20	20
R008	28	37	38	42	58	58	20	20
R009	35	32	37	52	55	57	20	20
R010	14	38	38	30	61	61	23	20
R012	32	37	38	46	60	60	22	20
R014	30	38	39	43	60	60	21	20
R015	26	37	37	41	60	60	23	20
R016	24	39	39	39	60	60	21	20
R017	38	31	39	56	55	59	20	20
R018	37	30	38	54	53	57	19	20
R019	23	40	40	38	62	62	22	20
R022	12	37	37	33	60	60	23	20
R024	13	38	38	34	60	60	22	20
R027	16	37	37	34	60	60	23	20
R030	16	38	38	33	61	61	23	20
R031	8	35	35	24	59	59	24	20
R032	7	37	37	23	60	60	23	20
R033	19	40	40	34	61	61	21	20
R034	19	39	39	42	61	61	22	20
R036	15	39	39	35	60	60	21	20
R040	29	14	29	46	37	47	18	20
R042	12	38	38	33	60	60	22	20
R045	19	38	38	42	61	61	23	20

Table 15: Application Case Low Frequency Noise Analysis – Daytime

Receptor Identification Code	A-Weighted Noise Levels [dBA]			C-Weighted Noise Levels			Maximum Difference (All Wind Speeds): dBC minus dBA	Rule 012 LFN Threshold
	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level		
R046	16	40	40	36	61	61	21	20
R047	24	36	36	40	58	58	22	20
R048	16	28	28	28	51	51	23	20
R049	7	36	36	23	58	58	22	20
R050	7	35	35	22	57	57	22	20
R051	10	40	40	24	62	62	22	20
R052	14	36	36	30	59	59	23	20
R053	8	40	40	27	61	61	21	20
R054	24	39	39	38	61	61	22	20
R055	8	31	31	23	54	54	23	20
R056	13	38	38	33	60	60	22	20
R060	22	34	34	34	57	57	23	20
R061	37	35	39	49	58	59	20	20
R063	9	36	36	23	58	58	22	20
R064	6	35	35	22	57	57	22	20
R065	8	38	38	27	60	60	22	20
R066	24	36	36	40	58	58	22	20
R067	23	36	36	40	58	58	22	20
R068	25	38	38	39	60	60	22	20
R070	15	40	40	33	62	62	22	20
R071	9	26	26	23	52	52	26	20
R072	11	25	25	29	51	51	26	20
R079	12	27	27	27	49	49	22	20
R081	24	40	40	39	62	62	22	20
R082	24	36	36	41	58	58	22	20

Table 15: Application Case Low Frequency Noise Analysis – Daytime

Receptor Identification Code	A-Weighted Noise Levels [dBA]			C-Weighted Noise Levels			Maximum Difference (All Wind Speeds): dBC minus dBA	Rule 012 LFN Threshold
	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level		
R083	10	40	40	24	62	62	22	20
R085	20	40	40	37	62	62	22	20
R086	21	24	26	43	48	49	23	20
R087	19	27	28	38	50	50	22	20
R088	23	29	30	39	52	52	22	20
R089	28	26	30	42	51	52	22	20
R090	21	29	30	36	53	53	23	20
R092	22	27	28	38	50	50	22	20
R093	18	26	27	32	51	51	24	20

Table 16: Application Case Low Frequency Noise Analysis – Nighttime

Receptor Identification Code	A-Weighted Noise Levels [dBA]			C-Weighted Noise Levels			Maximum Difference (All Wind Speeds): dBC minus dBA	Rule 012 LFN Threshold
	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level		
R004	32	28	33	55	54	58	25	20
R005	12	37	37	27	59	59	22	20
R007	30	37	38	43	58	58	20	20
R008	28	35	36	42	56	56	20	20
R009	35	30	36	52	53	56	20	20
R010	14	36	36	30	59	59	23	20
R012	32	35	37	46	58	58	21	20
R014	30	36	37	43	58	58	21	20
R015	26	35	36	41	58	58	22	20

Table 16: Application Case Low Frequency Noise Analysis – Nighttime

Receptor Identification Code	A-Weighted Noise Levels [dBA]			C-Weighted Noise Levels			Maximum Difference (All Wind Speeds): dBC minus dBA	Rule 012 LFN Threshold
	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level		
R016	24	36	36	39	58	58	22	20
R017	38	29	39	56	53	58	19	20
R018	37	28	38	54	51	56	18	20
R019	23	38	38	38	60	60	22	20
R022	12	35	35	33	58	58	23	20
R024	13	36	36	34	58	58	22	20
R027	16	35	35	34	58	58	23	20
R030	16	36	36	33	59	59	23	20
R031	8	33	33	24	57	57	24	20
R032	7	35	35	23	58	58	23	20
R033	19	38	38	34	59	59	21	20
R034	19	37	37	42	58	58	21	20
R036	15	37	37	35	58	58	21	20
R040	29	12	29	46	35	46	17	20
R042	12	36	36	33	58	58	22	20
R045	19	36	36	42	59	59	23	20
R046	16	38	38	36	59	59	21	20
R047	24	34	34	40	56	56	22	20
R048	16	26	26	28	49	49	23	20
R049	7	34	34	23	56	56	22	20
R050	7	33	33	22	55	55	22	20
R051	10	38	38	24	60	60	22	20
R052	14	34	34	30	57	57	23	20
R053	8	37	37	27	59	59	22	20
R054	24	37	37	38	59	59	22	20

Table 16: Application Case Low Frequency Noise Analysis – Nighttime

Receptor Identification Code	A-Weighted Noise Levels [dBA]			C-Weighted Noise Levels			Maximum Difference (All Wind Speeds): dBC minus dBA	Rule 012 LFN Threshold
	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level	Existing and Approved Industrial Facilities	Project Contribution	Application Case Cumulative Noise Level		
R055	8	29	29	23	52	52	23	20
R056	13	36	36	33	58	58	22	20
R060	22	32	32	34	55	55	23	20
R061	37	33	38	49	55	56	18	20
R063	9	34	34	23	56	56	22	20
R064	6	32	32	22	55	55	23	20
R065	8	36	36	27	58	58	22	20
R066	24	34	34	40	56	56	22	20
R067	23	34	34	40	56	56	22	20
R068	25	36	36	39	58	58	22	20
R070	15	38	38	33	60	60	22	20
R071	9	24	24	23	50	50	26	20
R072	11	23	23	29	49	49	26	20
R079	12	24	24	27	47	47	23	20
R081	24	38	38	39	60	60	22	20
R082	24	34	34	41	56	56	22	20
R083	10	38	38	24	60	60	22	20
R085	20	38	38	37	60	60	22	20
R086	21	22	25	43	46	48	23	20
R087	19	25	26	38	48	48	22	20
R088	23	27	28	39	50	50	22	20
R089	28	24	29	42	48	49	20	20
R090	21	27	28	36	50	50	22	20
R092	22	24	26	38	48	48	22	20
R093	18	24	25	32	49	49	24	20

Results from Table 15 suggest that, during the daytime period, the maximum difference between Application Case noise levels expressed in dBA and dBC is predicted to be greater than or equal to 20 for 57 receptors. Results from Table 16 suggest that, during the nighttime period, the maximum difference between Application Case noise levels expressed in dBA and dBC is predicted to be greater than or equal to 20 for 55 receptors. At these receptors, a potential for Application Case LFN issues could exist based on the first part of the Rule 012 LFN test. However, it is likely that the difference between Application Case dBA and dBC noise levels would be reduced if ASL values were included in the LFN analysis.

In addition, the first part of the LFN test only identifies potential LFN issues. As discussed in Section 3.3.2 of this report, both the first part and the second part of the Rule 012 LFN test must be satisfied for a LFN issue to exist. Detailed analysis of one-third octave-band noise emissions data for the Project wind turbine generators showed no clear tones that would satisfy the second part of the Rule 012 LFN test. As such, the Project cannot produce LFN issues, regardless of the outcome of the first part of the LFN test. In other words, even though the maximum difference between Application Case dBC and dBA noise levels is predicted to be greater than 20 for some receptors, the absence of a clear tone in the Project noise emissions precludes the presence of a Project-related LFN issue for any of the receptors considered in the Project NIA.

6.0 SUMMARY AND DISCUSSION

A NIA was conducted for the Project to meet the requirements of Rule 007. The Project NIA was conducted in accordance with assessment methods presented in Rule 012. The NIA characterized potential noise impacts from the Project in the context of broadband and LFN compliance criteria specified by Rule 012. As required by Rule 012, the Project NIA assessed *"…the maximum noise emitted when the wind turbine operates under the planned maximum operating conditions for both the daytime and nighttime period"* (AUC 2013).

For both the daytime period and the nighttime period, the Project NIA predicts that Application Case cumulative noise levels (which include the contribution from natural and non-industrial sources, existing and approved industrial facilities, and the Project itself) will comply with applicable Rule 012 PSL limits for all receptors at all operating wind speeds.

Based on detailed analysis of the noise emissions spectra for the Project wind turbine generators, the Project NIA also predicts that there will be no Project-related LFN issues at any receptors for any operating wind speeds. In other words, the Project NIA predicts daytime and nighttime compliance with applicable broadband and LFN criteria for all receptors and for all operating wind speeds.

7.0 ACOUSTICAL PRACTITIONER INFORMATION

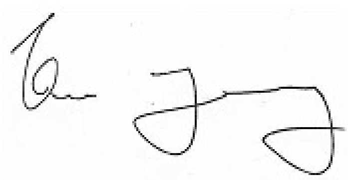
Andrew Faszer, BSc, INCE, PEng, was responsible for senior technical review of all field measurements, emissions calculations, modelling, and reporting related to the Project NIA. Andrew is a senior acoustical engineer with a broad environmental and industrial background, and over 18 years of consulting experience. Andrew's experience includes noise studies for oil and gas developments, conventional and wind power projects, industrial, and mining projects.

Victor Young, MSc, performed noise emissions calculations, developed the computer noise model, and authored the Project NIA report. Victor has worked as an acoustic scientist in the Golder Calgary office for more than six years. During this time, Victor has been involved in a variety of energy, utilities, and mining projects throughout Western Canada. Victor's experience includes field measurements and data analysis, computer noise modelling, and preparation of noise assessment reports.

Tomasz Nowak, MSc, MEng, conducted the field program to measure noise emissions from existing industrial facilities (see Appendix A). Tomasz is an acoustic scientist in the Golder Edmonton office. Tomasz has more than four years of consulting experience and has worked on a variety of energy, utilities, and mining projects throughout Western Canada.

Report Signature Page

GOLDER ASSOCIATES LTD.



Victor Young, MSc
Acoustic Scientist

Andrew Faszer, BSc, INCE, PEng
Senior Acoustical Engineer

VY/AF/kpl

https://golderassociates.sharepoint.com/sites/10018g/3000env assessments/3002 noise/1543760_halkirk2_nia.docx

8.0 REFERENCES

AUC (Alberta Utilities Commission). 2013. *Rule 012: Noise Control.* Effective April 1, 2013.

AUC. 2016. *Rule 007: Applications for Power Plants, Substations, Transmission Lines, Industrial System Designations, and Hydro Developments.* Effective February 1, 2016.

Crocker, M.J. 2007. *Handbook of Noise and Vibration Control.* John Wiley & Sons. New York, NY.

ISO (International Organization for Standardization). 1996. *ISO 9613-2 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.* Dated December 15, 1996.

ISO. 2003. *ISO 1996-1 Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures.* Dated August 1, 2003.

APPENDIX A

Noise Measurements and Emissions Calculations for Baseline Facilities

TECHNICAL MEMORANDUM

DATE April 2017 **PROJECT No.** 1543760 / 3000 / 3002

TO Jeff Sansom | Senior Environmental Advisor
Capital Power Corporation

CC Sarah Gagne (Golder Associates Ltd.)

FROM Victor Young (Golder Associates Ltd.) **EMAIL** victor_young@golder.com

HALKIRK 2 NOISE IMPACT ASSESSMENT – NOISE MEASUREMENTS AND EMISSIONS CALCULATIONS FOR BASELINE FACILITIES

1.0 INTRODUCTION

Capital Power Corporation (Capital Power) retained Golder Associates Ltd. (Golder) to conduct a Noise Impact Assessment (NIA) for the proposed Halkirk 2 Wind Power Project ("the Project"). The results of the Project NIA are presented in the NIA report, to which this technical appendix is attached.

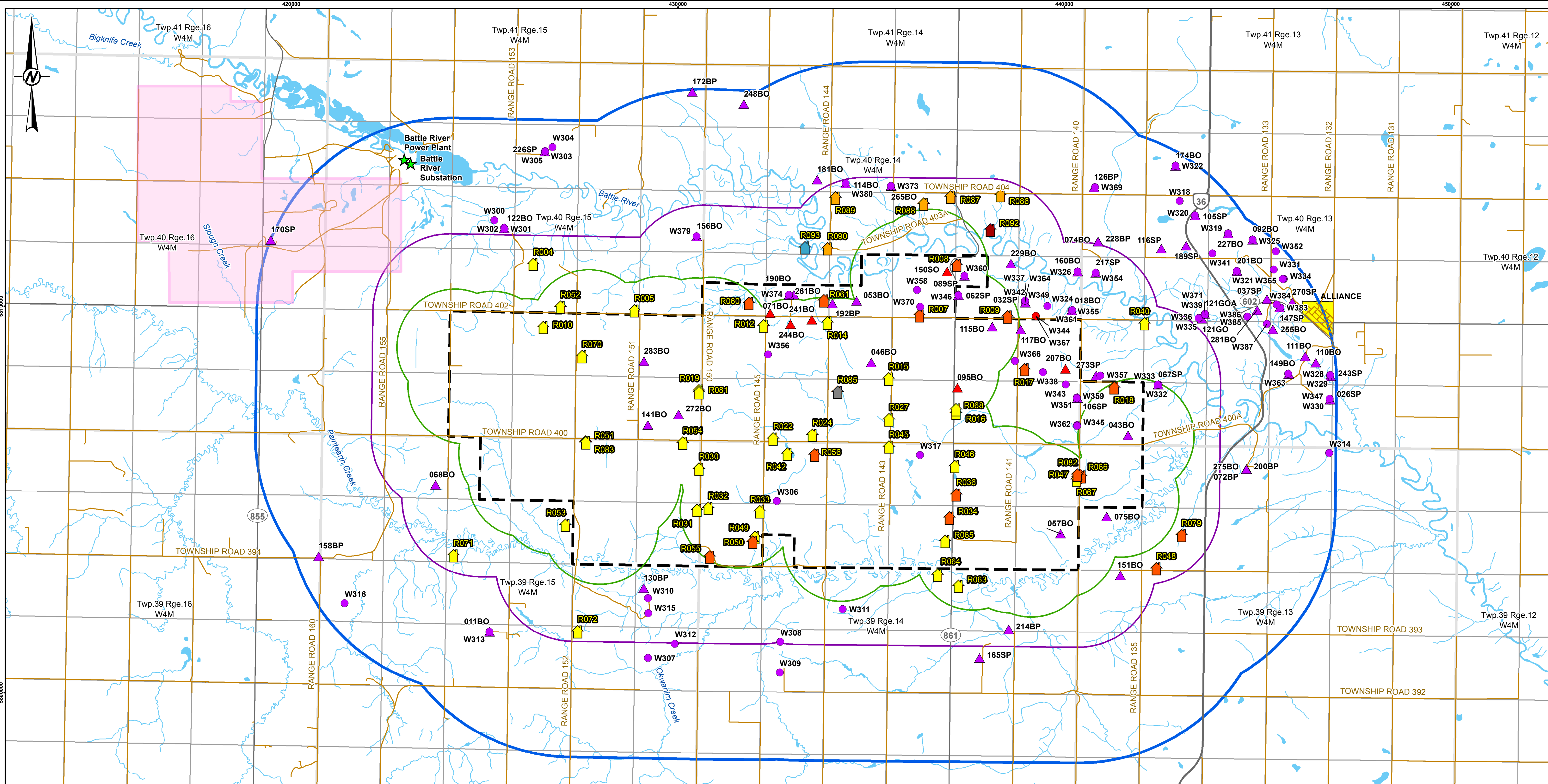
The Project NIA was conducted in accordance with Alberta Utilities Commission (AUC) *Rule 012: Noise Control* (AUC 2013). Rule 012 requires an assessment of cumulative noise impacts, which considers the contribution of existing and approved industrial facilities. This technical appendix to the main NIA document describes the steps taken by Golder to identify existing and approved industrial facilities with the potential to contribute to cumulative noise levels at dwelling receptors in the Project area. In addition, this technical appendix describes the steps taken by Golder to quantify emissions from these baseline facilities.

2.0 IDENTIFICATION OF RELEVANT FACILITIES

There are four classes of baseline facilities with the potential to contribute to cumulative noise levels at dwelling receptors in the Project area:

- oil & gas facilities, which are regulated by the Alberta Energy Regulator (AER);
- oil & gas wells, which are regulated by the AER;
- electrical facilities, which are regulated by the AUC; and
- the Paintearth Coal Mine, which is regulated by the AER.

Figure 1 presents a map showing the location of all baseline facilities considered in the Project NIA. In this map, baseline facilities whose emissions were obtained via direct measurement have been highlighted. The process used to identify each of the facilities included in Figure 1 is described below.



LEGEND

THIRD PARTY NOISE SOURCES

- ELECTRICAL FACILITY
- OIL & GAS FACILITY MEASURED IN FIELD
- OIL & GAS FACILITY NOT MEASURED IN FIELD
- OIL & GAS WELL MEASURED IN FIELD
- OIL & GAS WELL NOT MEASURED IN FIELD
- PAINTEARTH MINE

DWELLING TYPES

- CABIN
- CAMPGROUND
- ONE-STOREY
- TWO-STOREY
- TWO-STOREY (ASSUMED)
- POTENTIAL FUTURE DWELLING (LOCATION APPROXIMATE)

- ASSESSMENT BOUNDARY
- NOISE STUDY AREA
- PROJECT AREA
- PROJECT NOISE SOURCES 1.5 km BUFFER
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- POPULATED PLACE
- WATERBODY

0 2 4

1:100,000 KILOMETRES

REFERENCE(S)
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REVIEWED	VY
APPROVED	AF

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
THIRD-PARTY FACILITIES

PROJECT NO.	CONTROL	REV.	FIGURE
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2.1 Oil & Gas Facilities

IHS Inc. (IHS) maintains a database of existing and approved oil & gas facilities in Alberta. Golder submitted a query to the IHS database seeking a list of oil & gas facilities located within 5 km of the lands optioned by Capital Power for development of the Project. A search buffer of 5 km was selected to capture all oil & gas facilities that might contribute to cumulative noise levels at dwelling receptors in the Project area.

In response to Golder's query, the IHS database identified 285 existing and approved oil & gas facilities, consisting of:

- two hundred and forty-three batteries;
- nineteen satellites;
- two meter stations;
- four gas gathering systems;
- four compressor stations;
- five injection plants;
- six regulator stations; and
- two terminals.

For ease of reference, each of the 285 existing and approved oil & gas facilities was assigned a unique five character identification code. The first character was a letter identifying the type of facility – e.g., B for battery, S for satellite. The second character was a letter identifying the facility's status – e.g., O for "Operating", P for "Permitted", A for "Abandoned". The last three characters were a three digit number identifying each facility's location in the IHS list – e.g., the first facility from the IHS list was labelled 001, the two hundred and sixth facility from the IHS list was labelled 206.

Golder filtered the initial list of 285 oil & gas facilities based on the status field included in the IHS database. In particular, Golder eliminated from further consideration any oil & gas facilities with status fields other than "Operating" or "Permitted". For example, Golder eliminated oil & gas facilities with the status fields "Abandoned" or "Discontinued" since these facilities were assumed not to emit noise. In addition, based on professional experience, Golder eliminated from further consideration all meter stations and regulator stations, since these facilities were assumed not to make noise under normal operating conditions.

After filtering based on the IHS status field and eliminating facility types assumed to be effectively silent, a total of 80 potentially-relevant oil & gas facilities remained, consisting of:

- fifty-five batteries;
- nineteen satellites;
- two gas gathering systems;
- two compressor stations; and
- two terminals.

A baseline field program was undertaken to quantify noise emissions from potentially-relevant oil & gas facilities. However, it was not practical to visit and measure each and every one of the 80 potentially-relevant oil & gas facilities during the field program. Instead, in advance of the field program, Golder identified a sub-sample of 19 oil & gas facilities that were representative of the larger data set that would be targeted during the field program. The 19 oil & gas facilities targeted during the baseline field program consisted of:

- twelve batteries (BO046, BO053, BO071, BO079, BO095, BO115, BO117, BO132, BO207, BO241, BO244, B0261);
- one satellite (SO150);
  - Note that only one of the 19 satellites was listed in the IHS database as “Operating”. The other 18 satellites were listed as “Permitted”. It was assumed that “Permitted” satellites were still under development and that it would not be possible to measure noise from normal operation of these satellites.
- two gas gathering systems (GO121, GO152);
- two compressor stations (CO069, CO187); and
- two terminals (TO061, TO102).

A three-day baseline field program was conducted by Tomasz Nowak, MSc, MEng, an experienced member of the Golder noise team. The baseline field program began on April 14, 2016 and concluded on April 16, 2016. Permission to access oil & gas facilities was coordinated through Capital Power’s land agent. The results of the baseline field program were as follows:

- four of the targeted batteries (BO071, BO095, BO241, BO244) were observed to be fully operational and were measured directly;
- one of the targeted batteries (BO207) was observed to be partially operational – i.e., to have operating noise emitting equipment on-site, which was measured directly, and to have additional non-operating noise emitting equipment on-site, which would also have to be accounted for in the Project NIA;
- three of the targeted batteries (BO115, BO117, BO261) were observed to have noise emitting equipment on-site that was not operating at the time of the field program but that would have to be accounted for the in the Project NIA;
- two of the targeted batteries (BO046, BO053) were not visited because access permission could not be coordinated;
- two of the targeted batteries (BO079, BO132) were observed to have no noise emitting equipment present on-site;
- the one targeted satellite (SO150) was observed to be fully operational and was measured directly;
- one of the targeted gas gathering systems (GO152) was observed not to be operating and post-field discussions with the operator (April 22, 2016) confirmed that this facility was decommissioned and would not operate again;

- one of the targeted gas gathering systems (GO121) was observed to have noise emitting equipment on-site that was not operating at the time of the field program but that would have to be accounted for in the Project NIA;
- a possible expansion of GO121 was observed adjacent to this gas gathering system; noise emitting equipment observed at the expansion site (coded GO121A for ease of reference) was not operating at the time of the field program but would have to be accounted for in the Project NIA;
- one of the targeted compressor stations (CO69) was observed not to be operating and post-field discussions with the operator (April 22, 2016) confirmed that this facility was decommissioned and would not operate again (CO069);
- one of the targeted compressor stations (CO187) was observed not be operating and post-field discussions with the operator (April 26, 2016) confirmed that this facility was decommissioned and would not operate again; and
- both of the targeted terminals (TO061, TO102) were observed to have no noise emitting equipment present on-site.

Based on information gathered during the baseline field program, Golder's list of 80 potentially-relevant oil & gas facilities was reduced to 70, consisting of 49 batteries, 19 satellites, and two gas gathering systems. In particular, the list of potentially-relevant oil & gas facilities was adjusted as follows:

- BO004 was eliminated because it was found to be the same facility as BO071 (i.e., multiple licences and IHS database entries for the same facility);
- TO061 was eliminated because it was found not to be a noise source;
- BO063 was eliminated because it was found to be the same facility as GO121;
- CO069 was eliminated because it was found not to be a noise source;
- BO079 was eliminated because it was found not to be a noise source;
- TO102 was eliminated because it was found not to be a noise source;
- GO121A was added as a separate noise source;
- BO132 was eliminated because it was found not to be a noise source;
- GO152 was eliminated because it was found not to be a noise source;
- CO187 was eliminated because it was found not to be a noise source;
- BO219 was eliminated because it was found to be the same facility as GO121; and
- BO269 was eliminated because it was found to be the same facility as BO207.

Table 1 summarizes the final list of 70 existing and approved oil & gas facilities, which were identified through the process described above. Each of the 70 oil & gas facilities listed in Table 1 was included in the Project NIA as a baseline noise source.

Table 1: Existing and Approved Oil & Gas Facilities Considered in the Project NIA

Identification Code	Facility Type	Universal Transverse Mercator Coordinates [NAD83, Zone 12]	
		Easting [m]	Northing [m]
BO011	Battery	425125.49	5801575.29
BO018	Battery	440188.31	5809893.88
SP026	Satellite	446867.71	5807584.58
SP032	Satellite	438984.70	5810095.42
SP037	Satellite	445238.72	5810186.47
BO043	Battery	441644.77	5806664.06
BO046	Battery	434997.83	5808547.20
BO053	Battery	434619.93	5810144.59
BO057	Battery	439897.88	5804118.29
SP062	Satellite	437253.23	5810292.48
SP067	Satellite	442422.80	5807968.99
BO068	Battery	423732.05	5805379.97
BO071	Battery	432386.76	5809825.48
BP072	Battery	444702.76	5805787.72
BO074	Battery	440864.44	5811672.22
BO075	Battery	441090.34	5804563.09
SP089	Satellite	437411.03	5810789.35
BO092	Battery	444867.29	5811727.26
BO095	Battery	437225.84	5807892.49
SP105	Satellite	443380.70	5812351.44
SP106	Satellite	440336.16	5807628.20
BO110	Battery	446497.28	5808544.85
BO111	Battery	446225.42	5808710.38
BO114	Battery	434340.79	5813176.24
BO115	Battery	438132.95	5809476.34
SP116	Satellite	442504.22	5811493.58
BO117	Battery	438864.79	5809399.45
GO121	Gas Gathering System	443561.01	5809677.23
GO121A	Gas Gathering System (possible expansion of GO121)	443623.00	5809804.00
BO122	Battery	425506.34	5812024.99
BP126	Battery	440768.19	5813083.01
BP130	Battery	429111.78	5802706.19
BO141	Battery	429221.86	5806927.97
SP147	Satellite	445568.12	5809973.85
BO149	Battery	445803.75	5808253.67

Table 1: Existing and Approved Oil & Gas Facilities Considered in the Project NIA

Identification Code	Facility Type	Universal Transverse Mercator Coordinates [NAD83, Zone 12]	
		Easting [m]	Northing [m]
SO150	Satellite	436959.87	5810902.43
BO151	Battery	441446.46	5803035.38
BO156	Battery	430483.54	5811814.49
BP158	Battery	420705.32	5803536.31
BO160	Battery	440337.95	5810898.20
SP165	Satellite	437802.17	5800900.82
SP170	Satellite	419471.42	5811717.44
BP172	Battery	430371.82	5815555.18
BO174	Battery	442875.91	5813637.49
BO181	Battery	433601.59	5813281.86
SP189	Satellite	443143.63	5811573.72
BO190	Battery	432874.50	5810298.06
BP192	Battery	433996.93	5810072.50
BP200	Battery	444707.58	5805787.71
BO201	Battery	444461.06	5810909.64
BO207	Battery	440021.24	5808387.45
BP214	Battery	438553.35	5801638.81
SP217	Satellite	440810.67	5810868.63
SP226	Satellite	426557.35	5814004.72
BO227	Battery	444233.41	5811890.83
BP228	Battery	440867.54	5811679.24
BO229	Battery	438610.26	5811105.50
BO241	Battery	433461.45	5809656.37
SP243	Satellite	446880.45	5808194.08
BO244	Battery	432911.13	5809539.86
BO248	Battery	431704.70	5815238.07
BO255	Battery	445388.63	5809408.16
BO261	Battery	432997.48	5810298.97
BO265	Battery	435517.11	5813116.48
SP270	Satellite	445892.32	5810102.04
BO272	Battery	430018.55	5807204.81
SP273	Satellite	440817.58	5808210.49
BO275	Battery	444702.76	5805787.72
BO281	Battery	444979.94	5809898.97
BO283	Battery	429119.86	5808583.49

2.2 Oil & Gas Wells

IHS maintains a database of existing and approved oil & gas wells in Alberta. Golder submitted a query to the IHS database seeking a list of oil & gas wells located within 5 km of the lands optioned by Capital Power for development of the Project. A search buffer of 5 km was selected to capture all oil & gas wells that might contribute to cumulative noise levels at dwelling receptors in the Project area. In response to Golder's query, the IHS database identified 790 existing and approved oil & gas wells.

A baseline field program was undertaken to quantify noise emissions from potentially-relevant oil & gas wells. However, it was not practical to visit and measure each and every one of the 790 potentially-relevant oil & gas wells during the field program. Instead, in advance of the field program, Golder identified a sub-sample of 13 oil & gas wells that were representative of the larger data set that would be targeted during the field program. The 13 oil & gas wells targeted during the baseline field program consisted of:

- two wells with the status field “Flowing Oil” in the IHS database (out of a total of 25 such wells);
- one well with the status field “Flowing Gas” in the IHS database (out of a total of 26 such wells);
- one well with the status field “Commingled” in the IHS database (out of a total three such wells);
- eight wells with the status field “Pumping Oil” in the IHS databased (out of a total of 76 such wells); and
- one well with the status field “Pumping Gas” in the IHS database (out of a total of 12 such wells).

A three-day baseline field program was conducted by Tomasz Nowak, MSc, MEng, an experienced member of the Golder noise team. The baseline field program to study oil & gas wells was conducted coincidently with the baseline field program to study oil & gas facilities. In particular, the baseline field program began on April 14, 2016 and concluded on April 16, 2016. Permission to access oil & gas wells was coordinated through Capital Power's land agent. The results of the baseline field program were as follows:

- one of the targeted “Flowing Oil” wells, located in 07-11-040-14W4, was observed to have no noise emitting equipment present on-site;
- one of the targeted “Flowing Oil” wells, located 16-05-040-13W4, was not visited because access permission could not be coordinated;
- the one targeted “Flowing Gas” well, located in 11-29-039-15W4, was observed to have no noise emitting equipment present on-site;
- the one targeted “Commingled” well, located in 05-11-040-15W4, was observed to have no noise emitting equipment present on-site;
- one of the targeted “Pumping Oil” wells, located in 13-09-040-14W4, was observed to have no noise emitting equipment present on-site;
- four of the targeted “Pumping Oil” wells, located in 02-13-040-14W4, 04-14-040-14W4, 14-07-040-13W4, and 14-15-040-14W4, were observed to have noise emitting on-site that would have to be accounted for in the Project NIA but that could not be measured because access permission could not be coordinated;
- one of the targeted “Pumping Oil” wells, located in 16-17-040-14W4, was observed to be the same facility as the battery (BO241), which was measured directly;

- two of the targeted “Pumping Oil” wells, both located in 04-12-040-14W4, were observed to be fully operational and were measured directly; and
- the one targeted “Pumping Gas” well, located in 02-05-040-14W4, was observed to have no noise emitting equipment present on-site.

Based on the results of the baseline field program, it was concluded that only oil & gas wells with the status field “Pumping Oil” or “Pumping Gas” were likely to contain noise emitting sources. As such, Golder filtered the initial IHS list of 790 oil & gas wells to eliminate from further consideration any wells that had status fields other than “Pumping Oil” or “Pumping Gas”. This filtering process reduced the number of potentially-relevant oil & gas wells to 88: 76 “Pumping Oil” wells and 12 “Pumping Gas” wells. For ease of reference, the remaining oil & gas wells were assigned unique identification codes running from W300 to W387.

As a result of site-specific information gathered during the baseline field program and augmented by cross-referencing the IHS lists of wells and facilities, the list of potentially-relevant oil & gas wells was further reduced from 88 down to 74 through the following adjustments:

- W323 was eliminated because it was found to have no noise emitting equipment present on-site;
- W327 was eliminated because it was found to be the same facility as battery BO117 (i.e., multiple licences and IHS database entries for the same site);
- W340 was eliminated because it was found to be the same facility as satellite SO150;
- W348 was eliminated because it was found to be the same facility as battery BO071;
- W350 was eliminated because it was found to be the same facility as battery BO115;
- W353 was eliminated because it was found to be the same facility as satellite SO150;
- W368 was eliminated because it was found to be the same facility as battery BO095;
- W372 was eliminated because it was found to be the same facility as battery BO261;
- W375 was eliminated because it was found to be the same facility as battery BO053;
- W376 was eliminated because it was found to be the same facility as battery BO241;
- W377 was eliminated because it was found to be the same facility as battery BO244;
- W378 was eliminated because it was found to be the same facility as battery BO241;
- W381 was eliminated because it was found to have no noise emitting equipment present on-site; and
- W382 was eliminated because it was found to be the same facility as battery BO046.

Table 2 summarizes the final list of 74 existing and approved oil & gas wells, which were identified through the process described above. Each of the 74 oil & gas wells listed in Table 2 was included in the Project NIA as a baseline noise source.

Table 2: Existing and Approved Oil & Gas Wells Considered in the Project NIA

Identification Code	Universal Transverse Mercator Coordinates [NAD83, Zone 12]	
	Easting [m]	Northing [m]
W300	425250.02	5812231.02
W301	425503.92	5812037.92
W302	425520.64	5812001.73
W303	426569.66	5814019.27
W304	426758.83	5814126.03
W305	426569.02	5814003.93
W306	432562.50	5804961.35
W307	429229.35	5800895.31
W308	432651.10	5801315.81
W309	432635.00	5800521.84
W310	429231.09	5802448.53
W311	434266.55	5802162.15
W312	429921.00	5801266.89
W313	425125.49	5801575.28
W314	446848.69	5806205.09
W315	429237.53	5802057.28
W316	421382.59	5802312.89
W317	436263.76	5806147.85
W318	442982.20	5812728.84
W319	444233.41	5811890.83
W320	443376.30	5812351.17
W321	444461.06	5810909.64
W322	442875.91	5813637.49
W324	439562.20	5810010.33
W325	444867.27	5811727.26
W326	440337.98	5810898.26
W328	446875.42	5808194.12
W329	446875.76	5808219.15
W330	446859.41	5807556.21
W331	445412.92	5810948.70
W332	442432.80	5807968.81
W333	442412.81	5807969.16
W334	445671.67	5810706.55
W335	443491.72	5809701.48
W336	443471.67	5809701.82
W337	438983.04	5810106.37
W338	439445.35	5808295.82
W339	443636.63	5809809.61
W341	443823.09	5811370.10
W342	438983.29	5810126.28
W343	440037.76	5807979.97
W344	439260.38	5809750.63

Table 2: Existing and Approved Oil & Gas Wells Considered in the Project NIA

Identification Code	Universal Transverse Mercator Coordinates [NAD83, Zone 12]	
	Easting [m]	Northing [m]
W345	440329.36	5806922.17
W346	437253.23	5810292.47
W347	446860.02	5807606.27
W349	438982.62	5810078.35
W351	440318.17	5807642.27
W352	445468.87	5811420.75
W354	440810.67	5810868.62
W355	440178.63	5809885.98
W356	432333.84	5808750.68
W357	440930.03	5808209.35
W358	436185.59	5810424.03
W359	440317.93	5807622.25
W360	437412.17	5810782.48
W361	440197.99	5809901.76
W362	440329.12	5806902.15
W363	445785.13	5808248.85
W364	438983.54	5810146.31
W365	445646.32	5810707.16
W366	438723.95	5808580.32
W367	439260.38	5809750.63
W369	440788.16	5813082.77
W370	436270.68	5809982.17
W371	443636.33	5809789.59
W373	435517.11	5813116.48
W374	432874.50	5810298.06
W379	430483.54	5811814.49
W380	434340.79	5813176.24
W383	445581.98	5809968.23
W384	445487.38	5810044.36
W385	444727.82	5809728.36
W386	444734.39	5809725.61
W387	445238.78	5809540.53

2.3 Electrical Facilities

By reviewing maps maintained by the Alberta Electric System Operator (AESO), Golder identified five existing and approved electrical facilities with the potential to influence cumulative noise levels at dwelling receptors in the Project area (i.e., electrical facilities located within 5 km of the lands optioned by Capital Power for development of the Project):

- ATCO Electric Battle River Power Plant;
- ATCO Electric Battle River Substation;

- ATCO Electric Cordell Substation;
- ATCO Electric Tinchebray Substation; and
- ATCO Electric Bigfoot Substation.

Golder obtained a copy of the most recent noise assessment completed for the Battle River Substation (ATCO 2010); this noise assessment is attached to the main Project NIA document as Appendix C. The noise assessment for the Battle River Substation presented noise emissions data for both the Battle River Substation and the Battle River Power Plant, which Golder used to characterize these facilities in the Project NIA.

The noise assessment for the Battle River Substation also stated that the Cordell Substation *"…has no noise-producing equipment"* (ATCO 2010). Based on this statement, Golder eliminated the Cordell Substation from further consideration in the Project NIA. The noise assessment for the Battle River Substation does not contain any information about the Bigfoot Substation.

Golder obtained a copy of a letter from ATCO Structures and Logistics to ATCO Electric that describes noise associated with the Tinchebray Substation (ATCO 2011); this letter is attached to the main Project NIA document as Appendix D. The Tinchebray Substation letter stated that equipment associated with this facility *"…does not produce any noise during normal operation"* (ATCO 2011). Based on this statement, Golder eliminated the Tinchebray Substation from further consideration in the Project NIA.

Golder was unable to obtain an equipment list or any noise data for the Bigfoot Substation. In particular, the Bigfoot Substation was not discussed in the Battle River Substation NIA (ATCO 2010). Furthermore, the Bigfoot Substation was not discussed in the most recent noise assessment completed for the Paintearth Coal Mine (ACI 2009), despite the fact that the Bigfoot Substation is located within the study area identified for this noise assessment. The lack of available noise data suggests that the Bigfoot Substation is not a major source – i.e., that noise emissions from the Bigfoot Substation are totally dominated by noise emissions from the nearby Paintearth Coal Mine. In addition, the Bigfoot Substation is located approximately 4 km from the nearest dwelling receptor considered in the Project NIA; therefore, even if there were non-negligible noise emissions from equipment at the Bigfoot Substation, their influence on cumulative noise levels at relevant receptors would likely be negligible given the large propagation distances. Based on this reasoning, Golder eliminated the Bigfoot Substation from further consideration in the Project NIA.

Table 3 summarizes the final two existing and approved electrical facilities, which were identified through the process described above. Both of the electrical facilities listed in Table 3 were included in the Project NIA as a baseline noise sources.

Table 3: Existing and Approved Electrical Facilities Considered in the Project NIA

Identification Code	Facility Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]	
		Easting [m]	Northing [m]
BRPP	Battle River Power Plant	422923.00	5813799.00
BRSS	Battle River Substation	423090.00	5813698.00

2.4 Paintearth Coal Mine

Based on general knowledge of the Project area, Golder was aware of the existence of the Paintearth Coal Mine and recognized that this facility had the potential to influence cumulative noise levels at dwelling receptors considered in the Project NIA. Golder obtained a copy of the most recent noise assessment completed for the Paintearth Coal Mine (ACI 2009); this noise assessment is attached to the main Project NIA document as Appendix E. The noise assessment for the Paintearth Coal Mine presented noise emissions data, which Golder used to characterize this facilities in the Project NIA.

Because equipment associated with the Paintearth Coal Mine are spatially distributed, this facility was treated as an area source in the Project NIA. Table 4 presents coordinates describing the spatial extent of the area source used to characterize the Paintearth Coal Mine.

Table 4: Spatial Extent of Paintearth Coal Mine in the Project NIA

Identification Code	Facility Description	Universal Transverse Mercator Coordinates [NAD83, Zone 12]	
		Easting [m]	Northing [m]
PEM	Paintearth Coal Mine	416034.00	5815704.00
		416034.00	5811704.00
		416834.00	5811704.00
		416838.00	5810104.00
		420034.00	5810104.00
		420034.00	5810904.00
		422834.00	5810904.00
		422834.00	5813304.00
		419234.00	5813304.00
		419234.00	5815304.00
		418434.00	5815304.00
		418434.00	5815704.00

3.0 BASELINE FIELD PROGRAM

As discussed above, a three-day baseline field program was undertaken to characterize noise emissions from existing and approved oil & gas facilities and wells. The baseline field program was conducted by Tomasz Nowak, MSc, MEng, an experienced member of the Golder noise team. The baseline field program began on April 14 and concluded on April 16, 2016. Permission to access oil & gas facilities and wells was coordinated through Capital Power's land agent.

In accordance with Rule 012, baseline field measurements were completed using a Brüel and Kjær Model 2250 Type I sound level meter (serial number 2551387), which had been calibrated by the instrument manufacturer *"…within a two-year period immediately preceding the measurements"* (AUC 2013). A copy of the relevant calibration certificate for the sound level meter is presented in Figure 2. Also in accordance with Rule 012, the sound level meter was field calibrated with a Brüel and Kjær Mode 4231 Type I calibrator unit (serial number 2292623) *"…immediately prior to the measurement..."* (AUC 2013) and had its calibration checked *"…immediately after the measurement using the same calibrator…"* (AUC 2013). As required by Rule 012, the calibrator unit was calibrated by the instrument manufacturer less than one year prior to the field program. A copy of the relevant calibration certificate for the calibrator unit is presented in Figure 3.

Brüel & Kjær
North America Inc.
The Brüel & Kjær Calibration Laboratory
2815 Colonnades Court
Norcross, GA 30071-1588
Telephone: 770/209-6907
Fax: 770/447-4033
Web site address: http://www.bkhome.com

Calibration Certificate Number 1568.01

ACCREDITED

CERTIFICATE OF CALIBRATION

Certificate No: CAS-43566-T7K2Z5-801

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CALIBRATION OF:

Sound Level Meter:	Brüel & Kjær	2250	Serial No: 2551387
Microphone:	Brüel & Kjær	4189	Serial No: 2555993
Preamplifier:	Brüel & Kjær	ZC-0032	Serial No: 11581
Supplied Calibrator:	Brüel & Kjær	4231	Serial No: 2292623
Software version:	BZ7222 Version 3.5.3		

CLIENT:

Golder Associates
102, 2535 - 3rd Avenue SE
Calgary, AB T2A 7W5

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 ± 3 °C
Environment conditions See actual values in Environmental Condition sections

SPECIFICATIONS:

This document certifies that the instrument as listed under "Model/Serial Number" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95%. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurement. The calibration of the listed instrumentation, was accomplished using a test system which conforms with the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and ISO 10012-1. For "as received" and/or "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation This Certificate and attached data pages shall not be reproduced, except in full, without the written approval of the Brüel and Kjær Calibration Laboratory-Norcross, GA. Results relate only to the items tested. This instrument has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants.

PROCEDURE:

Brüel and Kjær Model 3630 Sound Level Meter Calibration System Software 7763 Version 5.0 - DB: 5.00 Test Collection 2250-4189.

RESULTS:

As Received Condition	As Received Data	Final Data
_X_ Received in good condition	_X_ Within acceptance criteria	_X_ Within acceptance criteria
___ Damaged - See attached report	___ Outside acceptance criteria	___ Limited test - See attached details
	___ Inoperative	
	___ Data not taken	

Date of Calibration: 10 Apr. 2015

Certificate issued: 13 Apr. 2015

Debra Wilson

Calibration Technician

John atl

Quality Representative

Figure 2: Calibration Certificate for Sound Level Meter

Golder Associates

Brüel & Kjær
North America Inc.

The Bruel and Kjaer Calibration Laboratory
2815-A Colonnades Court
Norcross, GA 30071-1588
Telephone: 770-209-6907
Fax: 770-447-4033
Web site address: http://www.bkhome.com

ACCREDITED

Calibration Certificate # 1568.01

CERTIFICATE OF CALIBRATION No.: CAS-125033-C4W8F7-901 Page 1 of 3

CALIBRATION OF:

Calibrator:	Brüel & Kjær	Type 4231 IEC Class: 1	Serial No.:	2292623

CUSTOMER:

Golder Associates
102, 2535 - 3rd Ave SE
Calgary, AB T2A 7W5

CALIBRATION CONDITIONS:

Environment conditions:	Air temperature:	24	°C
	Air pressure:	98.768	kPa
	Relative Humidity:	27	%RH

SPECIFICATIONS:

This document certifies that the acoustic calibrator as listed under "Type" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurements. The calibration of the listed transducer was accomplished using a test system which conforms to the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and guidelines of ISO 10012-1. For "as received" and "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation. This Certificate and attached data pages shall not be reproduced, except in full, without written approval of the Bruel and Kjaer Calibration Laboratory-Norcross, GA. Results relate only to the items tested. The transducer has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants. The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:

The measurements have been performed with the assistance of Brüel & Kjær acoustic calibrator calibration application Software version 2.3.4 Type 7794 using calibration procedure 4231 Complete

RESULTS:

[X] "As Received" Data: Within Acceptance Criteria [ ] "As Received" Data: Outside Acceptance Criteria

[X] "Final" Data : Within Acceptance Criteria [ ] "Final" Data : Outside Acceptance Criteria

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: April 06, 2016 Certificate issued: April 06, 2016

Harold Williams
Calibration Technician

Quality Representative

Figure 3: Calibration Certificate for Calibrator Unit

As discussed in Section 2.1 and Section 2.2 of this technical appendix, the baseline field program targeted 19 facilities and 13 wells. However, many of the facilities and wells targeted during the field program had no noise emitting equipment on-site or had noise emitting equipment on-site that was not operating. In addition, access permission could not be coordinated for several of the facilities and wells targeted by the baseline field program. Ultimately, noise emissions were measured for six facilities: BO071, BO095, BO207, BO241, BO244, SO150, and for two wells: W344 and W367. The specific facilities and wells at which noise emissions were measured are highlighted in Figure 1.

Photographs showing noise emitting equipment on-site at BO071, BO095, BO207, BO241, BO244, SO150, W344, and W367 are presented in Figures 4 through 10. Note that all noise emitting equipment was observed to be operating at BO071, BO095, BO241, BO244, SO150, W344, and W367. However, at BO207 only some of the noise emitting equipment was operating at the time of the measurements. In particular, the noise measurements at BO207 captured operation of the pump jack shown on the right side of Figure 6 but did not capture operation of the compressor and associated equipment shown in the centre and on the left side of Figure 6. Non-operational equipment at BO207 was not omitted from the Project NIA but was instead characterized via desktop techniques.

Figure 4: Noise Emitting Equipment On-Site at BO071

Figure 5: Noise Emitting Equipment On-Site at BO095

Figure 6: Noise Emitting Equipment On-Site at BO207 (note: only the pump jack on the right side of the photograph was operating at the time of the field program)

Figure 7: Noise Emitting Equipment On-Site at BO241

Figure 8: Noise Emitting Equipment On-Site at BO244

Figure 9: Noise Emitting Equipment On-Site at SO150

Figure 10: Noise Emitting Equipment at W344 and W367

4.0 NOISE EMISSIONS FOR BASELINE CASE FACILITIES

4.1 Oil & Gas Facilities

Noise emissions for the 70 existing and approved oil & gas facilities listed in Table 1 of this technical appendix were established using measurement data collected during the baseline field program. Where appropriate measurement data was not available, professional judgment and experience were used to establish or augment noise emissions. A detailed description of the approach used to establish noise emissions for each of the relevant oil & gas facilities is provided below:

- Noise emissions from BO071 were established directly from field measurements of this facility.
- Noise emissions from BO095 were established directly from field measurements of this facility.
- Noise emissions from the pump jack at BO207 were established directly from field measurements of this facility. Noise emissions from the compressor and associated equipment at BO207, which were not operating at the time of the field program, were established based on professional judgment and experience. In particular, it was assumed that noise emissions from the non-operating sources at BO207 were consistent with a gas-driven 242 kW compressor and a 1,000,000 BTU/hour line heater.
- Noise emissions from BO241 were established directly from field measurements of this facility.
- Noise emissions from BO244 were established directly from field measurements of this facility.
- Noise emissions from BO53 were established by adding 3 dBA to the maximum battery noise emissions measured during the field program (i.e., the measured noise emissions for BO071). This approach was taken because BO53 was observed in the field to consist of two gas-driven pump jacks (i.e., twice as many gas-driven pump jacks as were present at BO071) and 3 dBA corresponds to a doubling of noise emissions.
- Noise emissions from each of the remaining 43 batteries were assumed to be equal to the maximum battery noise emissions measured during the field program (i.e., the measured noise emissions for BO071). This is a conservative assumption, since many of the remaining batteries likely have no noise emitting equipment present on-site.
- Noise emission from SO150 were established directly from field measurements of this facility.
- Noise emissions from each of the remaining 18 satellites were assumed to be equal to the noise emissions measured at SO150 during the baseline field program. This is a conservative assumption, since many of the remaining satellites likely have no noise emitting equipment present on-site.
- Noise emissions from GO121 and from GO121A, which were not operating at the time of the field program, were established based on professional judgment and experience. In particular, it was assumed that the equipment at each of GO121 and GO121A had noise emissions consistent with a gas-driven 242 kW compressor.

4.2 Oil & Gas Wells

Noise emissions for the 74 existing and approved oil & gas wells listed in Table 2 of this technical appendix were established using measurement data collected during the baseline field program. A detailed description of the approach used to establish noise emissions for each of the relevant oil & gas wells is provided below:

- Noise emissions from W344 were established directly from field measurements of this well.

- Noise emissions from W367 were established directly from field measurements of this well.
- Noise emissions from W324, W335, W336, W357, W358, and W371 were each set equal to the noise emissions measured at BO071. This approach was taken because each of these wells was observed in the field to consist of a single gas-driven pump jack, and BO071 represents the maximum noise emissions measured from a single gas-driven pump jack during the field program.
- Noise emissions from each of the remaining 66 wells were assumed to be equal to the maximum well noise emissions measured during the baseline field program (i.e., the noise emissions measured for W344). This is a conservative assumption, since many of the remaining wells likely have no noise emitting equipment present on-site.

4.3 Electrical Facilities

Noise emissions from the Battle River Power Plant (BRPP) were established using information presented in the most recent noise assessment conducted for the Battle River Substation (ATCO 2010). In particular, the Battle River Substation Noise assessment provides noise emissions estimates for equipment associated with the BRPP; Golder summed the contribution from all of these sources to obtain an estimate of total noise emissions from the BRPP.

Similarly, noise emissions from the Battle River Substation (BRSS) were established using information presented in the most recent noise assessment for this facility (ATCO 2010). In particular, the BRSS noise assessment provides noise emissions estimates for individual pieces of equipment associated with the BRSS; Golder summed the contribution from all of these sources to obtain an estimate of total emissions from the BRSS.

4.4 Paintearth Coal Mine

Noise emissions from the Paintearth Coal Mine (PEM) were established using information presented in the most recent noise assessment for this facility (ACI 2009). In particular, the PEM noise assessment provides noise emissions estimates for individual pieces of equipment associated with the PEM; Golder summed the contribution from all of these sources to obtain an estimate of total emissions from the PEM.

Victor Young, MSc
Acoustic Scientist

Andrew Faszer, BSc, INCE, PEng
Senior Acoustical Engineer

VY/AF/kpl

https://golderassociates.sharepoint.com/sites/10018g/3000env assessments/3002 noise/1543760_halkirk2_nia_appa_baselinefacilities.docx

5.0 REFERENCES

ACI (Acoustical Consultants Inc.). 2009. *Environmental Noise Impact Assessment for Paintearth Mine North Extension.* Dated December 1, 2009.

ATCO (ATCO Structures and Logistics). 2011. *Re: Project 747600 – Tinchebray Substation NIA, Rev. 0.* Letter from Arthur Kupper (ATCO Structures and Logistics) to Wes Caldwell (ATCO Electric). Dated January 10, 2011.

ATCO. 2010. *ATCO Electric Batter River Substation 757S – Noise Impact Assessment.* Dated July 28, 2010.

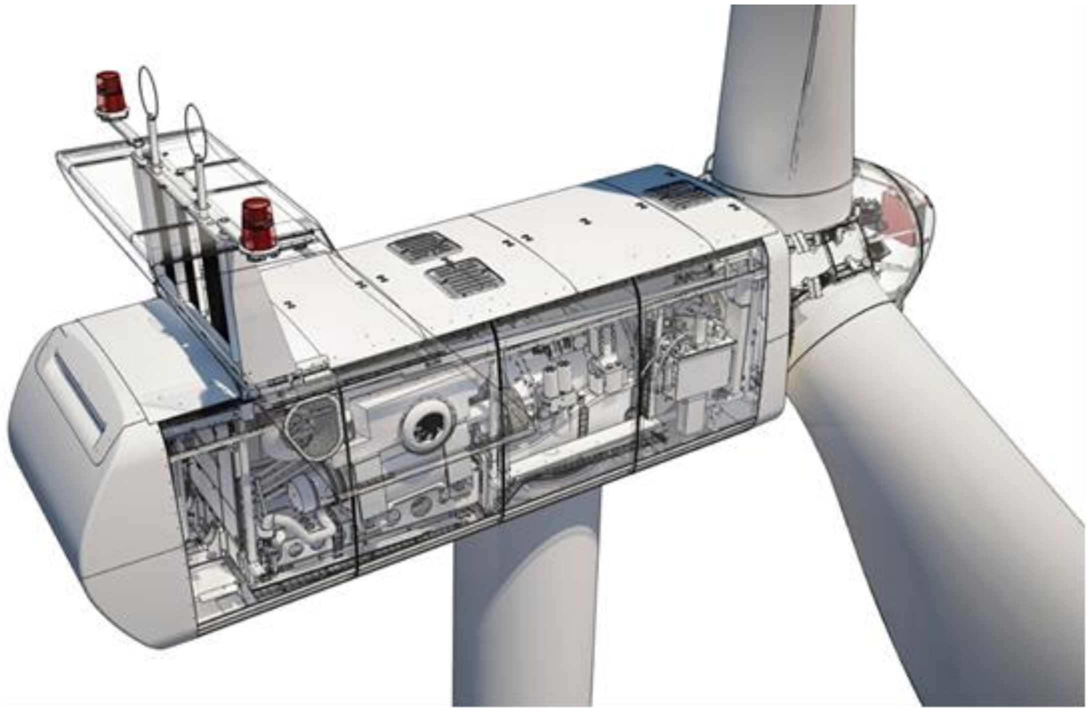
AUC (Alberta Utilities Commission). 2013. *Rule 012: Noise Control.* Effective April 1, 2013.

APPENDIX B

V110-2.0-MW Third Octave Noise Emission (DMS 0051-2907_04)

DMS 0051-2907_04

V110-2.0 MW
Third octave noise emission



Abstract

This document serves as a paper behind the General Specification.

The document describes the measured/estimated third octave spectra for noise levels according to the General Specification.

The document is a living document and will be updated regularly.

When new measurements exist the document might be updated.

Contents

1. Introduction

The purpose of this document is to present the expected third octave noise spectra for the V110-2.0 MW turbine.

All presented octaves for the turbine without Serrated Trailing Edges are based on internal measurement results obtained on a V110-2.0 MW turbine located at the Høvsøre test site in Denmark. Octave band values for the turbine with Serrated Trailing Edges are based upon internal measurement results on the same turbine after installation of Serrated Trailing Edges.

2. Method

2.1 Procedure

During measurements, a very large number of correlated values for noise emission spectra and turbine operating parameters are identified.

From these a relation between noise emission within each 1/3 octave band, wind speed and operational conditions are extracted. By combination of these extracted values and the actual turbine operation and rotor size, an estimate of the actual 1/3 octave performance is obtained.

In order to secure that measurement system limitations are not influencing the findings, the frequency content are limited to the frequency range 6.3 Hz to 10 kHz. The stated spectral values are thus representative for the expected noise emission from the turbine at each wind speed.

The method is verified as giving results corresponding to direct measured values.

The reported wind speed range cover hub height wind speeds from 3 to 20 m/s. Extrapolations outside this wind speed range is not possible due to limitations in the measured input data.

The stated values are expected to be representing an upper 95% confidence limit for the turbine performance, but do not in any way enable issuing guarantees on the values.

2.2 Physical environment

The results are valid for the downwind reference position as defined according to IEC 61400-11 Ed.3.

Applicable environmental conditions are thus corresponding to the standardized requirements as described directly and indirectly in IEC 61400-11.

These can be interpreted as air density 1.225 kg/m^3, yaw errors below +/- 15 deg. and vertical inflow angles below +/- 10 deg. Blade condition is clean and undamaged.

3. Results

Expected octave band performance, all noise modes.

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	18.5	16.8	16.0	20.9	21.7	24.3	26.8	28.5	29.7	30.6	31.2	31.8	32.3	32.7	33.1	33.3	33.7	33.9
8 Hz	25.4	23.6	22.8	27.8	28.7	31.4	34.0	35.7	37.0	37.9	38.5	39.1	39.6	40.0	40.5	40.7	41.1	41.3
10 Hz	31.3	29.9	29.4	34.4	35.4	38.2	40.6	42.1	43.2	44.0	44.5	45.0	45.4	45.7	46.1	46.2	46.5	46.7
12.5 Hz	38.6	37.7	37.4	42.3	43.5	46.2	48.5	49.7	50.5	51.2	51.5	51.9	52.2	52.5	52.7	52.8	53.1	53.2
16 Hz	43.9	43.3	43.2	48.1	49.3	52.0	54.2	55.3	55.9	56.5	56.8	57.1	57.3	57.5	57.7	57.8	58.0	58.1
20 Hz	49.2	48.6	48.7	53.5	54.8	57.5	59.7	60.7	61.3	61.8	62.0	62.3	62.5	62.7	62.9	63.0	63.1	63.2
25 Hz	54.7	53.8	53.6	58.6	59.8	62.6	65.0	66.3	67.1	67.7	68.1	68.5	68.8	69.1	69.3	69.5	69.7	69.8
31.5 Hz	58.9	57.9	57.6	62.7	63.9	66.7	69.0	70.3	71.2	71.8	72.2	72.7	73.0	73.2	73.5	73.6	73.9	74.0
40 Hz	62.8	61.9	61.7	66.7	68.0	70.7	73.0	74.2	75.0	75.6	76.0	76.3	76.6	76.9	77.1	77.2	77.4	77.5
50 Hz	66.9	66.4	66.5	71.3	72.6	75.3	77.4	78.4	79.0	79.5	79.8	80.1	80.3	80.4	80.6	80.7	80.8	80.9
63 Hz	71.0	71.3	71.9	76.0	77.4	79.8	81.5	81.9	82.1	82.3	82.3	82.4	82.4	82.4	82.4	82.3	82.4	82.3
80 Hz	73.3	73.8	74.6	78.7	80.2	82.6	84.2	84.5	84.6	84.7	84.6	84.6	84.5	84.5	84.5	84.4	84.4	84.3
100 Hz	75.0	75.5	76.4	80.7	82.3	84.8	86.5	86.7	86.8	86.9	86.8	86.8	86.7	86.7	86.7	86.6	86.6	86.5
125 Hz	77.4	78.3	79.4	83.5	85.2	87.6	89.1	89.2	89.0	89.0	88.8	88.7	88.5	88.4	88.3	88.1	88.1	87.9
160 Hz	78.6	80.3	82.0	85.7	87.6	90.0	91.1	90.6	90.1	89.7	89.2	89.0	88.6	88.3	88.0	87.8	87.6	87.3
200 Hz	79.5	81.6	83.6	87.2	89.3	91.6	92.6	91.8	91.1	90.5	89.9	89.5	89.0	88.7	88.3	88.0	87.7	87.3
250 Hz	80.6	83.1	85.5	89.1	91.3	93.6	94.5	93.4	92.4	91.7	91.0	90.5	89.8	89.5	89.0	88.6	88.2	87.8
315 Hz	82.4	85.0	87.4	90.8	93.1	95.3	96.0	94.9	93.9	93.1	92.4	91.8	91.2	90.8	90.3	89.8	89.5	89.1
400 Hz	82.6	84.7	86.8	90.5	92.6	95.0	96.0	95.2	94.5	93.9	93.3	92.9	92.4	92.1	91.7	91.4	91.2	90.8
500 Hz	83.8	85.8	87.8	91.8	93.9	96.4	97.6	96.9	96.2	95.7	95.1	94.8	94.3	94.0	93.6	93.3	93.1	92.7
630 Hz	84.5	86.1	87.9	92.0	94.0	96.6	97.8	97.4	96.9	96.5	96.1	95.8	95.4	95.2	94.9	94.7	94.5	94.2
800 Hz	84.4	85.6	87.1	91.5	93.5	96.1	97.6	97.4	97.1	96.9	96.6	96.4	96.2	96.0	95.8	95.6	95.5	95.3
1 kHz	85.7	86.1	87.0	91.6	93.3	96.0	97.8	98.2	98.3	98.4	98.4	98.4	98.3	98.4	98.3	98.2	98.2	98.1
1.25 kHz	86.2	86.0	86.4	91.2	92.6	95.4	97.4	98.2	98.6	99.0	99.1	99.3	99.4	99.5	99.6	99.7	99.8	99.8
1.6 kHz	85.5	85.7	86.4	91.0	92.6	95.3	97.1	97.6	97.9	98.1	98.1	98.2	98.2	98.2	98.2	98.2	98.2	98.2
2 kHz	84.7	84.2	84.3	89.3	90.6	93.4	95.7	96.7	97.3	97.7	98.0	98.3	98.5	98.7	98.8	98.9	99.1	99.1
2.5 kHz	83.0	81.9	81.4	86.6	87.7	90.5	93.0	94.4	95.3	96.1	96.5	97.0	97.4	97.7	98.0	98.1	98.4	98.6
3.15 kHz	80.4	79.3	79.0	84.1	85.2	88.0	90.4	91.8	92.7	93.4	93.8	94.3	94.6	94.9	95.2	95.3	95.6	95.7
4 kHz	77.2	76.4	76.2	81.3	82.5	85.3	87.7	88.9	89.6	90.3	90.6	91.0	91.3	91.5	91.7	91.9	92.1	92.2
5 kHz	73.2	73.1	73.4	78.1	79.6	82.3	84.3	85.0	85.4	85.8	85.9	86.1	86.2	86.3	86.4	86.4	86.5	86.5
6.3 kHz	67.1	68.0	69.2	73.6	75.5	78.1	79.8	79.8	79.7	79.6	79.4	79.4	79.2	79.1	79.0	78.8	78.8	78.6
8 kHz	59.8	62.5	65.1	68.7	71.0	73.4	74.2	73.1	72.0	71.2	70.4	69.9	69.2	68.8	68.3	67.8	67.5	67.0
10 kHz	52.3	56.5	60.1	63.0	65.7	67.9	68.0	65.8	64.0	62.6	61.4	60.5	59.4	58.7	57.9	57.2	56.6	55.9
A-wgt	95.3	96.1	97.5	101.7	103.6	106.1	107.6	107.6	107.6	107.6	107.6	107.6	107.6	107.6	107.6	107.6	107.6	107.6

Table 1 Expected 1/3 octave band performance V110-2.0 MW, Mode 0 (Standard blade)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	20.2	18.2	17.4	22.6	23.6	26.3	29.0	30.5	31.7	32.5	33.3	33.8	34.3	34.7	35.1	35.4	35.8	36.0
8 Hz	26.2	24.3	23.5	28.9	30.0	32.8	35.5	37.0	38.1	39.0	39.7	40.2	40.8	41.1	41.5	41.9	42.2	42.4
10 Hz	31.2	29.4	28.9	34.5	35.7	38.6	41.3	42.7	43.7	44.5	45.1	45.6	46.1	46.4	46.7	47.0	47.3	47.5
12.5 Hz	38.9	37.7	37.5	42.6	43.9	46.7	49.1	50.1	50.9	51.4	51.9	52.3	52.6	52.8	53.1	53.3	53.5	53.7
16 Hz	44.5	43.7	43.8	48.8	50.2	52.8	55.0	55.7	56.3	56.7	57.1	57.3	57.5	57.6	57.8	58.0	58.1	58.2
20 Hz	49.2	47.9	47.7	53.0	54.4	57.2	59.7	60.7	61.5	62.1	62.6	63.0	63.3	63.5	63.8	64.0	64.2	64.4
25 Hz	54.4	52.8	52.4	57.9	59.2	62.1	64.8	66.1	67.1	67.8	68.4	68.8	69.3	69.5	69.9	70.2	70.5	70.7
31.5 Hz	59.2	58.0	57.8	63.2	64.5	67.4	69.9	70.9	71.7	72.3	72.8	73.2	73.5	73.7	74.0	74.2	74.4	74.6
40 Hz	64.2	62.7	62.3	67.6	68.8	71.7	74.2	75.4	76.4	77.1	77.7	78.1	78.5	78.8	79.1	79.4	79.7	79.8
50 Hz	68.7	67.7	67.7	72.7	74.1	76.9	79.2	80.1	80.8	81.3	81.7	82.0	82.3	82.5	82.7	82.9	83.1	83.2
63 Hz	74.5	73.2	72.7	76.7	77.5	79.6	81.7	82.6	83.4	84.0	84.5	84.8	85.2	85.4	85.7	85.9	86.1	86.3
80 Hz	75.9	75.1	75.0	78.8	79.8	81.9	83.8	84.4	85.0	85.4	85.7	86.0	86.2	86.3	86.5	86.7	86.8	86.9
100 Hz	76.2	76.6	77.6	81.8	83.5	85.9	87.5	87.4	87.3	87.2	87.2	87.1	87.0	86.9	86.8	86.8	86.8	86.6
125 Hz	78.1	78.2	79.0	83.1	84.7	87.0	88.6	88.6	88.7	88.7	88.7	88.7	88.7	88.6	88.6	88.6	88.6	88.5
160 Hz	80.0	80.9	82.2	85.4	87.0	89.0	90.1	89.6	89.3	88.9	88.8	88.5	88.3	88.1	87.9	87.8	87.7	87.4
200 Hz	80.7	82.2	83.9	86.9	88.7	90.5	91.4	90.5	89.9	89.4	89.0	88.7	88.3	88.0	87.7	87.5	87.3	86.9
250 Hz	82.1	83.4	85.0	88.2	90.0	91.9	92.9	92.1	91.6	91.1	90.8	90.5	90.1	89.9	89.6	89.4	89.2	89.0
315 Hz	84.3	85.7	87.3	90.0	91.7	93.4	94.2	93.3	92.7	92.1	91.8	91.5	91.1	90.8	90.5	90.3	90.1	89.8
400 Hz	84.0	85.8	87.6	90.2	92.0	93.7	94.3	93.3	92.5	91.8	91.4	91.0	90.5	90.2	89.8	89.5	89.3	88.9
500 Hz	84.8	85.6	86.8	90.3	91.9	94.0	95.2	94.7	94.4	94.1	94.0	93.8	93.6	93.4	93.2	93.1	93.0	92.8
630 Hz	83.7	84.6	86.0	89.7	91.5	93.8	95.1	94.6	94.3	94.0	93.8	93.6	93.4	93.2	93.0	92.9	92.7	92.5
800 Hz	82.9	82.8	83.6	88.3	90.0	92.7	94.6	94.9	95.1	95.1	95.3	95.3	95.4	95.3	95.4	95.4	95.5	95.4
1 kHz	83.1	82.9	83.6	88.5	90.1	92.8	94.9	95.2	95.4	95.6	95.8	95.8	95.9	95.9	96.0	96.0	96.1	96.1
1.25 kHz	84.6	84.2	84.6	89.4	90.9	93.6	95.6	96.1	96.5	96.7	96.9	97.1	97.2	97.2	97.3	97.4	97.5	97.5
1.6 kHz	84.7	85.2	86.3	90.3	91.9	94.2	95.7	95.5	95.4	95.2	95.2	95.1	94.9	94.8	94.7	94.7	94.6	94.5
2 kHz	83.4	82.9	83.3	88.1	89.7	92.3	94.4	94.9	95.3	95.6	95.9	96.0	96.2	96.2	96.4	96.5	96.6	96.6
2.5 kHz	83.7	83.2	83.5	88.1	89.5	92.0	94.0	94.5	94.9	95.1	95.4	95.5	95.7	95.7	95.8	95.9	96.0	96.0
3.15 kHz	82.5	82.1	82.4	86.9	88.3	90.7	92.6	93.1	93.4	93.6	93.9	94.0	94.1	94.1	94.2	94.3	94.4	94.4
4 kHz	80.9	80.5	80.9	85.2	86.6	89.0	90.9	91.3	91.6	91.8	92.1	92.2	92.3	92.4	92.5	92.5	92.6	92.6
5 kHz	76.7	76.5	77.0	81.1	82.6	84.9	86.7	87.0	87.2	87.3	87.5	87.6	87.7	87.7	87.7	87.8	87.8	87.8
6.3 kHz	69.5	69.4	70.0	74.5	76.1	78.5	80.4	80.6	80.8	80.9	81.0	81.1	81.1	81.1	81.1	81.1	81.2	81.1
8 kHz	61.3	61.5	62.3	66.6	68.2	70.6	72.3	72.3	72.3	72.3	72.4	72.4	72.3	72.2	72.2	72.2	72.2	72.1
10 kHz	55.7	56.1	57.0	60.0	61.3	63.1	64.3	64.1	64.0	63.8	63.8	63.7	63.6	63.5	63.4	63.3	63.3	63.1
A-wgt	95.3	95.8	96.9	100.7	102.3	104.5	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0

Table 2 Expected 1/3 octave band performance V110-2.0 MW, Mode 0 (with optional serrated trailing edge)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	**4 m/s**	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**	**11 m/s**	**12 m/s**	**13 m/s**	**14 m/s**	**15 m/s**	**16 m/s**	**17 m/s**	**18 m/s**	**19 m/s**	**20 m/s**
6.3 Hz	18.5	16.8	16.0	20.8	21.9	23.9	25.0	26.3	27.4	28.2	28.8	29.3	29.9	30.3	30.7	31.0	31.2	31.6
8 Hz	25.4	23.6	22.8	27.8	28.9	30.9	32.1	33.4	34.7	35.5	36.1	36.6	37.2	37.6	38.0	38.4	38.6	39.0
10 Hz	31.3	29.9	29.4	34.4	35.5	37.5	38.6	39.7	40.8	41.5	42.0	42.4	42.9	43.2	43.6	43.9	44.0	44.3
12.5 Hz	38.6	37.7	37.4	42.3	43.5	45.4	46.3	47.3	48.1	48.7	49.0	49.4	49.7	49.9	50.2	50.4	50.5	50.8
16 Hz	43.9	43.3	43.2	48.0	49.3	51.2	51.9	52.8	53.5	54.0	54.3	54.5	54.8	55.0	55.2	55.4	55.5	55.6
20 Hz	49.2	48.6	48.7	53.5	54.8	56.6	57.4	58.1	58.8	59.2	59.5	59.7	60.0	60.2	60.3	60.5	60.6	60.7
25 Hz	54.7	53.8	53.6	58.6	59.9	61.9	62.8	63.8	64.6	65.2	65.6	65.9	66.3	66.5	66.8	67.0	67.1	67.4
31.5 Hz	58.9	57.9	57.6	62.7	63.9	65.9	66.8	67.8	68.7	69.3	69.7	70.1	70.4	70.7	71.0	71.2	71.3	71.6
40 Hz	62.8	61.9	61.7	66.7	68.0	69.9	70.8	71.7	72.6	73.1	73.5	73.8	74.1	74.3	74.6	74.8	74.9	75.1
50 Hz	66.9	66.4	66.5	71.3	72.6	74.4	75.1	75.9	76.6	77.0	77.3	77.5	77.7	77.9	78.1	78.2	78.3	78.4
63 Hz	71.0	71.3	71.9	76.0	77.3	78.8	79.2	79.5	79.8	79.8	79.8	79.8	79.9	79.9	79.9	79.9	79.8	79.8
80 Hz	73.3	73.8	74.6	78.6	80.0	81.5	81.8	82.0	82.2	82.2	82.1	82.0	82.0	82.0	81.9	81.9	81.8	81.8
100 Hz	75.0	75.5	76.4	80.6	82.1	83.6	83.9	84.2	84.3	84.3	84.3	84.2	84.2	84.1	84.1	84.1	84.0	83.9
125 Hz	77.4	78.3	79.4	83.5	84.9	86.3	86.5	86.6	86.6	86.4	86.2	86.1	85.9	85.8	85.7	85.6	85.5	85.4
160 Hz	78.6	80.3	82.0	85.7	87.2	88.4	88.3	88.0	87.6	87.1	86.7	86.3	86.0	85.7	85.4	85.2	84.9	84.7
200 Hz	79.5	81.6	83.6	87.2	88.9	89.9	89.7	89.2	88.5	87.9	87.3	86.9	86.4	86.0	85.6	85.3	85.0	84.7
250 Hz	80.6	83.1	85.5	89.1	90.8	91.8	91.4	90.7	89.8	89.0	88.4	87.8	87.2	86.7	86.3	85.9	85.5	85.1
315 Hz	82.4	85.0	87.4	90.8	92.5	93.5	93.0	92.2	91.3	90.5	89.8	89.2	88.5	88.1	87.6	87.2	86.8	86.4
400 Hz	82.6	84.7	86.8	90.5	92.1	93.3	93.0	92.5	91.9	91.3	90.7	90.3	89.8	89.4	89.1	88.8	88.4	88.1
500 Hz	83.8	85.8	87.8	91.8	93.5	94.7	94.5	94.1	93.5	93.0	92.5	92.1	91.6	91.3	90.9	90.7	90.3	90.0
630 Hz	84.5	86.1	87.9	92.0	93.6	94.9	94.9	94.7	94.3	93.9	93.5	93.1	92.8	92.5	92.2	92.0	91.8	91.5
800 Hz	84.4	85.6	87.1	91.5	93.2	94.6	94.7	94.7	94.5	94.2	94.0	93.7	93.5	93.3	93.1	93.0	92.8	92.6
1 kHz	85.7	86.1	87.0	91.6	93.1	94.8	95.2	95.5	95.7	95.8	95.8	95.7	95.7	95.7	95.7	95.7	95.6	95.6
1.25 kHz	86.2	86.0	86.4	91.2	92.6	94.3	95.0	95.6	96.1	96.4	96.6	96.7	96.8	97.0	97.1	97.2	97.2	97.3
1.6 kHz	85.5	85.7	86.4	91.0	92.4	94.1	94.6	95.0	95.3	95.5	95.5	95.5	95.6	95.6	95.6	95.6	95.6	95.6
2 kHz	84.7	84.2	84.3	89.3	90.6	92.5	93.3	94.1	94.8	95.2	95.4	95.7	95.9	96.1	96.2	96.4	96.5	96.6
2.5 kHz	83.0	81.9	81.4	86.5	87.8	89.8	90.8	91.9	92.9	93.5	94.0	94.4	94.8	95.1	95.4	95.7	95.9	96.2
3.15 kHz	80.4	79.3	79.0	84.1	85.3	87.3	88.2	89.3	90.2	90.9	91.3	91.7	92.0	92.3	92.6	92.9	93.0	93.3
4 kHz	77.2	76.4	76.2	81.2	82.6	84.5	85.4	86.3	87.2	87.7	88.1	88.4	88.7	88.9	89.2	89.4	89.5	89.7
5 kHz	73.2	73.1	73.4	78.1	79.5	81.2	81.8	82.5	82.9	83.2	83.4	83.5	83.6	83.7	83.8	83.9	83.9	84.0
6.3 kHz	67.1	68.0	69.2	73.6	75.2	76.7	77.0	77.1	77.1	77.0	76.8	76.7	76.5	76.4	76.3	76.2	76.1	76.0
8 kHz	59.8	62.5	65.1	68.7	70.5	71.5	71.0	70.3	69.3	68.5	67.8	67.1	66.5	66.0	65.5	65.1	64.7	64.3
10 kHz	52.3	56.5	60.1	63.0	64.9	65.5	64.4	63.0	61.3	59.9	58.7	57.7	56.7	55.9	55.1	54.4	53.8	53.1
A-wgt	95.3	96.1	97.5	101.7	103.3	104.7	104.9	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table 3 Expected 1/3 octave band performance V110-2.0 MW, Mode 1 (Standard blade)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	20.2	18.3	17.5	23.0	24.1	26.0	27.1	28.4	29.6	30.4	31.0	31.6	32.2	32.6	33.0	33.4	33.7	34.0
8 Hz	26.2	24.4	23.6	29.3	30.4	32.4	33.5	34.8	36.0	36.8	37.4	38.0	38.6	38.9	39.4	39.8	40.0	40.4
10 Hz	31.2	29.5	29.0	34.9	36.1	38.1	39.2	40.4	41.4	42.2	42.8	43.3	43.8	44.1	44.6	44.9	45.1	45.4
12.5 Hz	38.9	37.8	37.6	43.0	44.3	46.0	46.9	47.9	48.7	49.2	49.7	50.0	50.4	50.6	50.9	51.2	51.3	51.6
16 Hz	44.5	43.8	43.9	49.1	50.4	52.1	52.8	53.5	54.1	54.5	54.8	55.0	55.3	55.4	55.6	55.8	55.9	56.0
20 Hz	49.2	48.0	47.8	53.4	54.7	56.5	57.5	58.5	59.3	59.8	60.3	60.6	61.1	61.3	61.6	61.8	62.0	62.2
25 Hz	54.4	52.9	52.5	58.3	59.6	61.5	62.6	63.8	64.8	65.5	66.1	66.5	67.0	67.3	67.7	68.0	68.2	68.5
31.5 Hz	59.2	58.1	57.9	63.6	64.9	66.7	67.6	68.6	69.4	70.0	70.5	70.8	71.3	71.5	71.8	72.0	72.2	72.4
40 Hz	64.2	62.8	62.4	68.0	69.2	71.1	72.1	73.2	74.2	74.8	75.4	75.8	76.3	76.6	77.0	77.2	77.4	77.7
50 Hz	68.7	67.8	67.8	73.1	74.4	76.1	77.0	77.8	78.5	79.0	79.4	79.7	80.1	80.2	80.5	80.7	80.8	81.1
63 Hz	74.5	73.3	72.8	77.1	77.9	79.3	80.1	80.9	81.6	82.1	82.5	82.8	83.2	83.4	83.8	84.0	84.2	84.4
80 Hz	75.9	75.2	75.1	79.2	80.1	81.4	82.1	82.7	83.1	83.4	83.7	83.9	84.2	84.3	84.6	84.7	84.8	85.0
100 Hz	76.2	76.7	77.7	82.1	83.5	84.8	85.0	85.2	85.1	85.0	84.9	84.8	84.8	84.7	84.6	84.6	84.5	84.4
125 Hz	78.1	78.3	79.1	83.5	84.7	86.0	86.3	86.5	86.5	86.5	86.5	86.5	86.5	86.4	86.4	86.4	86.3	86.3
160 Hz	80.0	81.0	82.3	85.8	87.0	87.9	87.9	87.7	87.3	86.9	86.6	86.4	86.2	86.0	85.8	85.7	85.5	85.3
200 Hz	80.7	82.3	84.0	87.3	88.5	89.3	89.0	88.6	87.9	87.3	86.9	86.5	86.2	85.8	85.6	85.3	85.1	84.8
250 Hz	82.1	83.5	85.1	88.6	89.9	90.7	90.5	90.1	89.5	89.0	88.7	88.3	88.0	87.7	87.5	87.3	87.0	86.8
315 Hz	84.3	85.8	87.4	90.4	91.5	92.2	92.0	91.5	90.8	90.2	89.7	89.4	89.0	88.7	88.5	88.2	88.0	87.7
400 Hz	84.0	85.9	87.7	90.6	91.8	92.4	92.0	91.4	90.5	89.9	89.3	88.8	88.5	88.1	87.7	87.4	87.1	86.8
500 Hz	84.8	85.7	86.9	90.7	91.9	92.9	92.9	92.7	92.4	92.1	91.8	91.6	91.5	91.3	91.1	91.0	90.8	90.7
630 Hz	83.7	84.7	86.1	90.1	91.5	92.5	92.6	92.5	92.1	91.8	91.6	91.3	91.2	90.9	90.8	90.7	90.5	90.3
800 Hz	82.9	82.9	83.7	88.7	90.1	91.6	92.1	92.5	92.7	92.9	92.9	93.0	93.1	93.1	93.1	93.2	93.1	93.2
1 kHz	83.1	83.0	83.7	88.8	90.3	91.8	92.4	92.8	93.1	93.3	93.4	93.5	93.6	93.6	93.7	93.8	93.8	93.8
1.25 kHz	84.6	84.3	84.7	89.8	91.1	92.7	93.3	93.8	94.2	94.4	94.6	94.8	95.0	95.0	95.1	95.2	95.3	95.4
1.6 kHz	84.7	85.3	86.4	90.6	92.0	93.1	93.3	93.4	93.2	93.1	93.0	92.8	92.8	92.6	92.6	92.5	92.4	92.3
2 kHz	83.4	83.0	83.4	88.5	89.9	91.4	92.1	92.7	93.1	93.3	93.6	93.7	93.9	94.0	94.2	94.3	94.3	94.4
2.5 kHz	83.7	83.3	83.6	88.5	89.7	91.2	91.8	92.3	92.7	92.9	93.1	93.3	93.5	93.5	93.7	93.8	93.8	93.9
3.15 kHz	82.5	82.2	82.5	87.2	88.5	89.9	90.4	91.0	91.3	91.5	91.6	91.8	91.9	92.0	92.1	92.2	92.2	92.3
4 kHz	80.9	80.6	81.0	85.6	86.8	88.2	88.7	89.2	89.5	89.7	89.9	90.0	90.2	90.2	90.3	90.4	90.4	90.5
5 kHz	76.7	76.6	77.1	81.5	82.7	84.1	84.5	84.9	85.1	85.2	85.3	85.4	85.5	85.5	85.6	85.7	85.6	85.7
6.3 kHz	69.5	69.5	70.1	74.9	76.2	77.6	78.0	78.4	78.6	78.7	78.7	78.8	78.9	78.9	78.9	79.0	78.9	79.0
8 kHz	61.3	61.6	62.4	67.0	68.3	69.6	69.9	70.1	70.2	70.1	70.1	70.1	70.1	70.0	70.1	70.0	70.0	69.9
10 kHz	55.7	56.2	57.1	60.4	61.4	62.3	62.4	62.4	62.1	61.9	61.8	61.7	61.6	61.5	61.4	61.4	61.2	61.2
A-wgt	95.3	95.9	97.0	101.0	102.3	103.5	103.7	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8

Table 4 Expected 1/3 octave band performance V110-2.0 MW, Mode 1 (with optional serrated trailing edge)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	18.8	16.8	15.7	19.8	19.8	22.0	24.2	25.5	26.4	27.1	27.6	28.1	28.5	28.9	29.3	29.6	29.8	30.0
8 Hz	25.7	23.6	22.5	26.8	26.8	29.0	31.3	32.6	33.6	34.3	34.9	35.3	35.8	36.2	36.6	36.9	37.1	37.3
10 Hz	31.6	29.9	29.1	33.3	33.6	35.5	37.5	38.6	39.4	40.0	40.4	40.8	41.2	41.5	41.8	42.0	42.2	42.4
12.5 Hz	38.9	37.6	37.2	41.3	41.7	43.3	44.9	45.8	46.4	46.8	47.2	47.4	47.7	48.0	48.2	48.3	48.4	48.5
16 Hz	44.3	43.2	43.0	47.0	47.5	49.0	50.4	51.1	51.6	52.0	52.2	52.5	52.7	52.9	53.0	53.1	53.2	53.3
20 Hz	49.5	48.6	48.4	52.4	53.0	54.4	55.7	56.3	56.8	57.1	57.4	57.6	57.7	57.9	58.1	58.1	58.2	58.3
25 Hz	55.1	53.7	53.3	57.6	58.0	59.7	61.3	62.2	62.8	63.3	63.6	63.9	64.2	64.4	64.7	64.8	64.9	65.0
31.5 Hz	59.3	57.8	57.4	61.6	62.0	63.8	65.4	66.3	67.0	67.5	67.8	68.1	68.4	68.7	68.9	69.1	69.2	69.3
40 Hz	63.1	61.8	61.5	65.7	66.1	67.8	69.3	70.1	70.7	71.1	71.4	71.7	72.0	72.2	72.4	72.5	72.6	72.7
50 Hz	67.3	66.4	66.2	70.2	70.8	72.2	73.5	74.1	74.6	74.9	75.1	75.3	75.5	75.6	75.8	75.8	75.9	76.0
63 Hz	71.5	71.3	71.6	75.0	75.8	76.6	77.2	77.3	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.4	77.3	77.2
80 Hz	73.8	73.8	74.3	77.6	78.6	79.2	79.6	79.6	79.7	79.7	79.6	79.5	79.4	79.4	79.3	79.2	79.1	79.0
100 Hz	75.5	75.5	76.1	79.6	80.6	81.3	81.6	81.6	81.7	81.7	81.6	81.5	81.4	81.4	81.3	81.2	81.1	81.0
125 Hz	77.9	78.3	79.1	82.4	83.6	84.0	84.0	83.8	83.7	83.6	83.3	83.2	83.0	82.9	82.8	82.5	82.4	82.2
160 Hz	79.2	80.4	81.7	84.7	86.1	86.0	85.3	84.6	84.2	83.8	83.4	83.0	82.6	82.4	82.1	81.7	81.4	81.2
200 Hz	80.1	81.7	83.3	86.2	87.9	87.4	86.3	85.4	84.8	84.3	83.7	83.2	82.7	82.4	82.0	81.5	81.2	80.9
250 Hz	81.2	83.3	85.2	88.0	89.9	89.2	87.7	86.5	85.8	85.1	84.4	83.8	83.2	82.8	82.3	81.8	81.4	81.0
315 Hz	83.0	85.1	87.1	89.8	91.7	90.9	89.3	88.1	87.3	86.6	85.8	85.2	84.6	84.2	83.7	83.1	82.7	82.3
400 Hz	83.2	84.8	86.5	89.5	91.1	90.7	89.6	88.7	88.1	87.6	87.0	86.6	86.1	85.7	85.4	84.9	84.6	84.3
500 Hz	84.4	85.9	87.5	90.7	92.4	92.1	91.1	90.3	89.7	89.3	88.7	88.3	87.8	87.5	87.1	86.7	86.4	86.1
630 Hz	85.0	86.2	87.6	90.9	92.4	92.4	91.7	91.1	90.7	90.3	89.9	89.5	89.1	88.9	88.6	88.2	88.0	87.7
800 Hz	84.9	85.7	86.8	90.4	91.8	92.0	91.7	91.3	91.1	90.8	90.5	90.2	90.0	89.8	89.6	89.3	89.1	88.9
1 kHz	86.1	86.1	86.7	90.5	91.6	92.3	92.8	92.8	92.9	92.9	92.8	92.8	92.7	92.7	92.7	92.5	92.5	92.4
1.25 kHz	86.7	86.0	86.1	90.1	90.9	92.1	93.0	93.4	93.8	94.0	94.1	94.2	94.3	94.4	94.5	94.5	94.5	94.5
1.6 kHz	86.0	85.7	86.1	89.9	90.9	91.8	92.4	92.6	92.7	92.8	92.8	92.8	92.8	92.8	92.8	92.7	92.7	92.6
2 kHz	85.1	84.1	84.0	88.2	88.8	90.3	91.5	92.1	92.6	92.9	93.1	93.3	93.5	93.7	93.8	93.9	93.9	94.0
2.5 kHz	83.4	81.8	81.2	85.5	85.8	87.7	89.5	90.5	91.3	91.8	92.2	92.6	92.9	93.2	93.5	93.7	93.8	94.0
3.15 kHz	80.8	79.3	78.7	83.0	83.4	85.2	86.9	87.8	88.6	89.1	89.4	89.8	90.1	90.4	90.6	90.8	90.9	91.1
4 kHz	77.6	76.3	75.9	80.2	80.7	82.3	83.9	84.7	85.3	85.7	86.0	86.3	86.6	86.8	87.0	87.1	87.2	87.3
5 kHz	73.6	73.0	73.2	77.1	77.8	79.0	79.9	80.3	80.6	80.8	80.9	81.0	81.1	81.2	81.3	81.3	81.3	81.3
6.3 kHz	67.6	68.0	68.9	72.6	73.8	74.3	74.3	74.1	74.0	73.9	73.6	73.5	73.3	73.2	73.1	72.8	72.7	72.6
8 kHz	60.4	62.6	64.7	67.6	69.6	68.8	67.2	65.9	65.1	64.3	63.6	62.9	62.3	61.8	61.4	60.8	60.3	59.9
10 kHz	53.0	56.7	59.8	62.0	64.5	62.7	59.7	57.6	56.2	55.0	53.8	52.8	51.8	51.0	50.2	49.3	48.7	48.1
A-wgt	95.8	96.2	97.2	100.6	102.0	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2

Table 5 Expected 1/3 octave band performance V110-2.0 MW, Mode 2 (Standard blade)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	19.8	17.9	17.1	21.0	21.4	23.3	25.5	26.7	27.6	28.3	29.0	29.5	30.0	30.4	30.9	31.3	31.5	31.8
8 Hz	25.8	23.9	23.2	27.3	27.7	29.6	31.8	33.0	33.9	34.6	35.2	35.7	36.3	36.7	37.1	37.5	37.7	38.0
10 Hz	30.7	29.1	28.6	32.9	33.4	35.2	37.2	38.3	39.1	39.7	40.2	40.7	41.2	41.5	41.9	42.3	42.5	42.7
12.5 Hz	38.5	37.3	37.2	41.0	41.8	43.2	44.7	45.5	46.1	46.5	46.9	47.3	47.6	47.9	48.1	48.4	48.6	48.7
16 Hz	44.2	43.4	43.5	47.1	48.1	49.1	50.3	50.9	51.3	51.5	51.8	52.1	52.3	52.5	52.7	52.9	52.9	53.0
20 Hz	48.7	47.5	47.4	51.4	52.2	53.6	55.1	56.0	56.6	57.0	57.5	57.8	58.2	58.4	58.7	59.0	59.1	59.3
25 Hz	54.0	52.4	52.1	56.3	56.9	58.6	60.5	61.5	62.3	62.8	63.4	63.8	64.3	64.6	64.9	65.3	65.5	65.7
31.5 Hz	58.8	57.6	57.5	61.5	62.3	63.7	65.3	66.1	66.7	67.2	67.6	68.0	68.3	68.6	68.8	69.1	69.3	69.4
40 Hz	63.8	62.3	62.0	66.0	66.6	68.2	70.0	71.0	71.8	72.3	72.8	73.2	73.7	74.0	74.3	74.6	74.8	75.0
50 Hz	68.4	67.4	67.3	71.1	72.0	73.2	74.6	75.3	75.8	76.2	76.6	76.9	77.2	77.4	77.6	77.9	78.0	78.1
63 Hz	74.2	73.0	72.5	75.2	75.6	76.9	78.4	79.3	79.9	80.3	80.8	81.1	81.5	81.7	82.0	82.3	82.4	82.6
80 Hz	75.7	74.9	74.7	77.3	77.9	78.9	80.0	80.6	81.0	81.3	81.6	81.9	82.1	82.3	82.5	82.6	82.7	82.8
100 Hz	75.9	76.3	77.2	80.2	81.5	81.8	81.8	81.7	81.6	81.5	81.4	81.4	81.3	81.2	81.2	81.1	81.0	81.0
125 Hz	77.8	78.0	78.7	81.5	82.8	83.1	83.3	83.4	83.4	83.3	83.3	83.3	83.3	83.3	83.3	83.3	83.2	83.2
160 Hz	79.9	80.8	81.9	83.9	85.3	85.1	84.6	84.2	83.9	83.6	83.4	83.2	83.0	82.8	82.7	82.5	82.3	82.2
200 Hz	80.7	82.1	83.6	85.4	87.0	86.4	85.5	84.7	84.2	83.8	83.4	83.0	82.7	82.4	82.1	81.9	81.6	81.4
250 Hz	82.0	83.4	84.7	86.7	88.3	87.8	87.0	86.4	85.9	85.5	85.1	84.8	84.6	84.3	84.1	83.8	83.6	83.4
315 Hz	84.3	85.7	87.0	88.5	90.1	89.4	88.5	87.8	87.3	86.9	86.5	86.2	85.9	85.6	85.3	85.0	84.8	84.6
400 Hz	84.0	85.7	87.3	88.7	90.4	89.6	88.4	87.5	86.9	86.3	85.9	85.4	85.0	84.7	84.4	84.0	83.8	83.5
500 Hz	84.6	85.5	86.5	88.7	90.2	90.0	89.6	89.3	89.0	88.8	88.6	88.4	88.2	88.1	87.9	87.8	87.6	87.5
630 Hz	83.6	84.5	85.7	88.2	89.7	89.5	89.1	88.7	88.5	88.2	88.0	87.8	87.6	87.4	87.3	87.1	86.9	86.8
800 Hz	82.6	82.6	83.2	86.7	88.0	88.6	89.0	89.2	89.3	89.4	89.5	89.5	89.6	89.6	89.6	89.7	89.7	89.6
1 kHz	82.8	82.6	83.2	86.8	88.1	88.7	89.3	89.6	89.8	89.8	90.0	90.0	90.1	90.2	90.2	90.3	90.3	90.3
1.25 kHz	84.3	83.9	84.3	87.8	88.9	89.7	90.5	90.8	91.1	91.3	91.4	91.6	91.7	91.8	91.9	92.0	92.1	92.1
1.6 kHz	84.5	85.1	86.0	88.7	90.1	90.2	90.1	89.9	89.8	89.7	89.6	89.5	89.4	89.3	89.2	89.1	89.0	88.9
2 kHz	83.1	82.6	82.9	86.5	87.6	88.4	89.3	89.7	90.0	90.2	90.4	90.6	90.7	90.8	91.0	91.1	91.1	91.2
2.5 kHz	83.4	82.9	83.2	86.5	87.5	88.3	89.1	89.5	89.8	90.0	90.2	90.3	90.5	90.6	90.7	90.8	90.9	90.9
3.15 kHz	82.2	81.8	82.1	85.3	86.3	87.0	87.8	88.2	88.4	88.5	88.7	88.9	89.0	89.1	89.2	89.3	89.3	89.3
4 kHz	80.6	80.3	80.6	83.6	84.6	85.4	86.1	86.5	86.7	86.9	87.0	87.2	87.3	87.4	87.5	87.6	87.6	87.6
5 kHz	76.4	76.2	76.6	79.6	80.6	81.2	81.8	82.1	82.2	82.3	82.4	82.5	82.6	82.6	82.7	82.8	82.8	82.8
6.3 kHz	69.2	69.1	69.7	72.9	74.1	74.6	75.1	75.3	75.4	75.4	75.5	75.6	75.6	75.7	75.7	75.7	75.7	75.7
8 kHz	61.1	61.3	62.0	65.0	66.3	66.6	66.8	66.9	66.9	66.8	66.8	66.8	66.8	66.8	66.7	66.7	66.7	66.6
10 kHz	55.6	56.0	56.7	58.5	59.6	59.7	59.6	59.5	59.4	59.3	59.2	59.1	59.0	58.9	58.9	58.8	58.7	58.6
A-wgt	95.1	95.6	96.6	99.1	100.5	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6

Table 6 Expected 1/3 octave band performance V110-2.0 MW, Mode 2 (with optional serrated trailing edge)

4. Limitations

The values as stated in the present document are to be regarded as “best estimates” for the octave band performance for the turbine. The values are to be regarded as informative and cannot in any way be used as guaranteed for any projects.

The complete document can be handed out as pdf and must always be referred to using the complete document DMS number.

5. Recalculation to 10 m wind speeds

In case 10 m height wind speed references are required, recalculation of the stated values can be made using the following procedure:

1. The stated hub height wind speeds are recalculated to 10 m reference height.
2. Integer 10 m height wind speed related sound power levels are calculated using linear interpolation between the nearest non integer values.

Recalculation is made using procedures as defined in IEC 61400-11 ed.3. Appendix D.

APPENDIX C

Battle River Substation Noise Assessment

July 28, 2010

Project
744000
Rev. 0

SW-29-40-15 W4M
ATCO Electric

ATCO Electric Battle River Substation 757S

Noise Impact Assessment

ATCO Structures & Logistics

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TABLES AND FIGURES

1. NOISE IMPACT ASSESSMENT SUMMARY

ATCO Structures and Logistics (ASL), has completed a Noise Impact Assessment (NIA) as requested by ATCO Electric for the electrical substation located at LSD SW-29-40-15 W4M immediately adjacent to the ATCO Power Battle River Generating Station on the Battle River, about 55 km east-northeast of Stettler, Alberta.

ASL personnel conducted sound pressure level measurements of the significant noise sources associated with the ATCO Electric substation during a site visit on July 15, 2010. Sound power levels were then calculated for the existing major noise sources of the ATCO Electric substation. These sound power levels were used in a computer model to provide the overall facility sound level, to generate an individual source order ranking of the major noise sources at the receptors, and to generate a noise contour map that indicates overall sound levels from the facility to the receptors.

The predicted sound pressure levels from the ATCO Electric substation at hypothetical receptors R1, R2, R3 and R4 are presented below in Table 1. There are no residential receptors within a 1500m radius of the station.

ASL personnel also performed far-field and limited near-field sound level measurements of the generating station. These sound power levels were used to calculate facility sound power levels, to generate a computer model to provide the overall facility sound level, and to calculate the generating station's noise contribution at the receptors.

Table 1: Predicted Sound Pressure Levels from Existing / Proposed ATCO Electric substation

Receptor Location	Predicted Substation Sound Level (L_{eq}, dBA)	Ambient Sound Level* (dBA)	Total Predicted Sound Level at Receptor (Substation only) (L_{eq}, dBA)	Predicted Generating Station Sound Level (dBA)	Total Predicted Sound Level at Receptor (Substation & Gen. Station) (L_{eq}, dBA)	AUC Nighttime PSL** (L_{eq}, dBA)
R1 **1500m North of the ATCO Electric Substation**	9	35	35	23	35	40
R2 **1500m East of the ATCO Electric Substation**	30	35	36	42	43	43
R3 **1500m South of the ATCO Electric Substation**	22	35	35	37	39	40
R4 **1500m West of the ATCO Electric Substation**	8	35	35	32	37	40

**In AUC Rule 012 (2010), the average rural ambient sound level in Alberta is deemed 5 dB less than the BSL.*
*** The determination of the PSL is presented in Appendix D.*

Table 2: Low-Frequency Noise - Predicted Facility dBC – dBA Levels

Receptor Location	Predicted Substation Sound Level (L_{eq}, dBC)	Predicted Substation Sound Level (L_{eq}, dBA)	Substation dBC – dBA Level (dB)
R1 **1500m North of the ATCO Electric Substation**	19	9	10
R2 **1500m East of the ATCO Electric Substation**	38	30	8
R3 **1500m South of the ATCO Electric Substation**	30	22	8
R4 **1500m West of the ATCO Electric Substation**	17	8	9

Further NIA analysis is presented for R2 and R3 only, as the modeling indicates that these two receptors are the critical receptors among the four.

The ATCO Power Battle River Generating Station a pre-1988 facility and is the dominant noise source in the area. With the noise level produced by the nearby power plant, the contribution of the proposed ATCO Electric Battle River 757S substation causes no measurable effect on the noise levels at 1500m. As the generating station is a pre-1988 facility, the existing levels (ambient plus generating station) without the contribution from the substation are determined to be the PSL; PSL = 42 + 35 = 43 dBA. The predicted results indicate that both the existing and the proposed ATCO Electric substation comply with the nighttime Permissible Sound Level (PSL) set out in the AUC Rule 012 at all four theoretical receptors. The key points of Rule 012 are outlined in Appendix C.

2. SITE DESCRIPTION & RECEPTOR LOCATION

The existing ATCO Electric substation consists of one 45/60/75 MVA transformer (701T) and one 200 MVA transformer (912T) which are currently the only significant producers of noise within the substation. There are also various pieces of switching equipment, a building and other non noise-producing equipment. The site is immediately adjacent to the ATCO Power owned Battle River Generating Station, which, when compared to the noise contribution of the ATCO Electric substation, has an overwhelming noise contribution generated by a multitude of noise-producing equipment.

About 450m to the south-southwest is the ATCO Electric Cordell substation, which has no noise-producing equipment.

ATCO Electric proposes to expand the capacity of the substation by adding one 72 kV 10 MVA shunt capacitor bank and one 144 kV circuit breaker. It is expected that, of the added equipment, only the capacitor bank will be a significant producer of noise.

The substation is located in a shallow prairie river valley and is adjacent to a cooling reservoir. Otherwise, outside the valley, the topography is generally flat and is primarily agricultural and grassland. There are no residences within 1500m. Four theoretical receptors have been placed for evaluative purposes at 1500m distance from the substation at the four cardinal points of the compass. Therefore R1 is 1500m north of the ATCO substation. R2 is 1500m east, R3 is 1500m south and finally, R4 is 1500m west. An aerial view of the study area is presented in Figure 2 in Appendix B.

3. EQUIPMENT SOUND PRESSURE LEVEL MEASUREMENTS

ASL personnel conducted sound pressure level measurements of the significant noise sources associated with the existing substation equipment as well as measurements of the ATCO Power generating station during a site visit on July 15, 2010. The sound pressure level measurements were conducted with a Brüel & Kjaer 2250 Real Time Analyzer set on both the linear and A-weighted scales. The measured sound level data was recorded and stored on the equipment for later analysis in ASL's office.

The precision sound level meter is of Type 1 and meets the ANSI S1.4, Type 1 specification. The sound level meter was field calibrated before and after the sound level measurements and has current laboratory certification. The measurements were performed in accordance with ANSI standard S1.13-2005, "Methods for the Measurement of Sound Pressure Levels in Air", and applicable ISO standards. A windscreen was placed on the microphone of the sound level meter to reduce the effects of wind-induced noise. The frequency range of the instrumentation was set between 12.5 Hz and 20,000 Hz. Table 3 shows the detailed equipment setup.

Table 3: Sound Level Meter Instrumentation Setup

Instrumentation	Sound Level Meter – Brüel & Kjaer 2250
Bandwidth	1/3 Octave
Peaks Over	140.0 dB
Range	20 – 140 dB
Broad-band	A-weighted & Linear
Spectral measurement	Linear
SLM Serial Number	2630388
Microphone Serial Number	2586681
Calibration Level	94.0 dB

Wind, temperature and relative humidity can have a significant effect on the propagation and measurement of sound. When the sound level measurements were taken, the temperature and relative humidity were within limits recommended for the proper operation of the instruments or AUC Rule 012 guidelines. Detailed weather conditions are reported in Table 4.

Table 4: Meteorological Conditions during Sound Level Measurements

Measurement Period	Average Wind Speed (km/h)	Temp (°C)	Average Relative Humidity (%)	Condition
10:30 ~ 12:30	<5 – 12 northeast	23	44	Clear

4. SOUND POWER LEVEL

The sound power levels of the significant substation noise sources associated with the existing substation equipment were calculated from the diagnostic measurements using commonly accepted engineering methods. Calculations were performed for each identified source in full octave bands between 31.5 Hz and 8000 Hz.

Sound power levels for the proposed noise-producing equipment were calculated using data within the ASL noise database.

Calculated sound power levels of the equipment for the proposed ATCO Electric substation are presented in Table 5, order ranked from highest to lowest overall dBA sound power level.

Calculated sound power levels of the ATCO Power Battle River Generating Station are presented in Table 6 and are all based on measurements at the site.

Table 5: Substation Noise Source Sound Power Level

Rank	Noise Source	Octave Band Center Frequency, Hz									dBA
		31.5	63	125	250	500	1000	2000	4000	8000	
1	Transformer 912T South Side	85	90	92	98	103	86	76	75	71	**100**
2	Transformer 912T North Side	87	91	91	98	102	85	76	69	56	**100**
3	Transformer 912T Cooler Fans	95	97	94	98	99	90	84	79	74	**98**
4	Transformer 912T East End	81	84	89	100	97	80	72	70	64	**96**
5	Transformer 912T Top	86	86	96	99	97	82	72	65	56	**96**
6	Transformer 912T West End	85	86	95	98	96	81	72	64	55	**95**
7	Transformer 912T Cooler Fins	85	86	95	98	96	81	71	64	55	**95**
8	Transformer 701T Fans	85	88	87	84	89	80	74	66	58	**88**
9	Transformer 701T Top	87	90	87	83	89	75	65	57	45	**87**
10	Transformer 701T Side	86	90	87	83	88	74	65	57	45	**86**
11	Transformer 701T East End	84	88	85	81	86	72	62	55	42	**84**
12	Transformer 701T West End	84	88	85	81	86	72	62	55	42	**84**
13	Capacitor Bank	73	77	82	71	76	74	67	51	48	**78**

Table 6: Generating Station Noise Source Sound Power Level

Rank	Noise Source	Octave Band Center Frequency, Hz									dBA
		31.5	63	125	250	500	1000	2000	4000	8000	
1	ATCO Plant Wall Breakout / Aggregate equipment	133	132	128	122	110	106	90	85	66	**117**
2	ATCO Power Transformer 704T	98	100	108	107	108	104	100	94	87	**109**
3	ATCO Power Transformer 703T	98	110	110	109	110	100	95	92	85	**109**
4	ATCO Power Transformer 705T	86	90	95	105	102	85	77	75	70	**101**
5	ATCO Power Transformer 701T	94	100	101	95	94	89	86	82	74	**96**
6	ATCO Power Transformer 702T	95	100	103	95	93	87	83	78	68	**94**

5. NOISE PROPAGATION MODEL

The acoustical modeling for this project was conducted using the Cadna/A computer software program from DataKustik GmbH. The meteorological conditions used were downwind conditions which favor the transmission of sound from the facilities to the receptors. The inputs for the model are presented in Table 7.

Table 7: Modeling Parameters

Item	Modeling Input and Description
Terrain of Site Area	As per Natural Resources Canada topographic map. **See Figure 1 in Appendix B**
Temperature	10°C
Relative Humidity	70%
Wind	3.6 to 18 km/h, from facility to receptor*
Ground Attenuation	0.5, rural area
Number of Sound Reflections	2
Receptor Height	1.5 m above ground
Operation Condition	Full load including transformer cooling fans on

**Propagation calculations under the ISO 9613 standard incorporate the effects of downwind propagation (from facility to receptor) with wind speeds of 1 to 5 m/s (3.6 to 18 km/hr) measured at a height of 3 to 11 m above the ground. This encompasses the acceptable summertime modeling conditions of AUC Rule 012 which require modeling a wind speed of 5.0 to 7.5 km/hr from the facility to the receptor.*

6. NOISE SOURCE RANKING

Table 8 and Table 9 below presents the predicted sound pressure levels from the existing and proposed ATCO Electric Substation at the critical receptors R2 and R3, order ranked for each major noise source.

Table 8: Ranking of Noise Sources at R2
(Proposed ATCO Electric Battle River 757S Substation)

Rank	Noise Source	Predicted Sound Level, dBA
1	Transformer 912T North Cooler Fans	25
2	Transformer 912T North Side	23
3	Transformer 912T East End	22
4	Transformer 912T North Cooler Fins	21
5	Transformer 912T South Cooler Fans	20
6	Transformer 701T Northeast Fans	16
7	Transformer 912T Top	15
8	Transformer 912T South Side	14
9	Transformer 912T North Cooler Discharge	12
10	Transformer 912T West End	11
11	Transformer 701T East End	10
12	Transformer 912T South Cooler Discharge	9
13	Transformer 912T South Cooler Fins	9
14	Transformer 701T North Side	7
15	Transformer 701T Top	4
16	Transformer 701T Southeast Fans	4
17	Transformer 701T Northwest Fans	4
18	Transformer 701T Southwest Fans	2
19	Capacitor Bank	1
20	Transformer 701T South Side	0
...	...	...
Overall		**30**

Table 9: Ranking of Noise Sources at R3
(Proposed ATCO Electric Battle River 757S Substation)

Rank	Noise Source	Predicted Sound Level, dBA
1	912T South Cooler Fans	17
2	912T South Side	16
3	912T East End	15
4	912T Top	12
5	912T South Cooler Fins	9
6	701T Southeast Fans	9
7	912T North Side	5
8	701T East End	4
9	701T Top	3
10	912T North Cooler Fans	3
11	912T North Cooler Discharge	0
12	912T North Cooler Fins	0
13	912T West End	0
14	912T South Cooler Discharge	0
15	701T South Side	0
16	701T Southwest Fans	0
17	701T Northeast Fans	0
18	701T Northwest Fans	0
19	Cap Bank	0
20	701T North Side	0
…	…	…
Overall		**22**

A colour noise contour map is presented in Figure 3 of Appendix B, illustrating the overall predicted sound levels at varying distances from the expanded ATCO Electric substation. Figure 4 shows the predicted sound levels when the noise contribution of both the expanded ATCO Electric substation and the ATCO Power Generating Station are included.

7. CONCLUSIONS

The predicted results indicate that both the existing and the expanded ATCO Electric battle River substation will comply with the nighttime Permissible Sound Level (PSL) set out in the AUC Rule 012 at all four theoretical receptors.

The ATCO Power Battle River Generating Station is a pre-1988 facility and is the dominant noise source in the area. Its noise contribution alone, without that of the ATCO Electric substation, causes the total noise levels at the 1500m radius to exceed 40 dBA at some points (42 dBA at R2). As a pre-1988 facility and in the absence of a complaint, this source in conjunction with the ambient level of 35 dBA joins to form the existing sound level and thus the PSL of 43 dBA at R2. The key points of Rule 012 are outlined in Appendix C.

8. DISCLAIMER

This "Noise Impact Assessment (NIA)", which is reported in the preceding pages, has been prepared in response to a specific request for service from the Client to whom it is addressed. The information contained in this "NIA" is not intended for the use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed, with the exception of the applicable regulating authority to whom this document may be submitted for planning permission purposes. We deny any liability whatsoever to other parties who may obtain access to the information contained in this "NIA" for any damages or injury suffered by such third parties arising from the use of this "NIA" by them without the express prior written permission from ASL and its Client who has commissioned this "NIA".

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Appendix A GLOSSARY

Ambient sound level – the background sound level. It is the sound level that is present in the acoustic environment of a defined area. Aircraft fly over and rail noise may be excluded in some jurisdictions.

A-weighted sound level, dBA – the sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components, similar to the frequency response of the human ear.

Frequency – the number of cycles per unit interval of time. *Units Hz (Hertz).*

C-weighted sound level, dBC – the C-weighting approximates the sensitivity of human hearing at industrial noise levels (above about 85 dBA). The C-weighted sound level is more sensitive to sounds at low frequencies than the A-weighted sound level, and is sometimes used to assess the low-frequency content of complex sound environments.

dB (Decibel) – the standard unit of measure, in acoustics, for level or level difference. The decibel scale is based on the ratio 101/10; multiplying a power-like quantity (such as sound power or mean square) by this factor increases its level by 1 decibel. If a power-like quantity is increased by a factor $10^n/10$, its level goes up by n decibels. *Unit symbol for dB.*

Equivalent Sound Level (L_{eq}) – the prime descriptor used in assessing most types of sounds heard in a community. The L_{eq} is an average of sounds measured over time. It is strongly influenced by occasional loud, intrusive noises.

Sound Power – the rate of acoustic energy flow across a specified surface, or emitted by a specified sound source. *Units W (Watt).*

Sound Power Level (PWL, L_W) – the level of sound power expressed in decibels relative to a stated reference value. The quantity L_w is defined by $L_w = 10 \text{ Log}_{10} (W/W_{ref})$. Here W_{ref} is the reference sound power. *Units dB re 1pW.*

Sound Pressure (Pa) – the difference between the instantaneous pressure at a fixed point in a sound field, and the pressure at the same point with the sound absent. *Units Pa (Pascal).*

Sound Pressure Level (SPL, L_p) – or sound pressure-squared level, at a given point the quantity L_p defined by $L_p = 10 \text{ Log}_{10} (P_{rms}/P_{ref})2 = 20 \text{ Log}_{10}(P_{rms}/P_{ref})$. Here P_{rms} is the root mean square sound pressure, and P_{ref} is the reference rms sound pressure, 20µPa. *Units dB re 20µPa.*

Appendix B STUDY AREA, TOPOGRAPHICAL CONTOURS & NOISE CONTOUR MAP

Figure 1: Study Area Topographical Contours

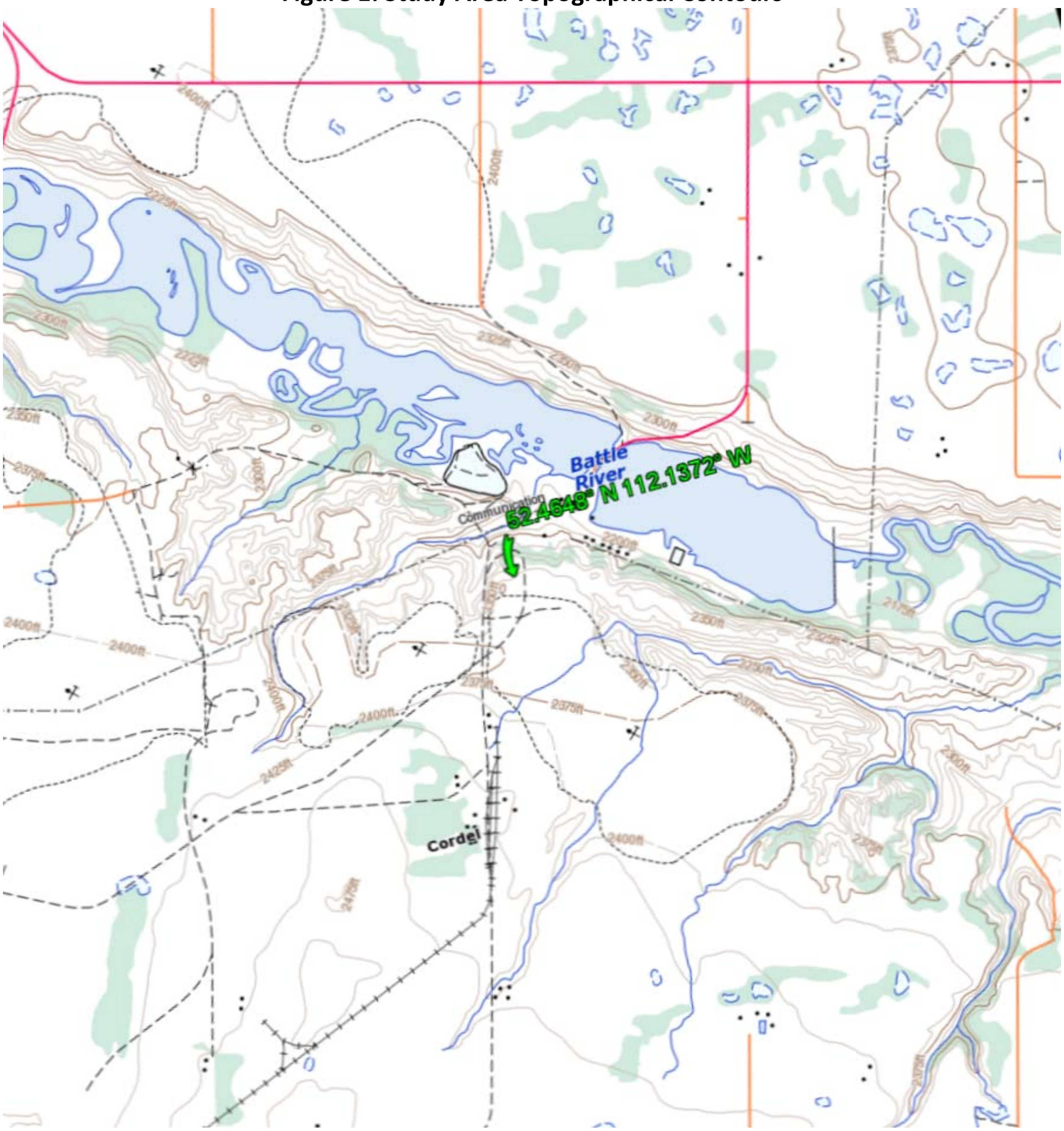


Figure 2: Study Area Map

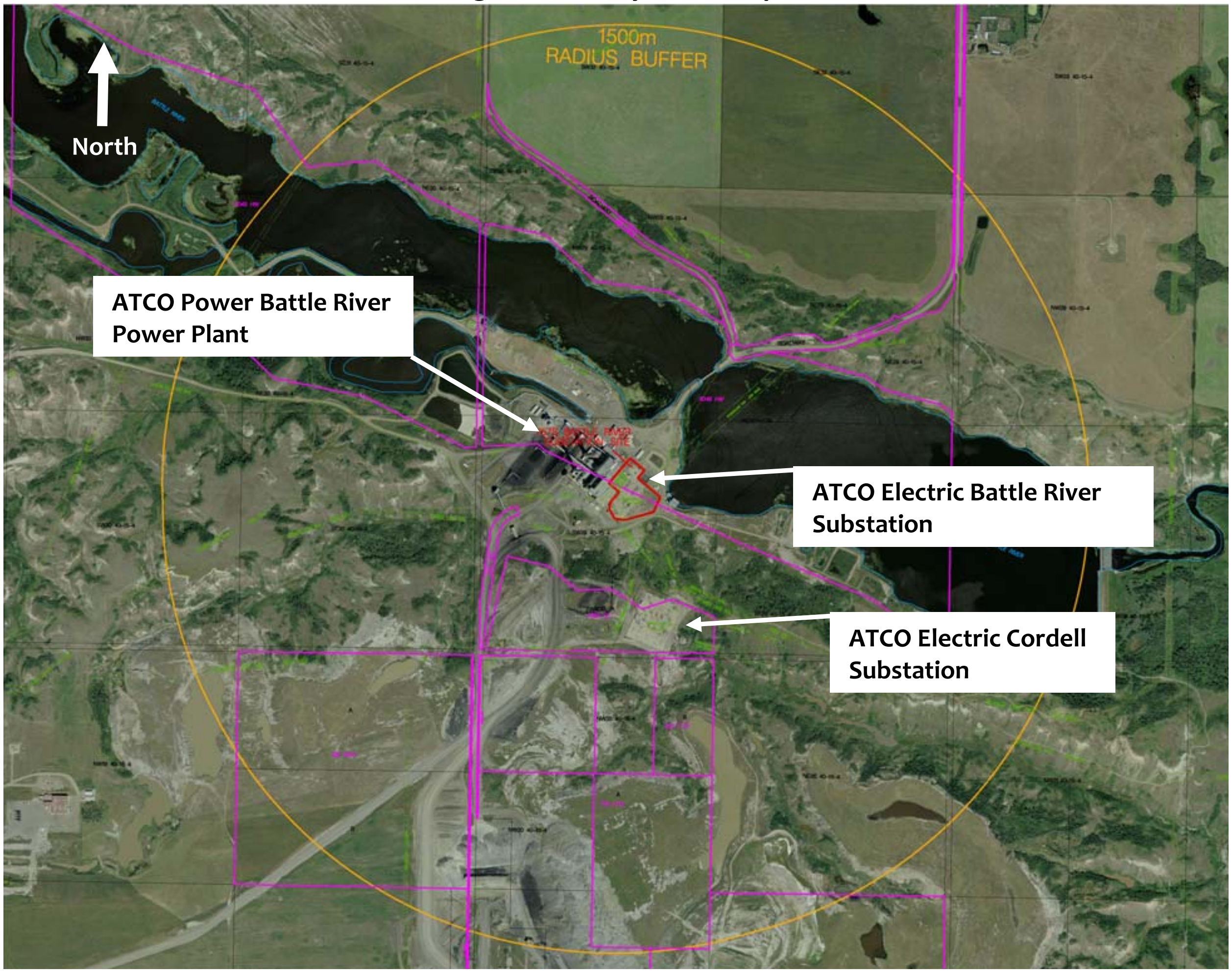


Figure 3: Noise Contour Map
(ATCO Electric Proposed Battle River 757S Substation)

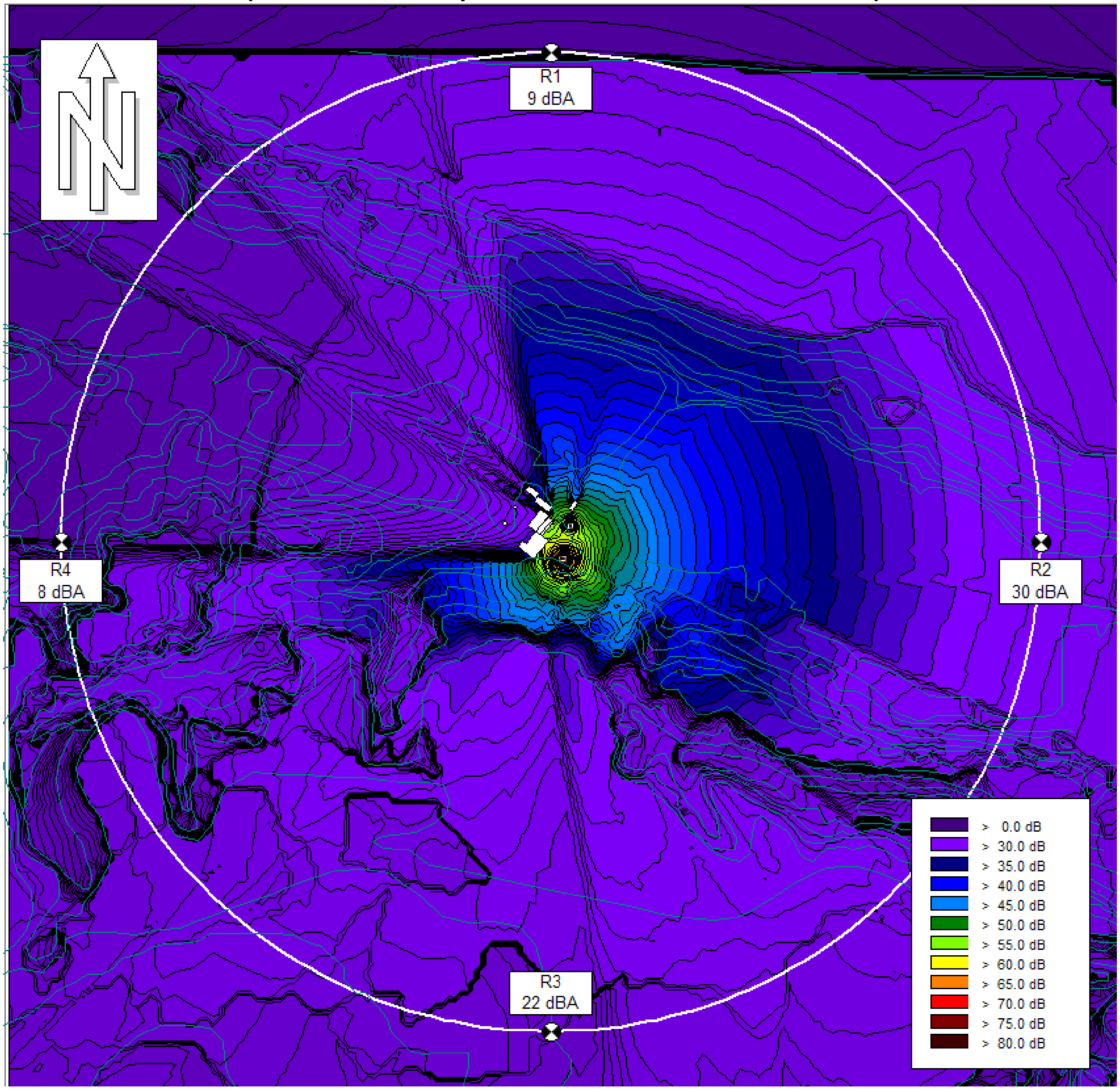
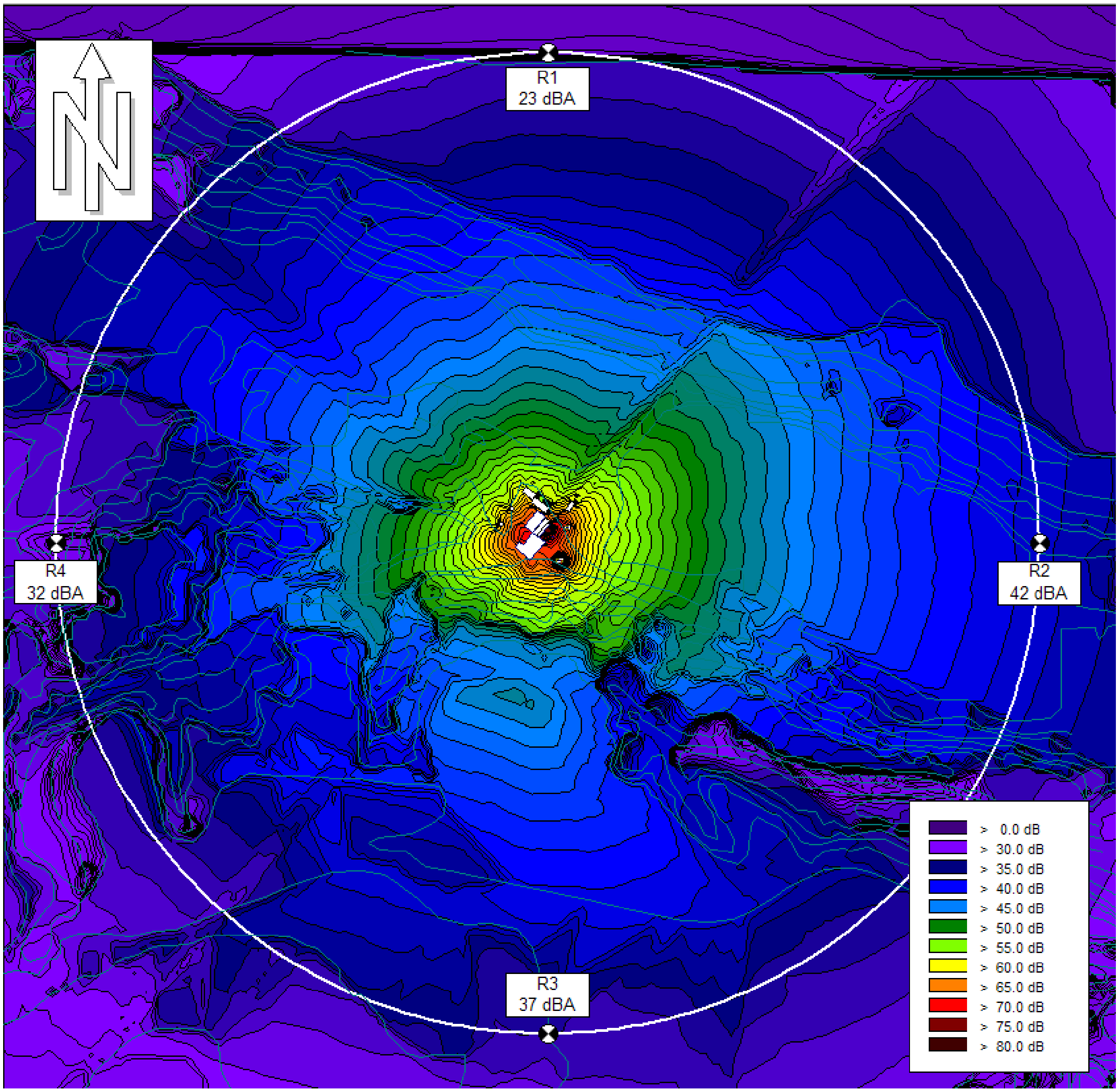


Figure 4: Noise Contour Map
(ATCO Electric Proposed Battle River 757S Substation and ATCO Power Battle River Generating Station)



Appendix C AUC RULE 012 KEY POINTS

Environmental noise from energy industry facilities in Alberta is regulated by the AUC, as described in AUC Rule 012. AUC Rule 012 has adopted the A-weighted energy equivalent sound levels (L_{eq}) as the sound pressure level criterion for a receptor location. AUC Rule 012 requires a Noise Impact Assessment (NIA) be completed for any new permanent facility or for modifications to existing permanent facilities where there is a reasonable expectation of a continuous noise source.

AUC Rule 012 considers noise from a receptor viewpoint, whereby noise emitted by energy industry facilities is specified at defined receptor locations, including residences. It applies to all facilities under the AUC jurisdiction or where the AUC will issue or has issued a permit to operate. New facilities planned for remote areas, where there are no impacted dwellings, must be designed to meet a target sound level of 40 dBA L_{eq} at a distance of 1500 m from the facility.

The PSLs are derived from information regarding the area population density, proximity to heavily traveled transportation routes including motor vehicle routes, rail lines and aircraft flyways and other specified adjustments. While actual compliance to the PSLs can only be determined by performing a valid comprehensive sound survey, the AUC expects the sound level for new facilities to meet the PSLs at the design phase through the preparation of a NIA.

PSL Determination for pre-1988 Facilities

(1) A facility constructed and in operation before October 17, 1988 is considered to be a deferred facility, meaning that it does not have to demonstrate compliance in the absence of a noise complaint.

(2) If a noise complaint is filed with the Commission, the licensee must calculate the PSL in accordance with sections 2.1 and 2.2.

(3) The pre-expansion or pre-modified PSL will become the PSL for any expansion or modification to the facility subsequent to 1988 if the PSL is currently above the PSL determined in accordance with section 2.

(4) A licensee must reduce existing noise from sources at the facility to make room for the introduction of new noise sources so that there is no net increase in total noise emitted from the facility.

(5) Effective October 17, 2018, the Commission will eliminate the deferred status for facilities built and in operation prior to 1988.

AUC Rule 012 includes a discussion on low frequency noise, which states that *"Low frequency noise (LFN) may be a problem in some situations where the dBA value is satisfactory but the concern is a dominant or resonant low frequency that creates a great deal of annoyance. Provided that data are available, weighted dBC minus dBA determinations should be made in the noise modeling of new plants or plant expansions to minimize the potential for LFN concerns."* A low frequency noise complaint condition may exist when:

- *"the isolated (i.e., nonfacility noise, such as wind noise, has been removed) time-weighted average dBC – dBA value for the measured day or night time period is equal to or greater than 20 dB, and*
- *a clear tonal component exists at a frequency below 250 Hz."*

Due to noise data and prediction method limitations the following restrictions apply to the predicted "dBC minus dBA" value:

- The dBC and dBA values can only be assessed in the full octave bands from 31.5 Hz to 8 kHz inclusive (based on ISO 9613).
- Due to the application of ISO 9613, noise prediction methods (including Cadna/A), only consider full octave band analysis – prediction in 1/3 octave band levels is not available. Therefore, the analysis of tonal components can only be assessed at the post-construction stage through measurement.

Appendix D PERMISSIBLE SOUND LEVEL DETERMINATION

Receptors R1, R3 and R4
ATCO Electric Substation LSD SW-29-40-15 W4M

Basic Nighttime Sound Level	Proximity to Transportation*	Dwelling Unit Density per ¼ Section of Land			Nighttime (22:00-07:00)	Daytime (07:00-22:00)
		1 – 8 Dwellings	9 – 160 Dwellings	>160 Dwellings		
	Category 1	40	43	46	40	50****
	Category 2	45	48	51		
	Category 3	50	53	56		
Class A Adjustments**	Class	Reason for Adjustment		Value (dBA Leq)		
	A1	Seasonal Adjustment (1 Nov – 31 Mar)		+5		
	A2	Ambient Monitoring Adjustment		-10 to +10		
Total Class A Adjustments					0	0
Class B Adjustments***	Class	Duration of Activity		Value (dBA Leq)		
	B1	1 day		+15		
	B2	1 week		+10		
	B3	< or = to 2 months		+5		
	B4	> 2 months		0		
Class B Adjustment					0	0
Permissible Sound Level (dBA)					40	50

**Proximity to Transportation Category Definitions:*

Category 1 - Dwelling units more than 500m from heavily traveled roads and/or rail lines and not subject to frequent aircraft flyovers;

Category 2 - Dwelling units more than 30m but less than 500m from heavily traveled roads and/or rail lines and not subject to frequent aircraft flyovers; and

Category 3 - Dwelling units less than 30m from heavily traveled roads and/or rail lines and subject to frequent aircraft flyovers.

***Class A Adjustment = Sum of A1 and A2 (as applicable), but not to exceed a maximum of 10 dBA Leq.*

****Class B Adjustment = One only of B1, B2, B3 or B4.*

*****Daytime Adjustment = 10 dB.*

Receptor R2

The PSL at R2 is determined by the existing sound levels produced by the pre-1988 ATCO Power generating station plus ambient sound without the inclusion of noise from the ATCO Electric Battle River substation. The generating station contribution was predicted from the computer modeling to be 42 dBA. Therefore the PSL is calculated as such:

$$PSL_{R2} = 42 + 35 \longrightarrow \mathbf{PSL_{R2} = 43\ dBA}$$

APPENDIX D

Letter Re: Tinchebray Substation

January 10, 2011

ATCO Electric
10035 105 St.
Edmonton, Alberta

Attention: Mr. Wes Caldwell

Re: Project 747600 – Tinchebray Substation NIA, Rev. 0

ATCO Structures & Logistics (ASL) has been retained by ATCO Electric to provide a Noise Impact Assessment (NIA) for the proposed Tinchebray substation. This substation is to be located at LSD 09-26-39-15 W4M which is roughly 24 km northeast of Halkirk, Alberta.

The proposed site is to be located in an area that is sparsely populated and primarily used for agriculture. From the review of satellite imagery, there appears to be no residential receptors within a 1500 metre perimeter of the proposed site boundary. ASL has determined the nighttime permissible sound level (PSL) for the facility to be 40 dBA at the 1500 metre perimeter in accordance with the Alberta Utilities Commission Rule 012 (2010).

The proposed Tinchebray substation will consist of the following equipment:

(a) Three 240 kV line circuit breakers;
(b) Manual disconnects on circuit breakers;
(c) Motorized disconnects on the line;
(d) Associated electrical and communications equipment.

The above stated equipment does not produce noise during normal operation. Therefore, this substation will comply with the PSL at the 1500 metre perimeter as outlined in the AUC Rule 012 (2010). Furthermore, the proposed substation will have no affect on the ambient sound levels at the 1500 metre perimeter.

ATCO STRUCTURES & LOGISTICS

Prepared by:	Reviewed by:
Arthur Küpper, P.Eng. Acoustical Engineer	Ashley Gibson, P.Eng. Manager, Acoustics

APPENDIX E

Paintearth Coal Mine Noise Assessment

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Phone: (780) 414-6373, Fax: (780) 414-6376
www.aciacoustical.com

Environmental Noise Impact Assessment
For

Paintearth Mine North Extension

Prepared for:
Prairie Mines & Royalty Ltd.

Prepared by:
S. Bilawchuk, M.Sc., P.Eng.
aci Acoustical Consultants Inc.
Edmonton, Alberta
APEGGA Permit to Practice #P7735

aci Project #: 09-053
December 1, 2009

Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Prairie Mines & Royalty Ltd. to conduct an environmental noise impact assessment for the proposed Paintearth Mine North Extension (the Project). The purpose of the work was to determine the potential noise impact in area surrounding the Project and compare to the Alberta Energy Resources Conservation Board (ERCB) Directive 038 on Noise Control and, if required, to provide noise mitigation recommendations.

The noise modeling results indicated sound levels (without additional noise mitigation) will be below their respective permissible sound levels (PSLs) at all of the nearby residential receptors as well as the 1,500 m receptors, except for a few locations to the west. When a single Dragline is operating at the northern portion of the North Extension Pit, no additional noise mitigation will be required. Once both Draglines are operational, however, noise mitigation may be required when mining activity is underway in both the “a” and “b” Pits. Various noise mitigation options are possible including constructing earth berms along the western sides of the Pits, equipment specific noise mitigation, and adjustments to operational procedures. The full extent of noise mitigation required is not fully known due to the variant nature of the equipment operation activity. Thus, upon operation of both the 8200 and 1570 Draglines in the year 2016 Pits, noise measurements will be conducted and operational conditions will be reviewed to determine the full extent of noise mitigation required and what will be done to achieve it.

Finally, the noise modeling indicated that low frequency tonal noise is not anticipated for most of the receptor locations for most of the modeling scenarios. There were some exceptions, however, but the calculated noise levels for those situations were well more than 5 dBA below the PSL. This means that any possible low frequency tonal penalties will not result in non-compliance.

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1.0 Introduction

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Prairie Mines & Royalty Ltd. to conduct an environmental noise impact assessment for the proposed Paintearth Mine North Extension (the Project). The purpose of the work was to determine the potential noise impact in area surrounding the Project and compare to the Alberta Energy Resources Conservation Board (ERCB) Directive 038 on Noise Control and, if required, to provide noise mitigation recommendations.

2.0 Descriptions

2.1. Location Description

The current Paintearth Mine is located in Townships 40 – 41 and Ranges 15 – 16 W4M, approximately 16 km south-southwest of Forestburg, Alberta. The current mining activity, as shown in Fig. 1, is spread out over two pits, straddling Highway 855. To the east, south, and west of the Mine License Boundary, the land is used for agricultural purposes and is sparsely populated by rural residents. To the north of the Mine License Boundary is the Battle River and Battle River Reservoir along with the Big Knife Provincial Park. Further north is more agricultural land with rural residents. The Project will extend the West Pit mine to the north into Sections 22, 23, 26, 27, 34, 35 in Township 40 and Range 16, W4M.

As indicated in Fig. 1, existing significant industrial facilities in the area include the ATCO Power Battle River Coal-Fired Electrical Generating Station (the Power Plant) which is a 670 MW Station with 3 boiler/generator units. The Power Plant is located in Sections 29 & 30, Township 40, Range 16, W4M. In addition, there is a TransCanada Compressor Station at Gadsby (LSD 04-15-40-16-W4M). This compressor station comprises of three gas turbine compressor units along with other minor mechanical equipment, piping, and valves. There are also some smaller wells located within the Mine License Area, however, the equipment at these wells is very small and produces negligible noise.

There are no residents within 1,500 m of the Mine License Area. The closest residents are at the following locations (as indicated in Fig. 1):

- LSD 04-16-40-16-W4M, - LSD 08-02-40-16-W4M
- LSD 05-01-40-16-W4M, - LSD 13-15-40-15-W4M

Topographically, the land in the area near the proposed North Mine Extension is relatively flat with a slight downward slope (approximately 15 m) from the southwest portion to the northeast portion. To the north of the Mine License Area the elevation reduces by approximately 55 m into the Battle River Valley. The land generally has an upward slope heading south towards the south end of the Mine License Area with minor depressions associated with water drainages. In general, the land that has not been disturbed by mining is covered primarily with grain crops and field grasses. There are small groups of trees and shrubs, however, the quantities are insufficient to result in significant acoustic absorption or barrier effect. In general, the ground cover is considered relatively absorptive.

2.2. Project Description

2.2.1. Current Operations

As mentioned previously, the current mining activity area, as shown in Fig. 1 is divided into the East Pit and the West Pit. The general mining equipment and operations are the same for each Pit, as follows:

- Scraper removing the topsoil and subsoil material from the area of the Pit yet to be mined and transporting to the areas which have had the overburden replaced (i.e. reclamation). This is typically at an elevation very near the existing grade.
- Dragline moving the overburden from the un-mined portion of the Pit to the recently mined portion. This is typically at an elevation approximately 3 metres below existing grade.
- Wheeled loader, loading coal into haul trucks for transport to the coal dump site. The loading activity is typically approximately 16 m below existing grade.
- Dozer pushing overburden into place in the recently mined portion of the Pit. This is typically at an elevation very near existing grade.
- Above mentioned Scraper depositing subsoil and topsoil after Dozer has moved on (again at an elevation near existing grade).
- Grader levelling topsoil for reclamation at an elevation near existing grade.

The coal haul trucks travel along the haul roads to the coal dump site, located just south of the Power Plant, then return for another load. The mining operations are 24-hours per day, 7-days per week.

2.2.2. Project Operations

The Project will involve extending the mine to the north of the existing West Pit. Starting in year 2013, the mining operations from the current West Pit will move to the far north area of the North Mine Extension (Sections 34 & 35, Township 40, Range 16, W4M) while the mining operations in the East Pit continue moving south. By year 2015, the mining operations from the East Pit will be completed and will move to the North Mine Extension and run adjacent to the existing mining operations. As a result, from 2015 – 2022, there will be two simultaneous mine pits operating within the Project area. The operations and equipment will be identical with the exception of the draglines. The western portion of the Project area will have a Marion 8200 Dragline while the eastern portion of the Project area will have a Bucyrus Erie 1570 Dragline. The remainder of the equipment is likely to be as follows[1]:

- Scrapers (Caterpillar 637G)
- Dozers (Caterpillar D10)
- Graders (Caterpillar 16M)
- Loaders (Caterpillar 993)
- Coal Haulers (Caterpillar 785)

The general mining operations from 2013 to 2022 will remain the same as the current operations with the coal haul going to the current dump site at the power plant and the dragline is scheduled to operate 24 hour per day. When operating in 2013 and 2020 – 2022, the operations will only be 12-hours per day but will rotate between day-shifts and night-shifts. As such, there will be regular day-time and night-time operations. When operating from 2014 – 2019 the amount of overburden that needs to be moved will be beyond the capacity of the existing draglines. As such, loaders and haul trucks will be used to pre-strip overburden to supplement the draglines. This will be done in 12-hour shifts, opposite to the coal haul. As a result, for 12-hours out of the day, the mining operations will be as described above in Section 2.2.1. (i.e. scrapers/draglines/loaders/haul trucks/dozers/graders). For the other 12-hours, the draglines will be operational, the loaders and haul trucks will move from the coal haul to pre-stripping of overburden in an area ahead of the dragline. The overburden will be hauled to the north-side of the Pit and deposited in the overburden piles created by the dragline. The scrapers and graders will be operational during this 12-hour period. These two 12-hour shifts will rotate through day/night such that each will impact both the day-time and night-time. This has been taken into account with the various noise modeling scenarios described in Section 3.5.

[1] Exact equipment used may differ from these listed, however, the general capacities will remain, resulting in similar noise levels

3.0 Measurement & Modeling Methods

3.1. Environmental Noise Monitoring

There are no residents within 1,500 m of the Project. In addition, there is a significant existing industrial noise source in the area to the southwest of the Project. However, this existing noise source was not operational during the time of the noise study (the facility was off-line for an overhaul for several months). As such, a baseline noise monitoring was not conducted. This conforms with the requirements of the ERCB Directive 038 on Noise Control.

3.2. Short Term Spot Measurements

Short term sound level measurements were conducted in order to determine the sound levels associated with some of the site equipment. The measurements involved placing the sound level meter at a fixed location and allowing it to log sound level data while specific equipment operated nearby at a known distance. The data were then reviewed and sound power levels were derived for some of the equipment and operations.

Refer to Appendix I for a detailed description of the measurement equipment used, Appendix II for a description of the acoustical terminology, and Appendix III for a list of common noise sources. All noise measurement instrumentation was calibrated at the start of the measurements and then checked afterwards to ensure that there had been no calibration drift over the duration of the measurements.

3.3. Computer Noise Modeling

The computer noise modeling was conducted using the CADNA/A (version 3.72.131) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and various stationary sources. In addition, topographical features such as land contours, vegetation, and bodies of water can be included. Finally, meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction can be included in the calculations. Note that all modeling methods used exceed the requirements of the Alberta Energy Resources Conservation Board Directive 038 on Noise Control.

The calculation method used for noise propagation follows the ISO standard 9613-2. All receiver locations were assumed as being downwind from the source(s). In particular, as stated in Section 5 of the ISO document:

> "Downwind propagation conditions for the method specified in this part of IS0 9613 are as specified in 5.4.3.3 of IS0 1996-2:1987, namely
>
> - wind direction within an angle of ± 45^0 of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver, and
> - wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.
>
> The equations for calculating the average downwind sound pressure level LAT(DW) in this part of IS0 9613, including the equations for attenuation given in clause 7, are the average for meteorological conditions within these limits. The term average here means the average over a short time interval, as defined in 3.1.
>
> These equations also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights".

Due to the small amount of vegetation, and thus relative ineffectiveness to mitigate the noise climate, no specific vegetative sound absorption was included in the model. Similarly, no snow cover was included since there can be variation in absorption/reflection caused by different snow conditions. As a result, all sound level propagation calculations are considered representative of summertime conditions for all surrounding receptors.

The computer noise modeling results were calculated in two ways. First, sound levels were calculated at specific receiver locations (i.e. 1,500 m receptors and residential receptors). Next, the sound levels were calculated using a 50 m x 50 m grid over the entire study area. This provided color noise contours for easier visualization of the results.

3.4. Noise Sources

The noise sources for the equipment associated with the Project and other adjacent industrial facilities are provided in Appendix IV. The data were obtained either from:

- noise measurements conducted at the existing site relative to existing equipment or,
- noise measurement assessments carried out for other projects using similar operating equipment or,
- aci in-house information and calculations using methods presented in various texts or,
- Sound level information provided by equipment suppliers/manufacturers.

With the exception of the Haul Trucks, all noise sources have been modeled as point sources at their appropriate heights[1] and operating at the locations detailed in Section 3.5. The Haul Trucks have been modeled as traveling point sources, driving along the haul roads with appropriate speeds and cycle times. All sound power levels (SWLs) used in the modeling are considered conservative.

In addition to the noise sources associated with the Scrapers, Dozers, Draglines, Loaders, Haul Trucks, Graders, and water truck, there will be noise associated with back-up beepers. In particular, the Haul Trucks are equipped with back-up beepers and they will be in use as the proposed method for loading is to have the Haul Trucks back into position near the Loaders. In addition, other equipment such as Dozers, Scrapers, and Graders may have back-up beepers. The relative noise impact of the back-up beepers is difficult to predict since the orientation of the equipment and surrounding topography will have a significant impact on the noise levels and these two variables are constantly changing. The relative error inherent with this is too great to accurately model such a noise source. In addition, the closest resident to the Project is more than 2.5 km away, which will render the high frequency back-up beeper noise in-audible. Thus, back-up beepers have not been modeled.

Noise level data associated with the TransCanada compressor station was determined from manufacturers published information for the specific gas turbine used. The station has three gas turbines, however, information provided by operations personnel indicated that it is typical for one specific unit to run while the others are off. In addition, a full equipment list was not available from TransCanada. As such, the noise levels from that particular gas turbine unit were used as the only noise sources on site. All other site noise sources are likely much lower in amplitude than the gas turbine, so

[1] The heights for many of the sources are generally slightly higher than actual. This makes the model more conservative

not including them will likely have a minimal impact on the accuracy of the noise modeling results. The noise sources associated with the TransCanada gas turbine are provided in Appendix IV.

Finally, Directive 038 requires the assessment to include background ambient noise levels in the model. As specified in Directive 038, in most rural areas of Alberta where there is an absence of industrial noise sources the average night-time ambient noise level is approximately 35 dBA. This is known as the average ambient sound level (ASL). This value was used as the ambient condition in the modeling with the various Project related noise sources added.

3.5. Modeling Scenarios

In order to determine the impact of the Project on the surrounding noise climate, several scenarios were modeled. These scenarios provide a representative account of the noise levels at various stages of the Project without going through the Project year-by-year.

3.5.1. Scenario 1

West end of year 2013 West Pit and east end of year 2013 East Pit
Coal Haul

- Scraper operating at west end of year 2013 West Pit
- 8200 Dragline operating at west end of year 2013 West Pit (north of Scraper)
- Loader operating at west end of year 2013 West Pit (north of Dragline)
- Dozer operating at west end of year 2013 West Pit (north of Loader)
- Grader operating at west end of year 2013 West Pit (north of Dozer)
- Coal Haul trucks at 4.5 trips per hour for year 2013 West Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2013 West Pit

- Scraper operating at east end of year 2013 East Pit
- 1570 Dragline operating at east end of year 2013 East Pit (north of Scraper)
- Loader operating at east end of year 2013 East Pit (north of Dragline)
- Dozer operating at east end of year 2013 East Pit (north of Loader)
- Grader operating at east end of year 2013 East Pit (north of Dozer)
- Coal Haul trucks at 3.5 trips per hour for year 2013 East Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2013 East Pit

3.5.2. Scenario 2

East end of year 2013 West Pit and east end of year 2013 East Pit
Coal Haul

- Scraper operating at east end of year 2013 West Pit
- 8200 Dragline operating at east end of year 2013 West Pit (north of Scraper)
- Loader operating at east end of year 2013 West Pit (north of Dragline)
- Dozer operating at east end of year 2013 West Pit (north of Loader)
- Grader operating at east end of year 2013 West Pit (north of Dozer)
- Coal Haul trucks at 4.5 trips per hour for year 2013 West Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2013 West Pit

- Scraper operating at east end of year 2013 East Pit
- 1570 Dragline operating at east end of year 2013 East Pit (north of Scraper)
- Loader operating at east end of year 2013 East Pit (north of Dragline)
- Dozer operating at east end of year 2013 East Pit (north of Loader)
- Grader operating at east end of year 2013 East Pit (north of Dozer)
- Coal Haul trucks at 3.5 trips per hour for year 2013 East Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2013 East Pit

3.5.3. Scenario 3a

West end of year 2016a Pit and west end of year 2016b Pit
Coal haul

- Scraper operating at west end of year 2016a Pit
- 8200 Dragline operating at west end of year 2016a Pit (north of Scraper)
- Loader operating at west end of year 2016a Pit (north of Dragline)
- Dozer operating at west end of year 2016a Pit (north of Loader)
- Grader operating at west end of year 2016a Pit (north of Dozer)
- Coal Haul trucks at 4.5 trips per hour for year 2016a Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016a Pit

- Scraper operating at west end of year 2016b Pit
- 1570 Dragline operating at west end of year 2016b Pit (north of Scraper)
- Loader operating at west end of year 2016b Pit (north of Dragline)
- Dozer operating at west end of year 2016b Pit (north of Loader)
- Grader operating at west end of year 2016b Pit (north of Dozer)
- Coal Haul trucks at 3.5 trips per hour for year 2016b Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016b Pit

3.5.4. Scenario 3b

West end of year 2016a Pit and west end of year 2016b Pit
Overburden pre-strip

- Scraper operating at west end of year 2016a Pit
- 8200 Dragline operating at west end of year 2016a Pit (north of Scraper)
- Loader operating at west end of year 2016a Pit (north of Dragline)
- Dozer operating at west end of year 2016a Pit (north of Loader)
- Grader operating at west end of year 2016a Pit (north of Dozer)
- Haul trucks hauling overburden to north of Dragline at 45 trips per hour for year 2016a Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016a Pit

- Scraper operating at west end of year 2016b Pit
- 1570 Dragline operating at west end of year 2016b Pit (north of Scraper)
- Loader operating at west end of year 2016b Pit (north of Dragline)
- Dozer operating at west end of year 2016b Pit (north of Loader)
- Grader operating at west end of year 2016b Pit (north of Dozer)
- Haul trucks hauling overburden to north of Dragline at 45 trips per hour for year 2016b Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016b Pit

3.5.5. Scenario 4a

East end of year 2016a Pit and east end of year 2016b Pit
Coal haul

- Scraper operating at east end of year 2016a Pit
- 8200 Dragline operating at east end of year 2016a Pit (north of Scraper)
- Loader operating at east end of year 2016a Pit (north of Dragline)
- Dozer operating at east end of year 2016a Pit (north of Loader)
- Grader operating at east end of year 2016a Pit (north of Dozer)
- Coal Haul trucks at 4.5 trips per hour for year 2016a Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016a Pit

- Scraper operating at east end of year 2016b Pit
- 1570 Dragline operating at east end of year 2016b Pit (north of Scraper)
- Loader operating at east end of year 2016b Pit (north of Dragline)
- Dozer operating at east end of year 2016b Pit (north of Loader)
- Grader operating at east end of year 2016b Pit (north of Dozer)
- Coal Haul trucks at 3.5 trips per hour for year 2016b Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016b Pit

3.5.6. Scenario 4b

East end of year 2016a Pit and east end of year 2016b Pit
Overburden pre-strip

- Scraper operating at east end of year 2016a Pit
- 8200 Dragline operating at east end of year 2016a Pit (north of Scraper)
- Loader operating at east end of year 2016a Pit (north of Dragline)
- Dozer operating at east end of year 2016a Pit (north of Loader)
- Grader operating at east end of year 2016a Pit (north of Dozer)
- Haul trucks hauling overburden to north of Dragline at 45 trips per hour for year 2016a Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016a Pit

- Scraper operating at east end of year 2016b Pit
- 1570 Dragline operating at east end of year 2016b Pit (north of Scraper)
- Loader operating at east end of year 2016b Pit (north of Dragline)
- Dozer operating at east end of year 2016b Pit (north of Loader)
- Grader operating at east end of year 2016b Pit (north of Dozer)
- Haul trucks hauling overburden to north of Dragline at 45 trips per hour for year 2016b Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2016b Pit

3.5.7. Scenario 5

West end of year 2021a Pit and west end of year 2021b Pit
Coal haul

- Scraper operating at west end of year 2021a Pit
- 8200 Dragline operating at west end of year 2021a Pit (north of Scraper)
- Loader operating at west end of year 2021a Pit (north of Dragline)
- Dozer operating at west end of year 2021a Pit (north of Loader)
- Grader operating at west end of year 2021a Pit (north of Dozer)
- Coal Haul trucks at 4.5 trips per hour for year 2021a Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2021a Pit

- Scraper operating at west end of year 2021b Pit
- 1570 Dragline operating at west end of year 2021b Pit (north of Scraper)
- Loader operating at west end of year 2021b Pit (north of Dragline)
- Dozer operating at west end of year 2021b Pit (north of Loader)
- Grader operating at west end of year 2021b Pit (north of Dozer)
- Coal Haul trucks at 3.5 trips per hour for year 2021b Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2021b Pit

3.5.8. Scenario 6

East end of year 2021a Pit and east end of year 2021b Pit
Coal haul

- Scraper operating at east end of year 2021a Pit
- 8200 Dragline operating at east end of year 2021a Pit (north of Scraper)
- Loader operating at east end of year 2021a Pit (north of Dragline)
- Dozer operating at east end of year 2021a Pit (north of Loader)
- Grader operating at east end of year 2021a Pit (north of Dozer)
- Coal Haul trucks at 4.5 trips per hour for year 2021a Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2021a Pit

- Scraper operating at east end of year 2021b Pit
- 1570 Dragline operating at east end of year 2021b Pit (north of Scraper)
- Loader operating at east end of year 2021b Pit (north of Dragline)
- Dozer operating at east end of year 2021b Pit (north of Loader)
- Grader operating at east end of year 2021b Pit (north of Dozer)
- Coal Haul trucks at 3.5 trips per hour for year 2021b Pit
- Water truck for dust suppression operating at 0.25 trips per hour for year 2021b Pit

3.6. Mitigation Scenarios

As a result of the noise modeling, some of the above listed scenarios resulted in noise levels that exceeded the permissible sound levels. As such, noise mitigation was incorporated into the noise models for scenarios 3a, 3b, and 5 and the sound levels were re-calculated. The noise mitigation included earth berms along the western edge of the pit development for both the "a" and "b" pits.

3.7. Modeling Confidence

As mentioned previously, the algorithms used for the noise modeling follow the ISO 9613 standard. The published accuracy for this standard is ±3 dBA between 100 m – 1,000 m. Accuracy levels beyond 1,000 m are not published. Experience based on similar noise models conducted over large distances shows that, as expected, as the distance increases, the associated accuracy in prediction decreases. Experience has shown that environmental factors such as wind, temperature inversions, topography and ground cover all have increasing effects over distances larger than approximately 1,500 m. As such, for all receptors within approximately 1,500 m of the various noise sources, the prediction confidence is considered high, while for all receptors beyond 1,500 m, the prediction confidence is considered moderate.

4.0 Permissible Sound Levels

Environmental noise levels from various sources are commonly described in terms of equivalent sound levels or L_{eq}. This is the level of a steady sound having the same acoustic energy, over a given time period, as the fluctuating sound. In addition, this energy averaged level is A–weighted to account for the reduced sensitivity of average human hearing to low frequency sounds. These L_{eq} in dBA, which are the most common environmental noise measure, are often given for day-time (07:00 to 22:00) L_{eq}Day and night-time (22:00 to 07:00) L_{eq}Night while other criteria use the entire 24-hour period as L_{eq}24.

The document which most directly relates to the Permissible Sound Levels (PSL's) for this NIA is the ERCB Directive 038 on Noise Control (2007). This Directive sets the PSL at the receiver location based on population density and relative distances to heavily traveled road and rail as shown in Table 1. In all instances, there is a Basic Sound Level (BSL) of 40 dBA for the night-time (night-time hours are 22:00 – 07:00) and 50 dBA for the day-time (day-time hours are 07:00 – 22:00). Note that for this location, none of the adjustments to the BSL (discussed in the Directive 038) apply. In addition, Directive 038 specifies that new facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line if there are no closer dwellings. As such, the PSL at each of the 1,500 m receptors and the residential receptors is an **L_{eq}Night of 40 dBA and an L_{eq}Day of 50 dBA.**

Table 1. Basic Night-Time Sound Levels (as per ERCB Directive 038)

	Dwelling Density per Quarter Section of Land		
Proximity to Transportation	**1-8 Dwellings**	**9-160 Dwellings**	**>160 Dwellings**
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

Category 1 Dwelling units more than 500m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

Category 2 Dwelling units more than 30m but less than 500m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

Category 3 Dwelling units less than 30m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

5.0 Results and Discussion

5.1. Scenario 1

The noise modeling results for Scenario 1 are shown in Table 2 and Fig. 2. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks. Based on the results, no additional noise mitigation is required.

Table 2. Scenario 1 Application Case Sound Levels

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	37.6	39.5	40.0	YES
R2 (1,500 m)	35.0	38.3	40.0	40.0	YES
R3 (1,500 m)	35.0	32.1	36.8	40.0	YES
R4 (1,500 m)	35.0	35.6	38.3	40.0	YES
R5 (1,500 m)	35.0	35.7	38.4	40.0	YES
R6 (1,500 m)	35.0	31.7	36.7	40.0	YES
R7 (1,500 m)	35.0	32.9	37.1	40.0	YES
R8 (1,500 m)	35.0	37.8	39.6	40.0	YES
R9 (1,500 m)	35.0	29.9	36.2	40.0	YES
R10 (1,500 m)	35.0	23.1	35.3	40.0	YES
R11 (1,500 m)	35.0	18.6	35.1	40.0	YES
R12 (1,500 m)	35.0	20.7	35.2	40.0	YES
R13 (1,500 m)	35.0	25.0	35.4	40.0	YES
R14 (1,500 m)	35.0	23.6	35.3	40.0	YES
R15 (1,500 m)	35.0	28.7	35.9	40.0	YES
R16 (1,500 m)	35.0	34.2	37.6	40.0	YES
R17 (1,500 m)	35.0	35.0	38.0	40.0	YES
R18 (1,500 m)	35.0	33.5	37.3	40.0	YES
R19 (1,500 m)	35.0	35.6	38.3	40.0	YES
R20 (1,500 m)	35.0	37.9	39.7	40.0	YES
R21 (1,500 m)	35.0	36.5	38.8	40.0	YES
Resident 1	35.0	34.7	37.9	40.0	YES
Resident 2	35.0	25.8	35.5	40.0	YES
Resident 3	35.0	26.0	35.5	40.0	YES
Resident 4	35.0	34.3	37.7	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 3 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 3, all locations have a dBC – dBA sound level less than 20 dB.

Table 3. Scenario 1 Application Case dBA and dBC Sound Levels

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	37.6	47.1	9.5	NO
R2 (1,500 m)	38.3	49.9	11.6	NO
R3 (1,500 m)	32.1	47.6	15.5	NO
R4 (1,500 m)	35.6	49.5	13.9	NO
R5 (1,500 m)	35.7	50.3	14.6	NO
R6 (1,500 m)	31.7	46.1	14.4	NO
R7 (1,500 m)	32.9	45.7	12.8	NO
R8 (1,500 m)	37.8	47.7	9.9	NO
R9 (1,500 m)	29.9	42.1	12.2	NO
R10 (1,500 m)	23.1	38.1	15.0	NO
R11 (1,500 m)	18.6	32.4	13.8	NO
R12 (1,500 m)	20.7	37.4	16.7	NO
R13 (1,500 m)	25.0	42.0	17.0	NO
R14 (1,500 m)	23.6	40.8	17.2	NO
R15 (1,500 m)	28.7	46.0	17.3	NO
R16 (1,500 m)	34.2	50.2	16.0	NO
R17 (1,500 m)	35.0	51.0	16.0	NO
R18 (1,500 m)	33.5	48.8	15.3	NO
R19 (1,500 m)	35.6	48.7	13.1	NO
R20 (1,500 m)	37.9	49.5	11.6	NO
R21 (1,500 m)	36.5	46.2	9.7	NO
Resident 1	34.7	50.9	16.2	NO
Resident 2	25.8	42.1	16.3	NO
Resident 3	26.0	42.1	16.1	NO
Resident 4	34.3	46.0	11.7	NO

5.2. Scenario 2

The noise modeling results for Scenario 2 are shown in Table 4 and Fig. 3. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks. Based on the results, no additional noise mitigation is required.

Table 4. Scenario 2 Application Case Sound Levels

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	34.7	37.9	40.0	YES
R2 (1,500 m)	35.0	37.4	39.4	40.0	YES
R3 (1,500 m)	35.0	33.9	37.5	40.0	YES
R4 (1,500 m)	35.0	35.8	38.4	40.0	YES
R5 (1,500 m)	35.0	35.7	38.4	40.0	YES
R6 (1,500 m)	35.0	31.8	36.7	40.0	YES
R7 (1,500 m)	35.0	33.0	37.1	40.0	YES
R8 (1,500 m)	35.0	37.8	39.6	40.0	YES
R9 (1,500 m)	35.0	29.9	36.2	40.0	YES
R10 (1,500 m)	35.0	23.0	35.3	40.0	YES
R11 (1,500 m)	35.0	18.6	35.1	40.0	YES
R12 (1,500 m)	35.0	20.7	35.2	40.0	YES
R13 (1,500 m)	35.0	25.0	35.4	40.0	YES
R14 (1,500 m)	35.0	23.6	35.3	40.0	YES
R15 (1,500 m)	35.0	28.7	35.9	40.0	YES
R16 (1,500 m)	35.0	34.1	37.6	40.0	YES
R17 (1,500 m)	35.0	34.8	37.9	40.0	YES
R18 (1,500 m)	35.0	32.6	37.0	40.0	YES
R19 (1,500 m)	35.0	31.6	36.6	40.0	YES
R20 (1,500 m)	35.0	31.5	36.6	40.0	YES
R21 (1,500 m)	35.0	30.6	36.3	40.0	YES
Resident 1	35.0	34.6	37.8	40.0	YES
Resident 2	35.0	25.9	35.5	40.0	YES
Resident 3	35.0	26.0	35.5	40.0	YES
Resident 4	35.0	34.3	37.7	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 5 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 5, all locations have a dBC – dBA sound level less than 20 dB.

Table 5. Scenario 2 Application Case dBA and dBC Sound Levels

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	34.7	45.5	10.8	NO
R2 (1,500 m)	37.4	47.4	10.0	NO
R3 (1,500 m)	33.9	47.7	13.8	NO
R4 (1,500 m)	35.8	49.6	13.8	NO
R5 (1,500 m)	35.7	50.2	14.5	NO
R6 (1,500 m)	31.8	46.1	14.3	NO
R7 (1,500 m)	33.0	45.8	12.8	NO
R8 (1,500 m)	37.8	47.8	10.0	NO
R9 (1,500 m)	29.9	42.1	12.2	NO
R10 (1,500 m)	23.0	38.1	15.1	NO
R11 (1,500 m)	18.6	32.4	13.8	NO
R12 (1,500 m)	20.7	37.4	16.7	NO
R13 (1,500 m)	25.0	42.0	17.0	NO
R14 (1,500 m)	23.6	40.8	17.2	NO
R15 (1,500 m)	28.7	46.0	17.3	NO
R16 (1,500 m)	34.1	50.1	16.0	NO
R17 (1,500 m)	34.8	50.9	16.1	NO
R18 (1,500 m)	32.6	48.6	16.0	NO
R19 (1,500 m)	31.6	45.7	14.1	NO
R20 (1,500 m)	31.5	43.6	12.1	NO
R21 (1,500 m)	30.6	42.9	12.3	NO
Resident 1	34.6	50.9	16.3	NO
Resident 2	25.9	42.1	16.2	NO
Resident 3	26.0	42.1	16.1	NO
Resident 4	34.3	46.1	11.8	NO

5.3. Scenario 3a (Without Noise Mitigation)

The noise modeling results for Scenario 3a without noise mitigation are shown in Table 6. The results indicate noise levels below the PSL at all but one of the 1,500 m receptor locations and at all of the residential receptor locations. As such, noise mitigation may be required. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks.

Table 6. Scenario 3a Application Case Sound Levels Without Noise Mitigation

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	33.7	37.4	40.0	YES
R2 (1,500 m)	35.0	33.6	37.4	40.0	YES
R3 (1,500 m)	35.0	33.2	37.2	40.0	YES
R4 (1,500 m)	35.0	35.7	38.4	40.0	YES
R5 (1,500 m)	35.0	34.9	38.0	40.0	YES
R6 (1,500 m)	35.0	30.0	36.2	40.0	YES
R7 (1,500 m)	35.0	27.4	35.7	40.0	YES
R8 (1,500 m)	35.0	25.5	35.5	40.0	YES
R9 (1,500 m)	35.0	19.2	35.1	40.0	YES
R10 (1,500 m)	35.0	14.9	35.0	40.0	YES
R11 (1,500 m)	35.0	7.2	35.0	40.0	YES
R12 (1,500 m)	35.0	15.7	35.1	40.0	YES
R13 (1,500 m)	35.0	24.2	35.3	40.0	YES
R14 (1,500 m)	35.0	24.6	35.4	40.0	YES
R15 (1,500 m)	35.0	29.5	36.1	40.0	YES
R16 (1,500 m)	35.0	34.7	37.9	40.0	YES
R17 (1,500 m)	35.0	36.4	38.8	40.0	YES
R18 (1,500 m)	35.0	36.9	39.1	40.0	YES
R19 (1,500 m)	35.0	42.8	43.5	40.0	NO
R20 (1,500 m)	35.0	36.8	39.0	40.0	YES
R21 (1,500 m)	35.0	32.8	37.0	40.0	YES
Resident 1	35.0	35.6	38.3	40.0	YES
Resident 2	35.0	25.9	35.5	40.0	YES
Resident 3	35.0	26.0	35.5	40.0	YES
Resident 4	35.0	26.7	35.6	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 7 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 7, most locations have a dBC – dBA sound level less than 20 dB. There are two locations with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 7. Scenario 3a Application Case dBA and dBC Sound Levels Without Noise Mitigation

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	33.7	45.2	11.5	NO
R2 (1,500 m)	33.6	45.6	12.0	NO
R3 (1,500 m)	33.2	47.7	14.5	NO
R4 (1,500 m)	35.7	49.6	13.9	NO
R5 (1,500 m)	34.9	49.5	14.6	NO
R6 (1,500 m)	30.0	45.4	15.4	NO
R7 (1,500 m)	27.4	43.7	16.3	NO
R8 (1,500 m)	25.5	42.5	17.0	NO
R9 (1,500 m)	19.2	38.5	19.3	NO
R10 (1,500 m)	14.9	35.8	20.9	Possible
R11 (1,500 m)	7.2	26.2	19.0	NO
R12 (1,500 m)	15.7	36.2	20.5	Possible
R13 (1,500 m)	24.2	41.9	17.7	NO
R14 (1,500 m)	24.6	41.2	16.6	NO
R15 (1,500 m)	29.5	46.7	17.2	NO
R16 (1,500 m)	34.7	50.3	15.6	NO
R17 (1,500 m)	36.4	51.7	15.3	NO
R18 (1,500 m)	36.9	50.8	13.9	NO
R19 (1,500 m)	42.8	53.5	10.7	NO
R20 (1,500 m)	36.8	47.1	10.3	NO
R21 (1,500 m)	32.8	44.4	11.6	NO
Resident 1	35.6	51.2	15.6	NO
Resident 2	25.9	42.2	16.3	NO
Resident 3	26.0	42.2	16.2	NO
Resident 4	26.7	43.1	16.4	NO

5.4. Scenario 3a (With Noise Mitigation)

The noise modeling results for Scenario 3a with noise mitigation (refer to Section 5.12.) are shown in Table 8 and Fig. 4. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks.

Table 8. Scenario 3a Application Case Sound Levels With Noise Mitigation

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	33.4	37.3	40.0	YES
R2 (1,500 m)	35.0	33.6	37.4	40.0	YES
R3 (1,500 m)	35.0	33.2	37.2	40.0	YES
R4 (1,500 m)	35.0	35.7	38.4	40.0	YES
R5 (1,500 m)	35.0	34.8	37.9	40.0	YES
R6 (1,500 m)	35.0	30.0	36.2	40.0	YES
R7 (1,500 m)	35.0	27.4	35.7	40.0	YES
R8 (1,500 m)	35.0	25.5	35.5	40.0	YES
R9 (1,500 m)	35.0	19.2	35.1	40.0	YES
R10 (1,500 m)	35.0	14.9	35.0	40.0	YES
R11 (1,500 m)	35.0	7.2	35.0	40.0	YES
R12 (1,500 m)	35.0	15.7	35.1	40.0	YES
R13 (1,500 m)	35.0	24.2	35.3	40.0	YES
R14 (1,500 m)	35.0	24.5	35.4	40.0	YES
R15 (1,500 m)	35.0	29.5	36.1	40.0	YES
R16 (1,500 m)	35.0	34.7	37.9	40.0	YES
R17 (1,500 m)	35.0	36.2	38.7	40.0	YES
R18 (1,500 m)	35.0	36.1	38.6	40.0	YES
R19 (1,500 m)	35.0	37.6	39.5	40.0	YES
R20 (1,500 m)	35.0	36.5	38.8	40.0	YES
R21 (1,500 m)	35.0	30.8	36.4	40.0	YES
Resident 1	35.0	35.6	38.3	40.0	YES
Resident 2	35.0	25.8	35.5	40.0	YES
Resident 3	35.0	25.9	35.5	40.0	YES
Resident 4	35.0	26.7	35.6	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 9 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 9, most locations have a dBC – dBA sound level less than 20 dB. There are two locations with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 9. Scenario 3a Application Case dBA and dBC Sound Levels With Noise Mitigation

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	33.4	45.0	11.6	NO
R2 (1,500 m)	33.6	45.7	12.1	NO
R3 (1,500 m)	33.2	47.6	14.4	NO
R4 (1,500 m)	35.7	49.6	13.9	NO
R5 (1,500 m)	34.8	49.4	14.6	NO
R6 (1,500 m)	30.0	45.4	15.4	NO
R7 (1,500 m)	27.4	43.7	16.3	NO
R8 (1,500 m)	25.5	42.5	17.0	NO
R9 (1,500 m)	19.2	38.5	19.3	NO
R10 (1,500 m)	14.9	35.8	20.9	Possible
R11 (1,500 m)	7.2	26.2	19.0	NO
R12 (1,500 m)	15.7	36.2	20.5	Possible
R13 (1,500 m)	24.2	41.9	17.7	NO
R14 (1,500 m)	24.5	41.1	16.6	NO
R15 (1,500 m)	29.5	46.2	16.7	NO
R16 (1,500 m)	34.7	50.3	15.6	NO
R17 (1,500 m)	36.2	51.3	15.1	NO
R18 (1,500 m)	36.1	49.4	13.3	NO
R19 (1,500 m)	37.6	48.0	10.4	NO
R20 (1,500 m)	36.5	47.0	10.5	NO
R21 (1,500 m)	30.8	43.3	12.5	NO
Resident 1	35.6	51.1	15.5	NO
Resident 2	25.8	42.2	16.4	NO
Resident 3	25.9	42.2	16.3	NO
Resident 4	26.7	43.1	16.4	NO

5.5. Scenario 3b (Without Noise Mitigation)

The noise modeling results for Scenario 3b without noise mitigation are shown in Table 10. The results indicate noise levels below the PSL at all but one of the 1,500 m receptor locations as well as at all of the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks.

Table 10. Scenario 3b Application Case Sound Levels Without Noise Mitigation

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	35.1	38.1	40.0	YES
R2 (1,500 m)	35.0	35.0	38.0	40.0	YES
R3 (1,500 m)	35.0	33.1	37.2	40.0	YES
R4 (1,500 m)	35.0	35.5	38.3	40.0	YES
R5 (1,500 m)	35.0	34.3	37.7	40.0	YES
R6 (1,500 m)	35.0	29.4	36.1	40.0	YES
R7 (1,500 m)	35.0	26.9	35.6	40.0	YES
R8 (1,500 m)	35.0	24.6	35.4	40.0	YES
R9 (1,500 m)	35.0	17.5	35.1	40.0	YES
R10 (1,500 m)	35.0	13.5	35.0	40.0	YES
R11 (1,500 m)	35.0	0.0	35.0	40.0	YES
R12 (1,500 m)	35.0	13.6	35.0	40.0	YES
R13 (1,500 m)	35.0	23.5	35.3	40.0	YES
R14 (1,500 m)	35.0	24.0	35.3	40.0	YES
R15 (1,500 m)	35.0	28.9	36.0	40.0	YES
R16 (1,500 m)	35.0	34.5	37.8	40.0	YES
R17 (1,500 m)	35.0	36.3	38.7	40.0	YES
R18 (1,500 m)	35.0	37.1	39.2	40.0	YES
R19 (1,500 m)	35.0	44.1	44.6	40.0	NO
R20 (1,500 m)	35.0	37.5	39.4	40.0	YES
R21 (1,500 m)	35.0	34.3	37.7	40.0	YES
Resident 1	35.0	35.5	38.3	40.0	YES
Resident 2	35.0	25.0	35.4	40.0	YES
Resident 3	35.0	24.9	35.4	40.0	YES
Resident 4	35.0	25.8	35.5	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 11 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 11, most locations have a dBC – dBA sound level less than 20 dB. There are two locations with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 11. Scenario 3b Application Case dBA and dBC Sound Levels Without Noise Mitigation

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	35.1	46.0	10.9	NO
R2 (1,500 m)	35.0	46.3	11.3	NO
R3 (1,500 m)	33.1	47.4	14.3	NO
R4 (1,500 m)	35.5	49.4	13.9	NO
R5 (1,500 m)	34.3	49.1	14.8	NO
R6 (1,500 m)	29.4	45.0	15.6	NO
R7 (1,500 m)	26.9	43.4	16.5	NO
R8 (1,500 m)	24.6	41.9	17.3	NO
R9 (1,500 m)	17.5	37.4	19.9	NO
R10 (1,500 m)	13.5	35.0	21.5	Possible
R11 (1,500 m)	0.0	0.0	0.0	NO
R12 (1,500 m)	13.6	35.0	21.4	Possible
R13 (1,500 m)	23.5	41.4	17.9	NO
R14 (1,500 m)	24.0	40.7	16.7	NO
R15 (1,500 m)	28.9	45.8	16.9	NO
R16 (1,500 m)	34.5	50.2	15.7	NO
R17 (1,500 m)	36.3	51.6	15.3	NO
R18 (1,500 m)	37.1	50.4	13.3	NO
R19 (1,500 m)	44.1	54.7	10.6	NO
R20 (1,500 m)	37.5	47.5	10.0	NO
R21 (1,500 m)	34.3	45.3	11.0	NO
Resident 1	35.5	51.1	15.6	NO
Resident 2	25.0	41.6	16.6	NO
Resident 3	24.9	41.5	16.6	NO
Resident 4	25.8	42.6	16.8	NO

5.6. Scenario 3b (With Mitigation)

The noise modeling results for Scenario 3b with noise mitigation (refer to Section 5.12.) are shown in Table 12 and Fig. 5. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks.

Table 12. Scenario 3b Application Case Sound Levels With Noise Mitigation

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	35.0	38.0	40.0	YES
R2 (1,500 m)	35.0	35.0	38.0	40.0	YES
R3 (1,500 m)	35.0	33.1	37.2	40.0	YES
R4 (1,500 m)	35.0	35.5	38.3	40.0	YES
R5 (1,500 m)	35.0	34.3	37.7	40.0	YES
R6 (1,500 m)	35.0	29.4	36.1	40.0	YES
R7 (1,500 m)	35.0	26.9	35.6	40.0	YES
R8 (1,500 m)	35.0	24.6	35.4	40.0	YES
R9 (1,500 m)	35.0	17.5	35.1	40.0	YES
R10 (1,500 m)	35.0	13.5	35.0	40.0	YES
R11 (1,500 m)	35.0	0.0	35.0	40.0	YES
R12 (1,500 m)	35.0	13.6	35.0	40.0	YES
R13 (1,500 m)	35.0	23.5	35.3	40.0	YES
R14 (1,500 m)	35.0	24.0	35.3	40.0	YES
R15 (1,500 m)	35.0	28.9	36.0	40.0	YES
R16 (1,500 m)	35.0	34.5	37.8	40.0	YES
R17 (1,500 m)	35.0	36.1	38.6	40.0	YES
R18 (1,500 m)	35.0	36.1	38.6	40.0	YES
R19 (1,500 m)	35.0	38.0	39.8	40.0	YES
R20 (1,500 m)	35.0	36.9	39.1	40.0	YES
R21 (1,500 m)	35.0	32.5	36.9	40.0	YES
Resident 1	35.0	35.5	38.3	40.0	YES
Resident 2	35.0	25.0	35.4	40.0	YES
Resident 3	35.0	24.9	35.4	40.0	YES
Resident 4	35.0	25.8	35.5	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 13 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 13, most locations have a dBC – dBA sound level less than 20 dB. There are two locations with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 13. Scenario 3b Application Case dBA and dBC Sound Levels With Noise Mitigation

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	35.0	45.9	10.9	NO
R2 (1,500 m)	35.0	46.3	11.3	NO
R3 (1,500 m)	33.1	47.4	14.3	NO
R4 (1,500 m)	35.5	49.4	13.9	NO
R5 (1,500 m)	34.3	49.0	14.7	NO
R6 (1,500 m)	29.4	45.0	15.6	NO
R7 (1,500 m)	26.9	43.4	16.5	NO
R8 (1,500 m)	24.6	41.9	17.3	NO
R9 (1,500 m)	17.5	37.4	19.9	NO
R10 (1,500 m)	13.5	35.0	21.5	Possible
R11 (1,500 m)	0.0	0.0	0.0	NO
R12 (1,500 m)	13.6	35.0	21.4	Possible
R13 (1,500 m)	23.5	41.4	17.9	NO
R14 (1,500 m)	24.0	40.7	16.7	NO
R15 (1,500 m)	28.9	45.8	16.9	NO
R16 (1,500 m)	34.5	50.2	15.7	NO
R17 (1,500 m)	36.1	51.3	15.2	NO
R18 (1,500 m)	36.1	49.3	13.2	NO
R19 (1,500 m)	38.0	48.9	10.9	NO
R20 (1,500 m)	36.9	47.2	10.3	NO
R21 (1,500 m)	32.5	44.3	11.8	NO
Resident 1	35.5	51.1	15.6	NO
Resident 2	25.0	41.6	16.6	NO
Resident 3	24.9	41.5	16.6	NO
Resident 4	25.8	42.6	16.8	NO

5.7. Scenario 4a

The noise modeling results for Scenario 4a are shown in Table 14 and Fig. 6. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks. Based on the results, no additional noise mitigation is required.

Table 14. Scenario 4a Application Case Sound Levels

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	33.3	37.2	40.0	YES
R2 (1,500 m)	35.0	35.3	38.2	40.0	YES
R3 (1,500 m)	35.0	35.6	38.3	40.0	YES
R4 (1,500 m)	35.0	36.3	38.7	40.0	YES
R5 (1,500 m)	35.0	35.0	38.0	40.0	YES
R6 (1,500 m)	35.0	30.2	36.2	40.0	YES
R7 (1,500 m)	35.0	27.9	35.8	40.0	YES
R8 (1,500 m)	35.0	26.2	35.5	40.0	YES
R9 (1,500 m)	35.0	20.4	35.1	40.0	YES
R10 (1,500 m)	35.0	14.9	35.0	40.0	YES
R11 (1,500 m)	35.0	7.2	35.0	40.0	YES
R12 (1,500 m)	35.0	15.7	35.1	40.0	YES
R13 (1,500 m)	35.0	24.5	35.4	40.0	YES
R14 (1,500 m)	35.0	24.4	35.4	40.0	YES
R15 (1,500 m)	35.0	29.5	36.1	40.0	YES
R16 (1,500 m)	35.0	34.5	37.8	40.0	YES
R17 (1,500 m)	35.0	35.6	38.3	40.0	YES
R18 (1,500 m)	35.0	34.7	37.9	40.0	YES
R19 (1,500 m)	35.0	34.6	37.8	40.0	YES
R20 (1,500 m)	35.0	32.9	37.1	40.0	YES
R21 (1,500 m)	35.0	31.4	36.6	40.0	YES
Resident 1	35.0	35.2	38.1	40.0	YES
Resident 2	35.0	26.4	35.6	40.0	YES
Resident 3	35.0	26.3	35.5	40.0	YES
Resident 4	35.0	27.3	35.7	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 15 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 15, most locations have a dBC – dBA sound level less than 20 dB. There are two locations with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 15. Scenario 4a Application Case dBA and dBC Sound Levels

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	33.3	44.9	11.6	NO
R2 (1,500 m)	35.3	46.4	11.1	NO
R3 (1,500 m)	35.6	48.2	12.6	NO
R4 (1,500 m)	36.3	49.8	13.5	NO
R5 (1,500 m)	35.0	49.4	14.4	NO
R6 (1,500 m)	30.2	45.6	15.4	NO
R7 (1,500 m)	27.9	44.0	16.1	NO
R8 (1,500 m)	26.2	42.8	16.6	NO
R9 (1,500 m)	20.4	38.9	18.5	NO
R10 (1,500 m)	14.9	35.8	20.9	Possible
R11 (1,500 m)	7.2	26.2	19.0	NO
R12 (1,500 m)	15.7	36.2	20.5	Possible
R13 (1,500 m)	24.5	42.0	17.5	NO
R14 (1,500 m)	24.4	41.1	16.7	NO
R15 (1,500 m)	29.5	46.9	17.4	NO
R16 (1,500 m)	34.5	50.3	15.8	NO
R17 (1,500 m)	35.6	51.2	15.6	NO
R18 (1,500 m)	34.7	49.8	15.1	NO
R19 (1,500 m)	34.6	48.0	13.4	NO
R20 (1,500 m)	32.9	44.7	11.8	NO
R21 (1,500 m)	31.4	43.6	12.2	NO
Resident 1	35.2	51.1	15.9	NO
Resident 2	26.4	42.4	16.0	NO
Resident 3	26.3	42.3	16.0	NO
Resident 4	27.3	43.4	16.1	NO

5.8. Scenario 4b

The noise modeling results for Scenario 4b are shown in Table 16 and Fig. 7. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks. Based on the results, no additional noise mitigation is required.

Table 16. Scenario 4b Application Case Sound Levels

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	33.5	37.3	40.0	YES
R2 (1,500 m)	35.0	35.5	38.3	40.0	YES
R3 (1,500 m)	35.0	35.6	38.3	40.0	YES
R4 (1,500 m)	35.0	36.1	38.6	40.0	YES
R5 (1,500 m)	35.0	34.5	37.8	40.0	YES
R6 (1,500 m)	35.0	29.7	36.1	40.0	YES
R7 (1,500 m)	35.0	27.3	35.7	40.0	YES
R8 (1,500 m)	35.0	25.3	35.4	40.0	YES
R9 (1,500 m)	35.0	19.2	35.1	40.0	YES
R10 (1,500 m)	35.0	13.5	35.0	40.0	YES
R11 (1,500 m)	35.0	0.0	35.0	40.0	YES
R12 (1,500 m)	35.0	13.6	35.0	40.0	YES
R13 (1,500 m)	35.0	23.8	35.3	40.0	YES
R14 (1,500 m)	35.0	23.7	35.3	40.0	YES
R15 (1,500 m)	35.0	29.0	36.0	40.0	YES
R16 (1,500 m)	35.0	34.4	37.7	40.0	YES
R17 (1,500 m)	35.0	35.4	38.2	40.0	YES
R18 (1,500 m)	35.0	34.1	37.6	40.0	YES
R19 (1,500 m)	35.0	34.4	37.7	40.0	YES
R20 (1,500 m)	35.0	33.0	37.1	40.0	YES
R21 (1,500 m)	35.0	31.6	36.6	40.0	YES
Resident 1	35.0	35.0	38.0	40.0	YES
Resident 2	35.0	25.3	35.4	40.0	YES
Resident 3	35.0	25.2	35.4	40.0	YES
Resident 4	35.0	26.5	35.6	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 17 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 17, most locations have a dBC – dBA sound level less than 20 dB. There are two locations with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 17. Scenario 4b Application Case dBA and dBC Sound Levels

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	33.5	45.0	11.5	NO
R2 (1,500 m)	35.5	46.6	11.1	NO
R3 (1,500 m)	35.6	48.0	12.4	NO
R4 (1,500 m)	36.1	49.7	13.6	NO
R5 (1,500 m)	34.5	49.0	14.5	NO
R6 (1,500 m)	29.7	45.2	15.5	NO
R7 (1,500 m)	27.3	43.5	16.2	NO
R8 (1,500 m)	25.3	42.2	16.9	NO
R9 (1,500 m)	19.2	38.0	18.8	NO
R10 (1,500 m)	13.5	35.0	21.5	Possible
R11 (1,500 m)	0.0	0.0	0.0	NO
R12 (1,500 m)	13.6	35.0	21.4	Possible
R13 (1,500 m)	23.8	41.5	17.7	NO
R14 (1,500 m)	23.7	40.6	16.9	NO
R15 (1,500 m)	29.0	46.2	17.2	NO
R16 (1,500 m)	34.4	50.2	15.8	NO
R17 (1,500 m)	35.4	51.1	15.7	NO
R18 (1,500 m)	34.1	49.1	15.0	NO
R19 (1,500 m)	34.4	47.6	13.2	NO
R20 (1,500 m)	33.0	44.6	11.6	NO
R21 (1,500 m)	31.6	43.6	12.0	NO
Resident 1	35.0	50.9	15.9	NO
Resident 2	25.3	41.6	16.3	NO
Resident 3	25.2	41.6	16.4	NO
Resident 4	26.5	42.9	16.4	NO

5.9. Scenario 5 (Without Noise Mitigation)

The noise modeling results for Scenario 5 without noise mitigation are shown in Table 18 and Fig. 8. The results indicate noise levels below the PSL at all but two of the 1,500 m receptor locations as well as at all of the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks.

Table 18. Scenario 5 Application Case Sound Levels Without Noise Mitigation

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	27.8	35.8	40.0	YES
R2 (1,500 m)	35.0	28.1	35.8	40.0	YES
R3 (1,500 m)	35.0	31.4	36.6	40.0	YES
R4 (1,500 m)	35.0	35.5	38.3	40.0	YES
R5 (1,500 m)	35.0	34.8	37.9	40.0	YES
R6 (1,500 m)	35.0	29.9	36.2	40.0	YES
R7 (1,500 m)	35.0	27.5	35.7	40.0	YES
R8 (1,500 m)	35.0	25.9	35.5	40.0	YES
R9 (1,500 m)	35.0	20.5	35.2	40.0	YES
R10 (1,500 m)	35.0	14.9	35.0	40.0	YES
R11 (1,500 m)	35.0	7.2	35.0	40.0	YES
R12 (1,500 m)	35.0	19.9	35.1	40.0	YES
R13 (1,500 m)	35.0	26.1	35.5	40.0	YES
R14 (1,500 m)	35.0	27.1	35.7	40.0	YES
R15 (1,500 m)	35.0	31.5	36.6	40.0	YES
R16 (1,500 m)	35.0	36.2	38.7	40.0	YES
R17 (1,500 m)	35.0	39.0	40.5	40.0	NO
R18 (1,500 m)	35.0	39.9	41.1	40.0	NO
R19 (1,500 m)	35.0	35.4	38.2	40.0	YES
R20 (1,500 m)	35.0	31.6	36.6	40.0	YES
R21 (1,500 m)	35.0	27.4	35.7	40.0	YES
Resident 1	35.0	37.5	39.4	40.0	YES
Resident 2	35.0	28.2	35.8	40.0	YES
Resident 3	35.0	28.4	35.9	40.0	YES
Resident 4	35.0	27.0	35.6	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 19 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 19, most locations have a dBC – dBA sound level less than 20 dB. There is one location with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 19. Scenario 5 Application Case dBA and dBC Sound Levels Without Noise Mitigation

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	27.8	42.1	14.3	NO
R2 (1,500 m)	28.1	43.0	14.9	NO
R3 (1,500 m)	31.4	47.0	15.6	NO
R4 (1,500 m)	35.5	49.5	14.0	NO
R5 (1,500 m)	34.8	49.2	14.4	NO
R6 (1,500 m)	29.9	45.4	15.5	NO
R7 (1,500 m)	27.5	43.8	16.3	NO
R8 (1,500 m)	25.9	42.6	16.7	NO
R9 (1,500 m)	20.5	38.9	18.4	NO
R10 (1,500 m)	14.9	35.8	20.9	Possible
R11 (1,500 m)	7.2	26.1	18.9	NO
R12 (1,500 m)	19.9	37.5	17.6	NO
R13 (1,500 m)	26.1	42.4	16.3	NO
R14 (1,500 m)	27.1	42.0	14.9	NO
R15 (1,500 m)	31.5	47.4	15.9	NO
R16 (1,500 m)	36.2	50.8	14.6	NO
R17 (1,500 m)	39.0	52.8	13.8	NO
R18 (1,500 m)	39.9	52.6	12.7	NO
R19 (1,500 m)	35.4	47.2	11.8	NO
R20 (1,500 m)	31.6	43.9	12.3	NO
R21 (1,500 m)	27.4	41.5	14.1	NO
Resident 1	37.5	51.7	14.2	NO
Resident 2	28.2	43.0	14.8	NO
Resident 3	28.4	43.0	14.6	NO
Resident 4	27.0	43.3	16.3	NO

5.10. Scenario 5 (With Noise Mitigation)

The noise modeling results for Scenario 5 with noise mitigation (refer to Section 5.12.) are shown in Table 20 and Fig. 8. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks.

Table 20. Scenario 5 Application Case Sound Levels With Noise Mitigation

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	27.4	35.7	40.0	YES
R2 (1,500 m)	35.0	28.1	35.8	40.0	YES
R3 (1,500 m)	35.0	31.4	36.6	40.0	YES
R4 (1,500 m)	35.0	35.5	38.3	40.0	YES
R5 (1,500 m)	35.0	34.8	37.9	40.0	YES
R6 (1,500 m)	35.0	29.9	36.2	40.0	YES
R7 (1,500 m)	35.0	27.5	35.7	40.0	YES
R8 (1,500 m)	35.0	25.9	35.5	40.0	YES
R9 (1,500 m)	35.0	20.4	35.1	40.0	YES
R10 (1,500 m)	35.0	14.9	35.0	40.0	YES
R11 (1,500 m)	35.0	7.2	35.0	40.0	YES
R12 (1,500 m)	35.0	18.7	35.1	40.0	YES
R13 (1,500 m)	35.0	25.2	35.4	40.0	YES
R14 (1,500 m)	35.0	26.5	35.6	40.0	YES
R15 (1,500 m)	35.0	30.6	36.3	40.0	YES
R16 (1,500 m)	35.0	35.4	38.2	40.0	YES
R17 (1,500 m)	35.0	37.3	39.3	40.0	YES
R18 (1,500 m)	35.0	38.1	39.8	40.0	YES
R19 (1,500 m)	35.0	34.9	38.0	40.0	YES
R20 (1,500 m)	35.0	31.0	36.5	40.0	YES
R21 (1,500 m)	35.0	24.0	35.3	40.0	YES
Resident 1	35.0	36.5	38.8	40.0	YES
Resident 2	35.0	26.5	35.6	40.0	YES
Resident 3	35.0	26.8	35.6	40.0	YES
Resident 4	35.0	27.0	35.6	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 21 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 21, most locations have a dBC – dBA sound level less than 20 dB. There is one location with a difference greater than 20 dB and others which are near 20 dB. At each of these locations, however, the broadband dBA sound levels are well more than 5 dBA lower than the PSL. As such, if a low frequency tonal component exists, the Project will still be in compliance (even after application of a 5 dBA penalty).

Table 21. Scenario 5 Application Case dBA and dBC Sound Levels With Noise Mitigation

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	27.4	42.0	14.6	NO
R2 (1,500 m)	28.1	43.0	14.9	NO
R3 (1,500 m)	31.4	46.7	15.3	NO
R4 (1,500 m)	35.5	49.5	14.0	NO
R5 (1,500 m)	34.8	49.2	14.4	NO
R6 (1,500 m)	29.9	45.4	15.5	NO
R7 (1,500 m)	27.5	43.8	16.3	NO
R8 (1,500 m)	25.9	42.6	16.7	NO
R9 (1,500 m)	20.4	38.9	18.5	NO
R10 (1,500 m)	14.9	35.8	20.9	Possible
R11 (1,500 m)	7.2	26.1	18.9	NO
R12 (1,500 m)	18.7	37.2	18.5	NO
R13 (1,500 m)	25.2	42.1	16.9	NO
R14 (1,500 m)	26.5	41.8	15.3	NO
R15 (1,500 m)	30.6	46.6	16.0	NO
R16 (1,500 m)	35.4	50.6	15.2	NO
R17 (1,500 m)	37.3	51.7	14.4	NO
R18 (1,500 m)	38.1	50.4	12.3	NO
R19 (1,500 m)	34.9	47.0	12.1	NO
R20 (1,500 m)	31.0	43.7	12.7	NO
R21 (1,500 m)	24.0	40.4	16.4	NO
Resident 1	36.5	51.5	15.0	NO
Resident 2	26.5	42.4	15.9	NO
Resident 3	26.8	42.4	15.6	NO
Resident 4	27.0	43.3	16.3	NO

5.11. Scenario 6

The noise modeling results for Scenario 6 are shown in Table 22 and Fig. 9. The results indicate noise levels below the PSL at all of the 1,500 m receptor locations as well as the residential receptor locations. The dominant noise sources at most locations were those associated with the Dozers and Scrapers, followed by the graders and haul trucks. Based on the results, no additional noise mitigation is required.

Table 22. Scenario 6 Application Case Sound Levels

Receptor	ASL-Night (dBA)	Application Case L_{eq}Night (dBA)	ASL + Application Case L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1,500 m)	35.0	27.4	35.7	40.0	YES
R2 (1,500 m)	35.0	28.8	35.9	40.0	YES
R3 (1,500 m)	35.0	32.2	36.8	40.0	YES
R4 (1,500 m)	35.0	35.7	38.4	40.0	YES
R5 (1,500 m)	35.0	34.9	38.0	40.0	YES
R6 (1,500 m)	35.0	30.2	36.2	40.0	YES
R7 (1,500 m)	35.0	27.6	35.7	40.0	YES
R8 (1,500 m)	35.0	26.6	35.6	40.0	YES
R9 (1,500 m)	35.0	22.1	35.2	40.0	YES
R10 (1,500 m)	35.0	16.7	35.1	40.0	YES
R11 (1,500 m)	35.0	7.2	35.0	40.0	YES
R12 (1,500 m)	35.0	20.9	35.2	40.0	YES
R13 (1,500 m)	35.0	26.8	35.6	40.0	YES
R14 (1,500 m)	35.0	26.9	35.6	40.0	YES
R15 (1,500 m)	35.0	30.8	36.4	40.0	YES
R16 (1,500 m)	35.0	35.4	38.2	40.0	YES
R17 (1,500 m)	35.0	36.6	38.9	40.0	YES
R18 (1,500 m)	35.0	36.3	38.7	40.0	YES
R19 (1,500 m)	35.0	32.3	36.9	40.0	YES
R20 (1,500 m)	35.0	29.3	36.0	40.0	YES
R21 (1,500 m)	35.0	26.4	35.6	40.0	YES
Resident 1	35.0	36.0	38.5	40.0	YES
Resident 2	35.0	29.1	36.0	40.0	YES
Resident 3	35.0	29.1	36.0	40.0	YES
Resident 4	35.0	27.4	35.7	40.0	YES

In addition to the broadband A-weighted sound levels, the broadband C-weighted sound levels have been modeled at each receptor location. Table 23 shows the dBA, the dBC, and the dBC – dBA sound levels at all locations. As specified in Directive 038, a difference of greater than 20 dB is required before there exists the possibility of a low frequency tonal component. As indicated in Table 23, all locations have a dBC – dBA sound level less than 20 dB.

Table 23. Scenario 6 Application Case dBA and dBC Sound Levels

Receptor	Application Case L_{eq}Night (dBA)	Application Case L_{eq}Night (dBC)	dBC - dBA	Tonal
R1 (1,500 m)	27.4	41.9	14.5	NO
R2 (1,500 m)	28.8	43.2	14.4	NO
R3 (1,500 m)	32.2	46.9	14.7	NO
R4 (1,500 m)	35.7	49.6	13.9	NO
R5 (1,500 m)	34.9	49.3	14.4	NO
R6 (1,500 m)	30.2	45.5	15.3	NO
R7 (1,500 m)	27.6	43.8	16.2	NO
R8 (1,500 m)	26.6	42.9	16.3	NO
R9 (1,500 m)	22.1	39.5	17.4	NO
R10 (1,500 m)	16.7	36.3	19.6	NO
R11 (1,500 m)	7.2	26.1	18.9	NO
R12 (1,500 m)	20.9	37.8	16.9	NO
R13 (1,500 m)	26.8	42.6	15.8	NO
R14 (1,500 m)	26.9	41.9	15.0	NO
R15 (1,500 m)	30.8	47.3	16.5	NO
R16 (1,500 m)	35.4	50.5	15.1	NO
R17 (1,500 m)	36.6	51.4	14.8	NO
R18 (1,500 m)	36.3	50.9	14.6	NO
R19 (1,500 m)	32.3	45.7	13.4	NO
R20 (1,500 m)	29.3	42.7	13.4	NO
R21 (1,500 m)	26.4	41.1	14.7	NO
Resident 1	36.0	51.3	15.3	NO
Resident 2	29.1	43.3	14.2	NO
Resident 3	29.1	43.3	14.2	NO
Resident 4	27.4	43.4	16.0	NO

5.12. Noise Mitigation Measures

The noise modeling results indicate that, for all years when both the 8200 and 1570 Draglines will be operational at the west end of their respective pits, noise mitigation may be required to meet the PSLs at the 1,500 m receptors. In order to accomplish this, one method is to construct an earth berm along the west side of the “a” Pits (i.e. near the 8200 Dragline) and along the west side of the “b” Pits (i.e. near the 1570 Dragline). At the time of generating the noise model, the berm heights required for the “a” and “b” Pits were 15 m and 10 m, respectively. These heights are based on conservative equipment sound power levels and sound propagation calculations.

Other forms of noise mitigation include installation of higher grade mufflers and other equipment noise reduction measures. Also, the equipment operational methods and locations could be reviewed to determine if there are ways to complete the desired work with a lesser noise impact.

At the current time, the exact extent of noise mitigation is not well known due to the variant nature of the equipment operation activity. The modeling indicates that noise levels below the PSLs are achievable. As such, upon operation of both the 8200 and 1570 Draglines in the year 2016 Pits, noise measurements will be conducted and operational conditions will be reviewed to determine the full extent of noise mitigation required and what will be done to achieve it. Given that there are no permanent residences within 4.5 km of the year 2016 Pits, there is minimal likelihood of noise complaints while the mitigation determination is underway (even if the initial noise levels are slightly above the PSLs).

6.0 Conclusion

The noise modeling results indicated sound levels (without additional noise mitigation) will be below their respective PSLs at all of the nearby residential receptors as well as the 1,500 m receptors, except for a few locations to the west. When a single Dragline is operating at the northern portion of the North Extension Pit, no additional noise mitigation will be required. Once both Draglines are operational, however, noise mitigation may be required when mining activity is underway in both the "a" and "b" Pits. Various noise mitigation options are possible including constructing earth berms along the western sides of the Pits, equipment specific noise mitigation, and adjustments to operational procedures. The full extent of noise mitigation required is not fully known due to the variant nature of the equipment operation activity. Thus, upon operation of both the 8200 and 1570 Draglines in the year 2016 Pits, noise measurements will be conducted and operational conditions will be reviewed to determine the full extent of noise mitigation required and what will be done to achieve it.

Finally, the noise modeling indicated that low frequency tonal noise is not anticipated for most of the receptor locations for most of the modeling scenarios. There were some exceptions, however, but the calculated noise levels for those situations were well more than 5 dBA below the PSL. This means that any possible low frequency tonal penalties will not result in non-compliance.

7.0 References

- Alberta Energy Resources Conservation Board (ERCB), *Directive 038 on Noise Control, 2007*, Calgary, Alberta
- International Organization for Standardization (ISO), *Standard 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures, 2003*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere, 1993*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, 1996*, Geneva Switzerland.
- *Power Plant Construction Noise Emissions*. Allan M. Teplitzky & Eric W. Wood, Internoise '78 Conference Proceedings, pp 279 – 284.
- *Environmental Codes of Practice for Steam Electric Power Generation – Construction Phase*. Report EPS 1/PG/3, Environment Canada, 1989.
- *Engineering Noise Control, Theory and Practice*. David A. Bies and Colin H. Hansen, 2003, Spon Press
- *Noise and Vibration Control Engineering, Principles and Applications*. Istvan L. Ver and Leo L. Beranek, 2006, John Wiley & Sons Inc.
- *Industrial Noise Control and Acoustics*. Randall F. Barron, 2003, Marcel Dekker Inc.

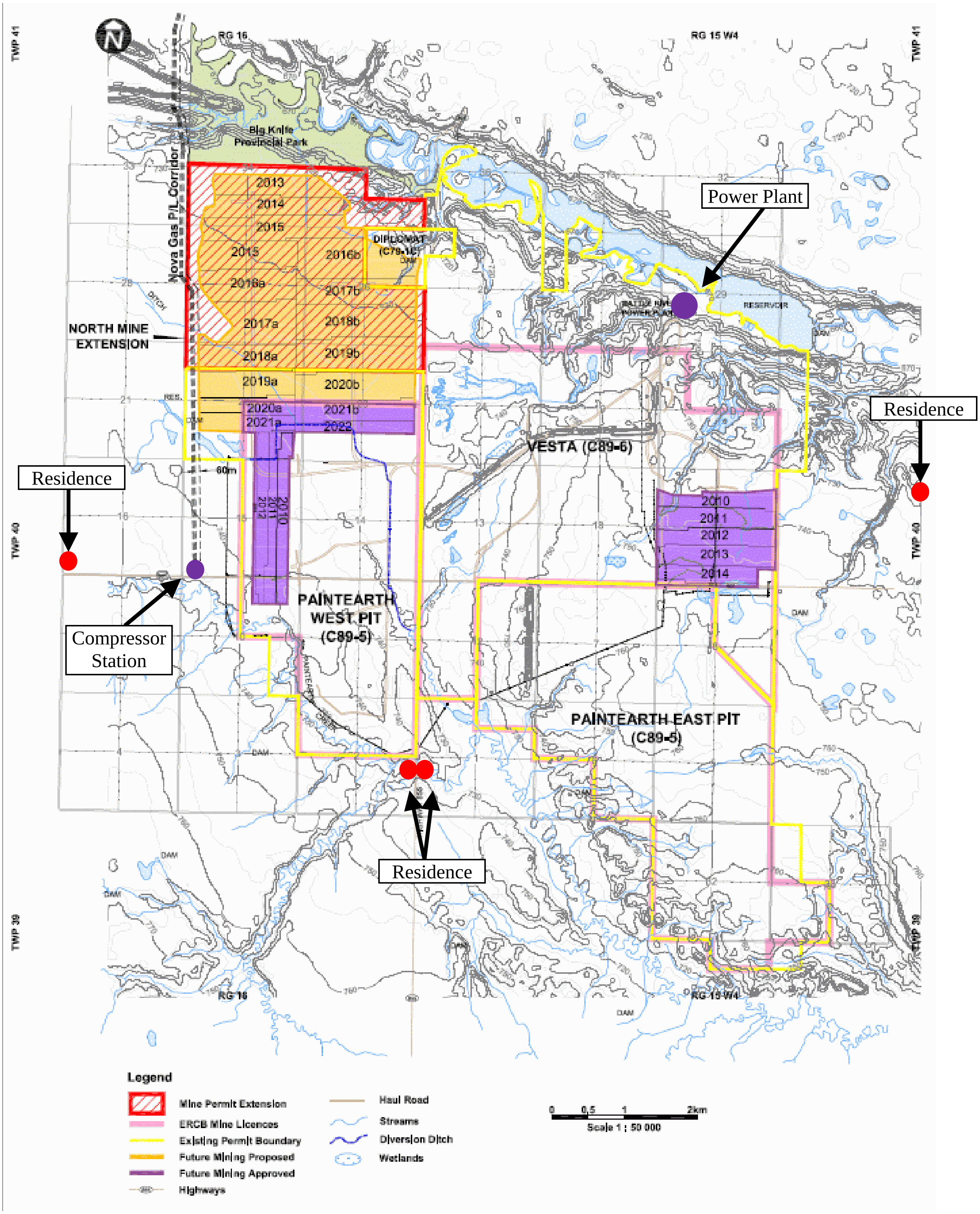

Figure 1. Study Area

acoustical consultants inc

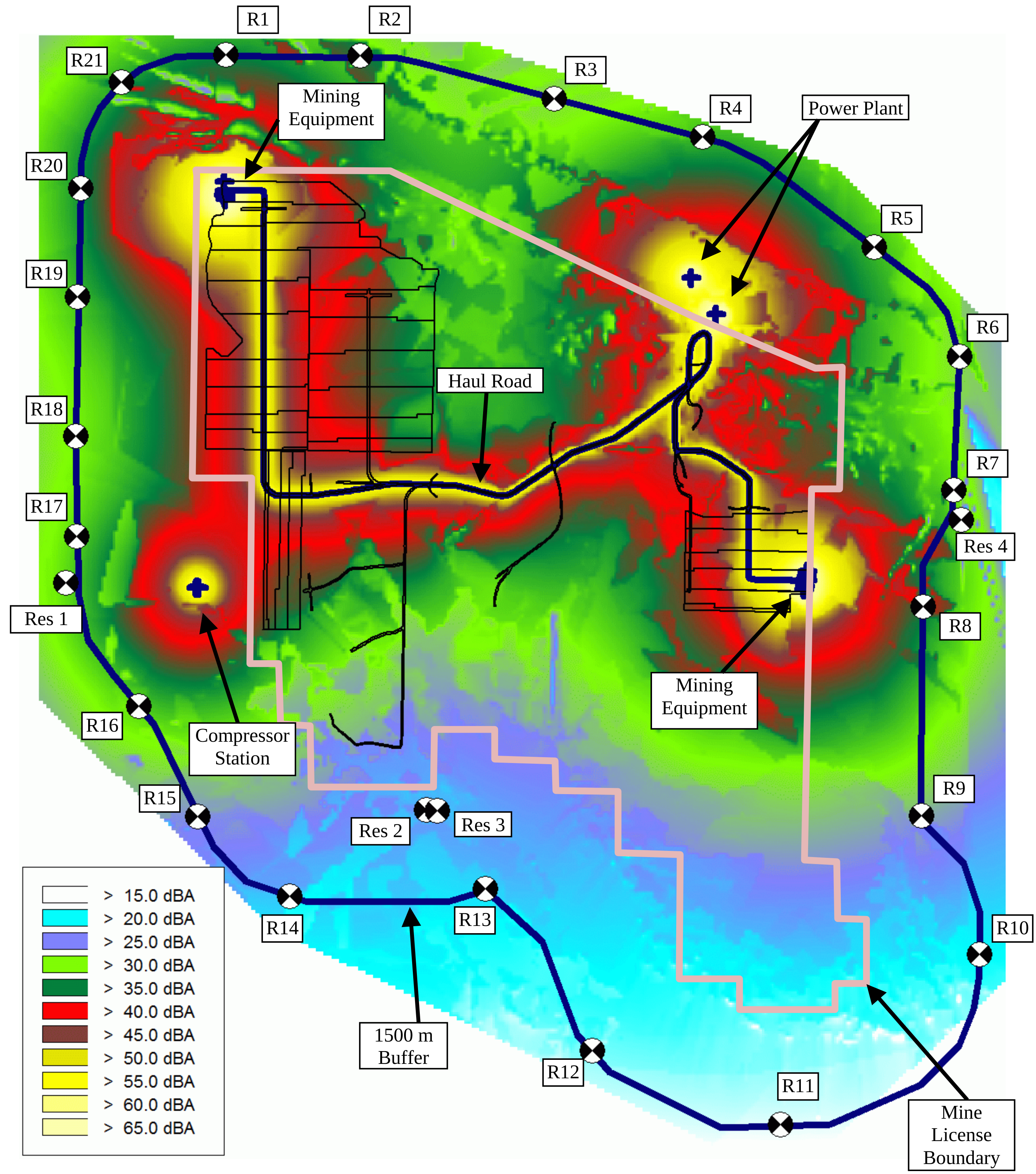

Figure 2. Scenario 1 Application Case Sound Levels (Without ASL)

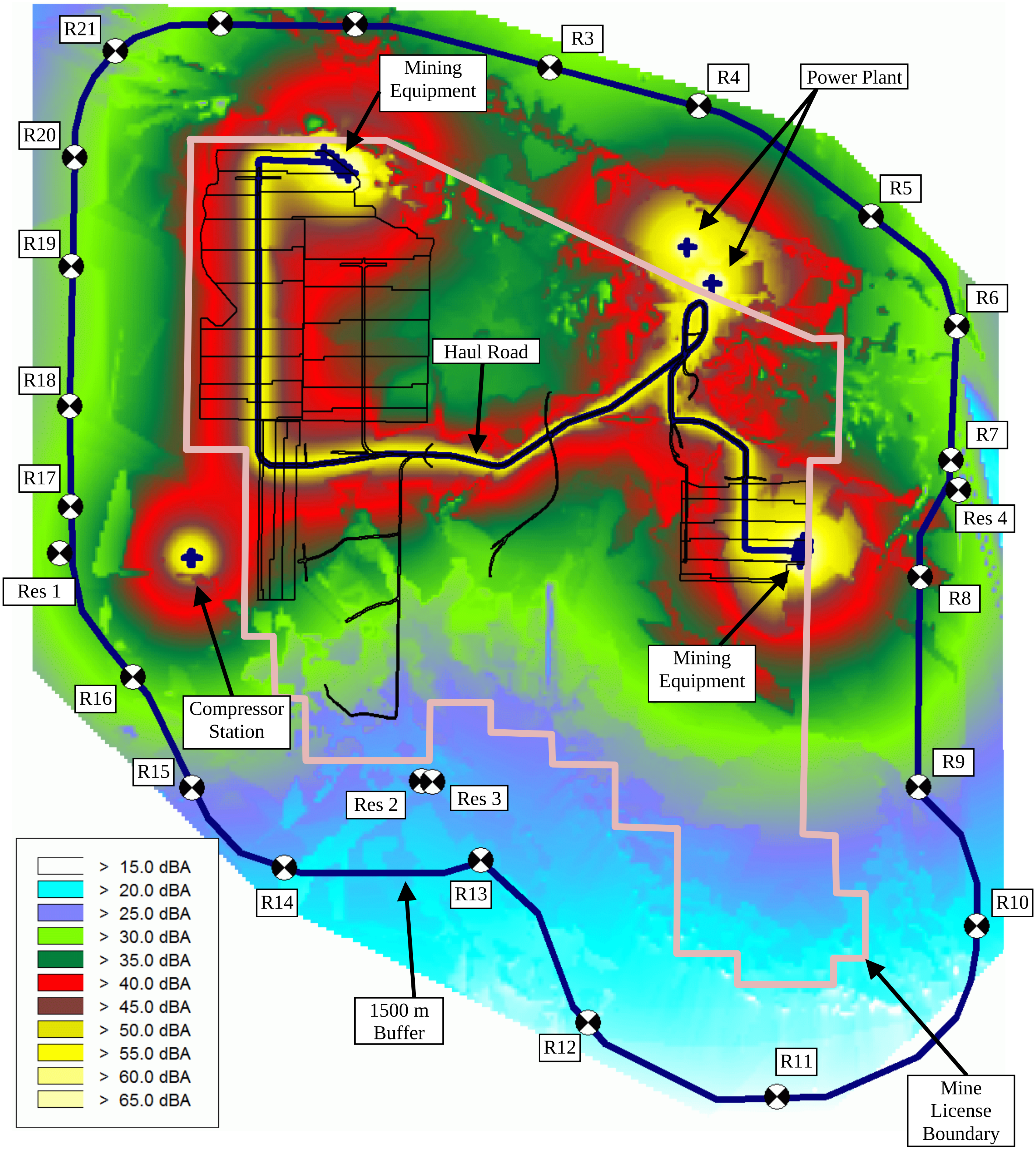

Figure 3. Scenario 2 Application Case Sound Levels (Without ASL)

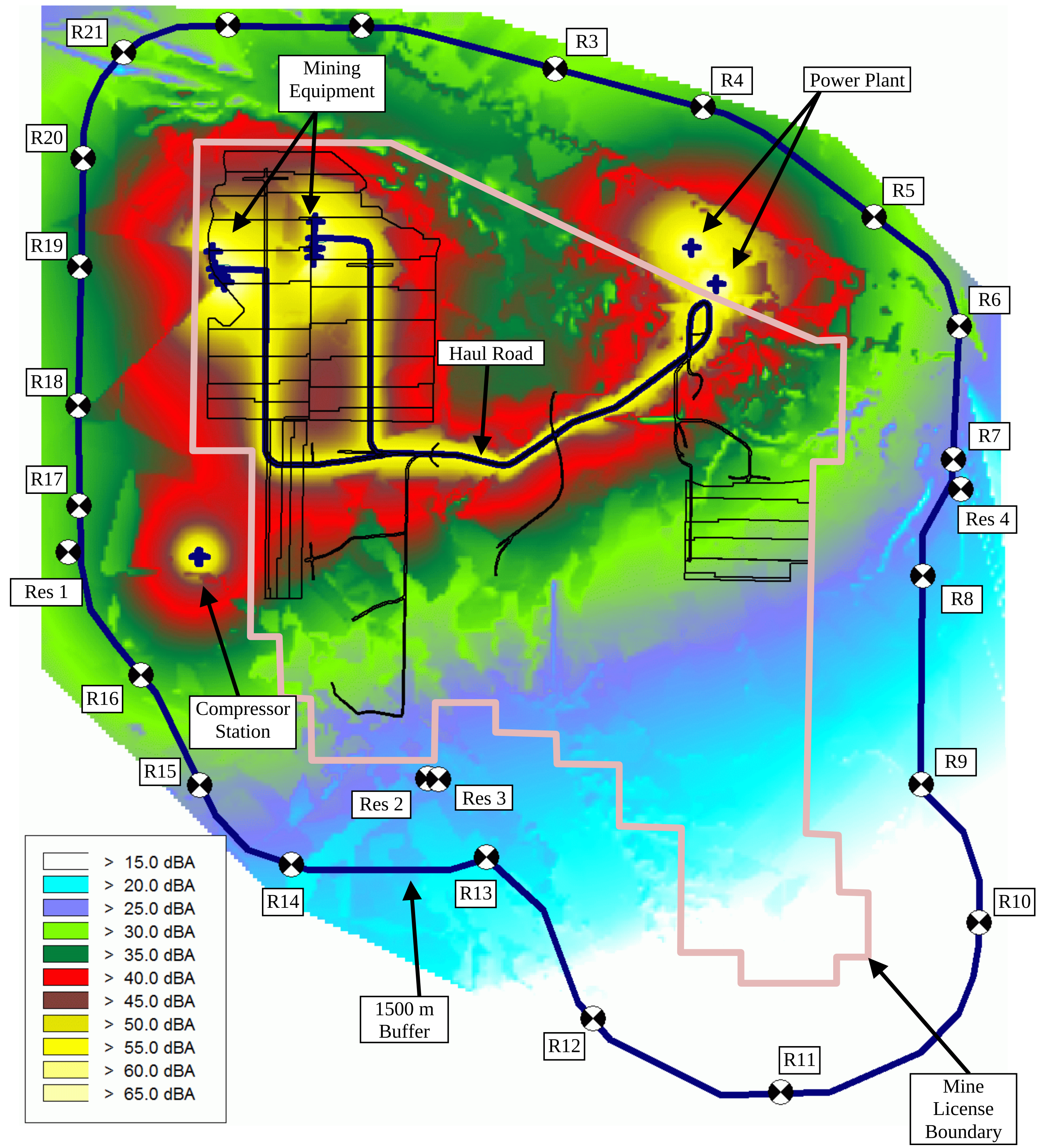

Figure 4. Scenario 3a Application Case Sound Levels With Noise Mitigation (Without ASL)

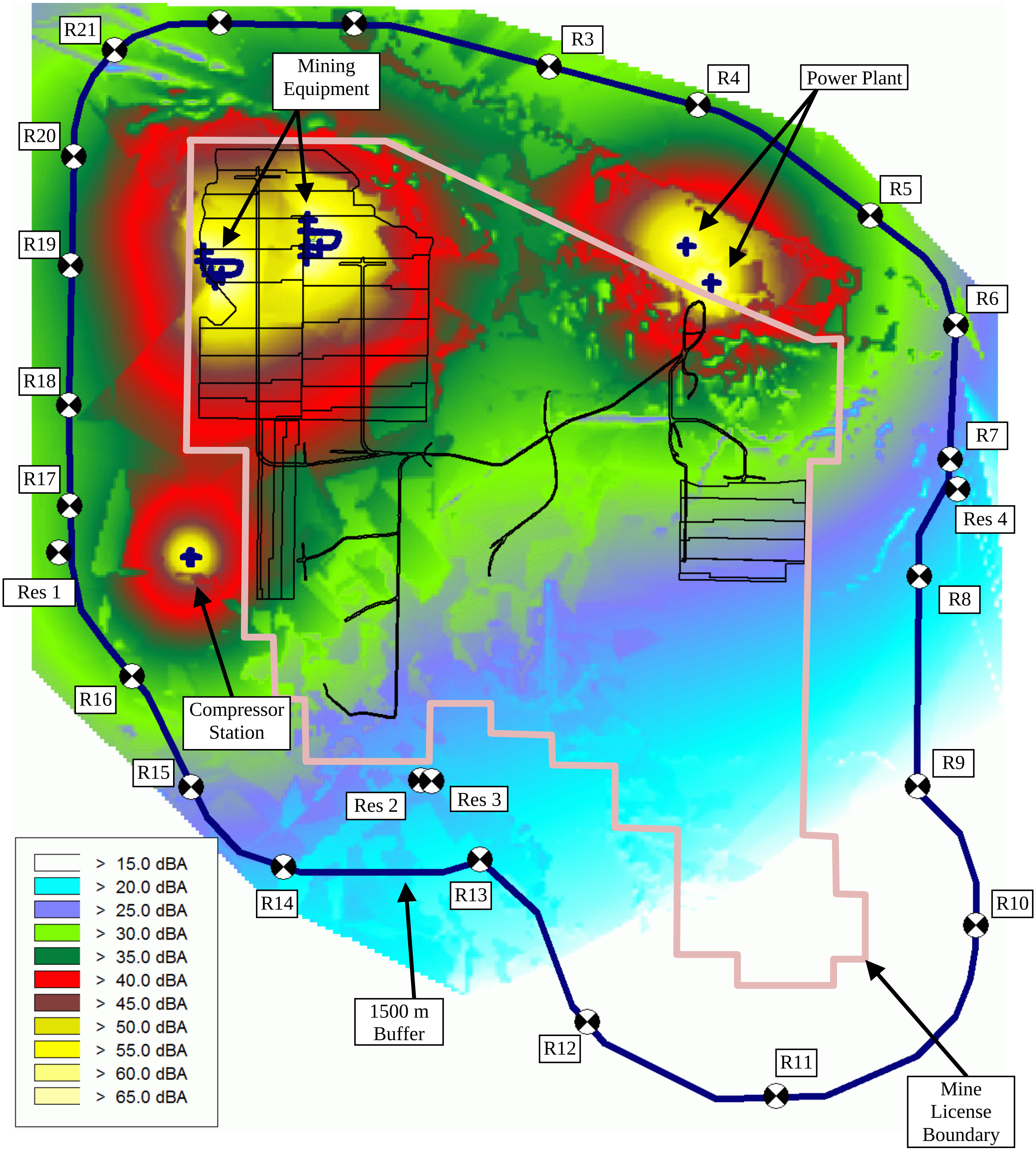

Figure 5. Scenario 3b Application Case Sound Levels With Noise Mitigation (Without ASL)

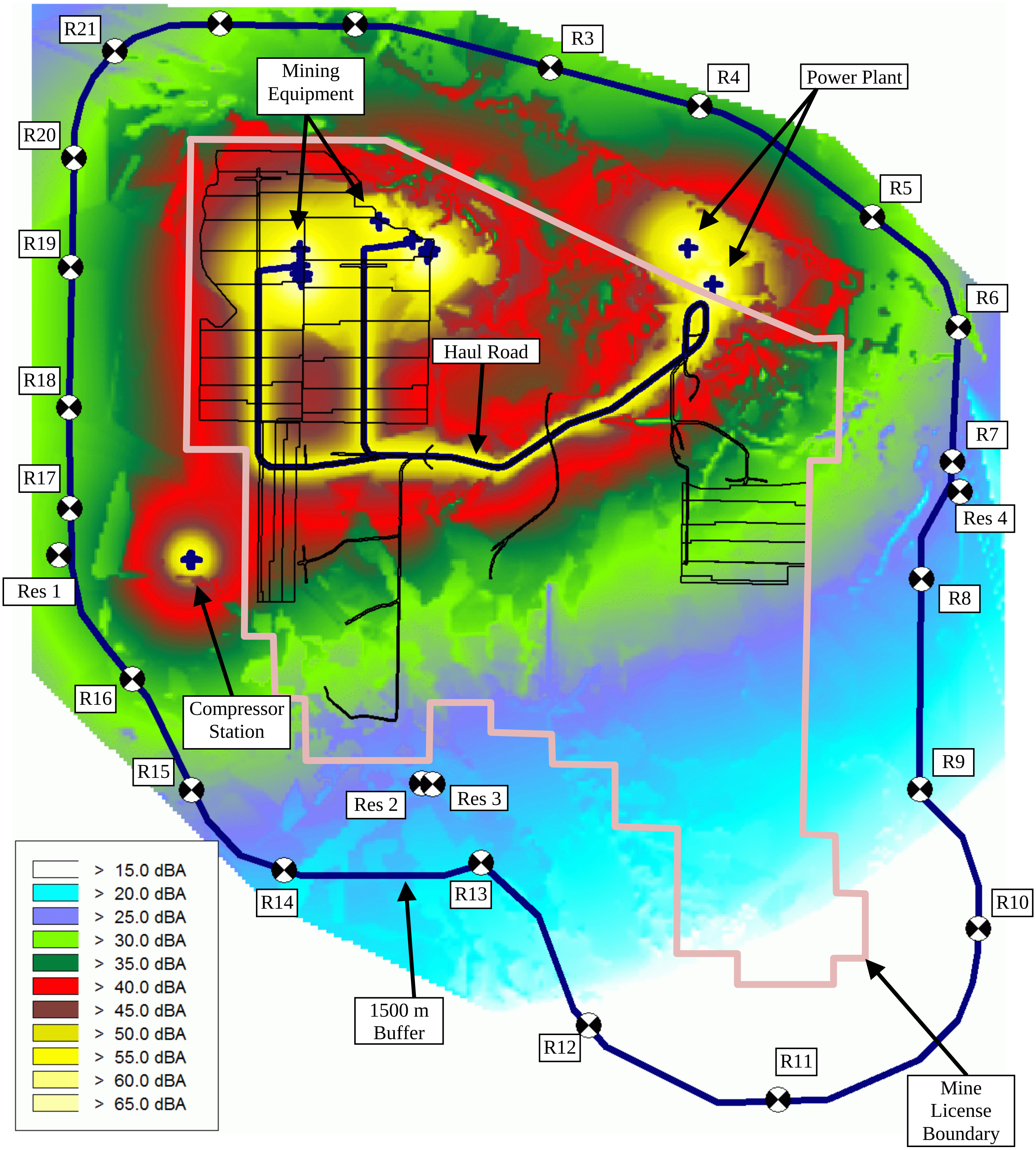

Figure 6. Scenario 4a Application Case Sound Levels (Without ASL)

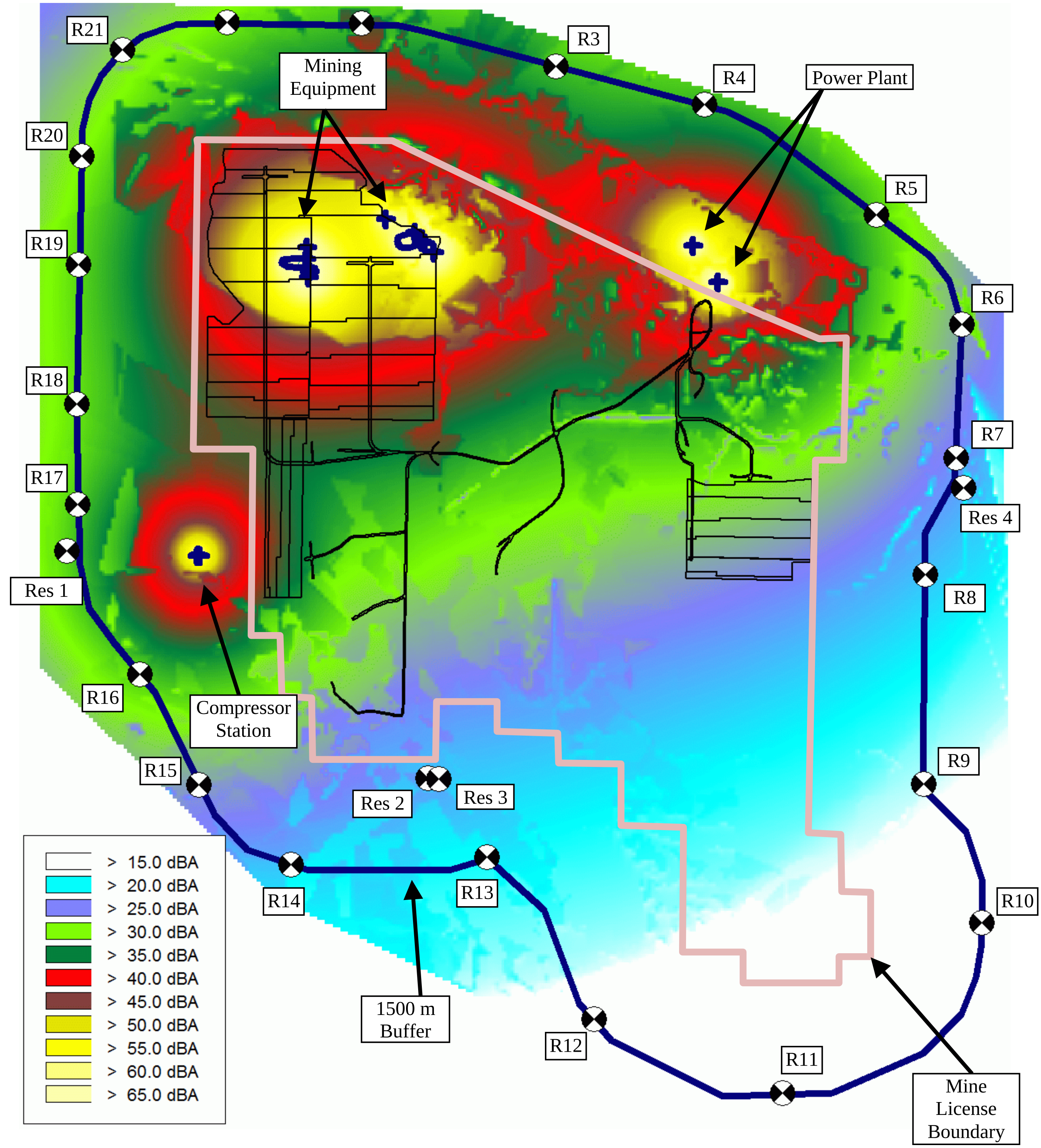

Figure 7. Scenario 4b Application Case Sound Levels (Without ASL)

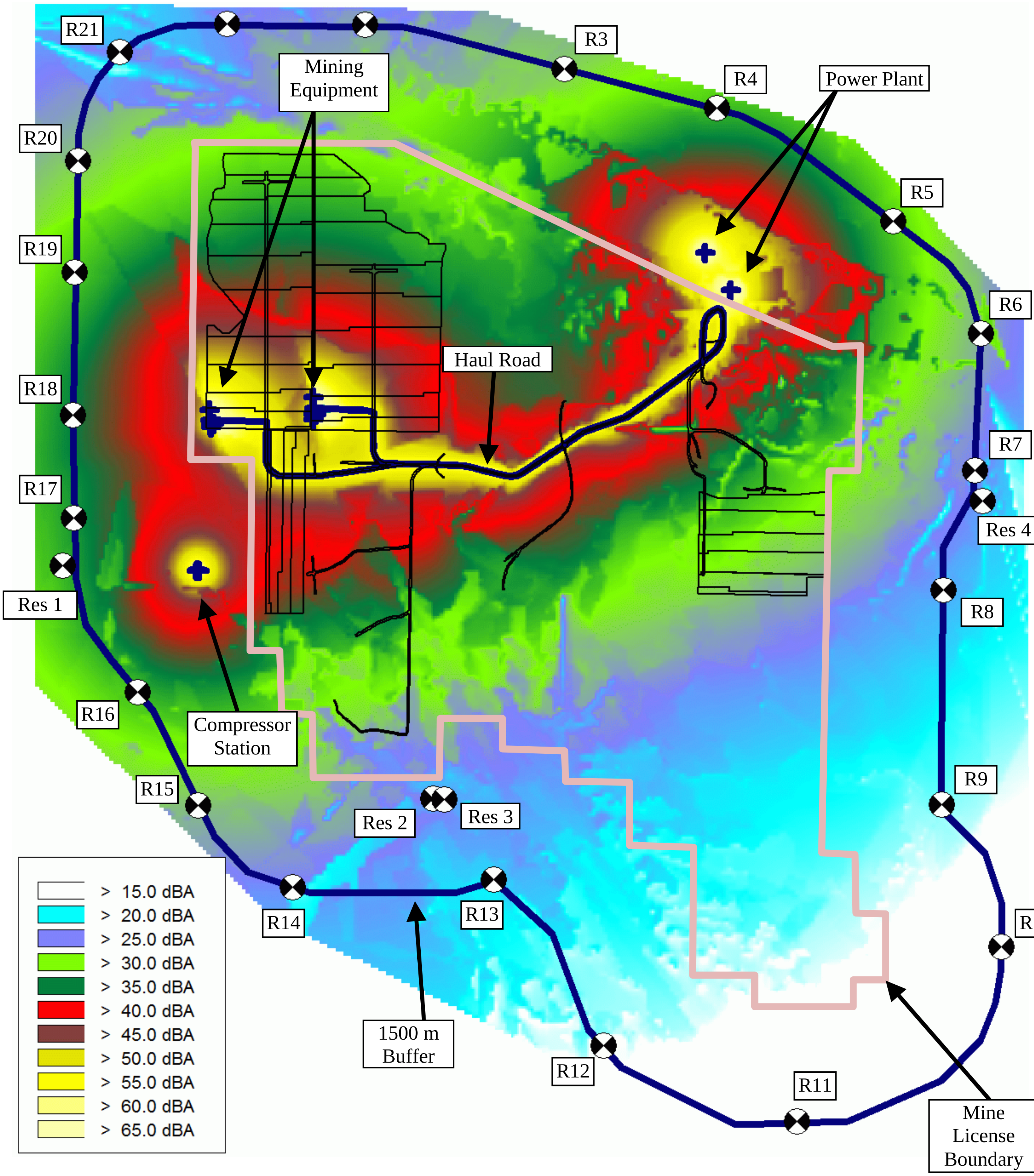

Figure 8. Scenario 5 Application Case Sound Levels With Noise Mitigation (Without ASL)

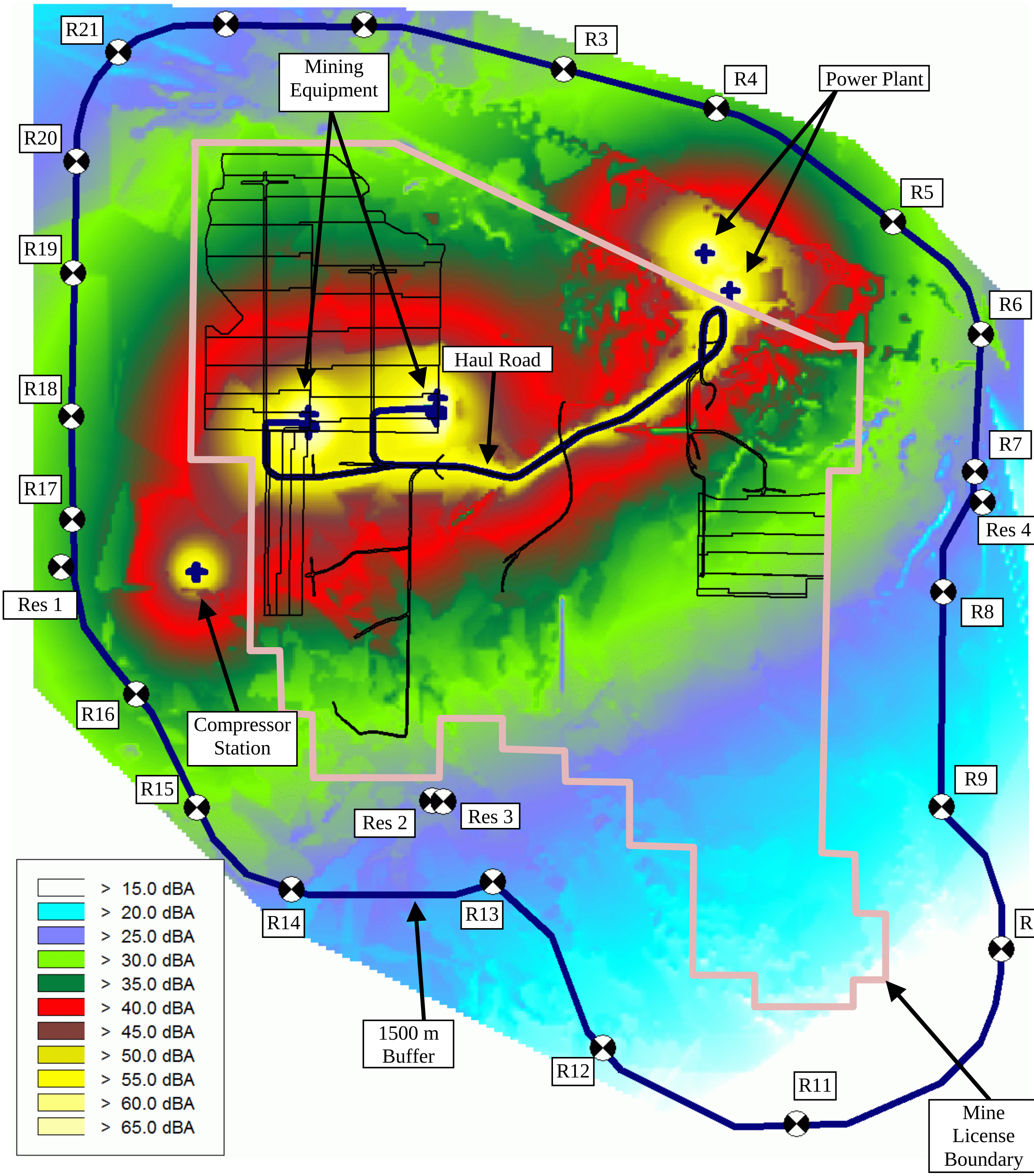

Figure 9. Scenario 6 Application Case Sound Levels (Without ASL)

Appendix I

MEASUREMENT EQUIPMENT USED

Short Term Sound Level Measurements

The equipment used for the short term sound level measurements consisted of a Brüel and Kjær Type 2250 Precision Integrating Sound Level Meter. The system acquired data in 5-second L_{eq} samples using 1/3 octave band frequency analysis and overall A-weighted and C-weighted sound levels. The sound level meter conforms to Type 1, ANSI S1.4, ANSI S1.43, IEC 61672-1, IEC 60651, IEC 60804 and DIN 45657. The 1/3 octave filters conform to S1.11 – Type 0-C, and IEC 61260 – Class 0. The calibrator conforms to IEC 942 and ANSI S1.40. The sound level meter, pre-amplifier and microphone were certified on September 24, 2007 and the calibrator (type B&K 4231) was certified on October 16, 2008 by a NIST NVLAP Accredited Calibration Laboratory for all requirements of ISO 17025: 1999 and relevant requirements of ISO 9002:1994, ISO 9001:2000 and ANSI/NCSL Z540: 1994 Part 1. All measurement methods and instrumentation conform to the requirements of the ERCB Directive 038. Refer to the next section in the Appendix for a detailed description of the various acoustical descriptive terms used.

B&K 2250 Calibration Certificate(s)

OB. NR | LOC.

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

We certify that Brüel & Kjær -2250--- Serial No 2600498
has been tested and passed all production tests, confirming compliance with the manufacturer's published specification at the date of the test.

The final test has been performed using calibrated equipment, traceable to National or International Standards or by ratio measurements.

Brüel & Kjær is certified under ISO 9001:2000 assuring that all calibration data for test equipment are retained on file and are available for inspection upon request.

Nærum 24-sep-2007

Torben Bjørn
Vice President
Operations

Please note that this document is not a calibration certificate, for information on our calibration services please contact your nearest Brüel & Kjær Service Center.

BA 0238 – 15

WORLD HEADQUARTERS: DK-2850 Nærum · Denmark
Telephone: +45 45 80 05 00 · Fax: +45 45 80 14 05 · http://www.bksv.com · e-mail: info@bksv.dk

Brüel & Kjær

Prepolarized Free-field 1/2" Microphone Type 4189

Bruel & Kjær

Calibration Chart

Serial No: 2595637

Open-circuit Sensitivity*, S_0:	-26.0	dB re 1V/Pa
Equivalent to:	50.0	mV/Pa
Uncertainty, 95 % confidence level	0.2	dB
Capacitance:	13.0	pF
Valid At:		
Temperature:	23	°C
Ambient Static Pressure:	101.3	kPa
Relative Humidity:	50	%
Frequency:	251.2	Hz
Polarization Voltage, external:	0	V

Sensitivity Traceable To:
DPLA: Danish Primary Laboratory of Acoustics
NIST: National Institute of Standards and Technology, USA

IEC 61094-4: Type WS 2 F

Environmental Calibration Conditions:
98.9 kPa 23 °C 50 % RH

Procedure: 704215 **Date:** 26. Jun. 2007 **Signature:** H.P.

*$K_0 = -26 - S_0$ Example: $K_0 = -26 - (-26.2) = +0.2$ dB

BC 0224 – 12

B&K 2250 Calibrator Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1 and relevant requirements of ISO 9002:1994 ACCREDITED by NVLAP (an ILAC and APLAC signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.18780

Instrument:	**Acoustical Calibrator**
Model:	**4231**
Manufacturer:	**Brüel and Kjær**
Serial number:	**2594693**
Class (IEC 60942):	**1**
Barometer type:	
Barometer s/n:	

Date Calibrated: **10/16/2008**

Status:	**Received**	**Sent**
In tolerance:	**X**	**X**
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes _X_ No

Customer: **Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373/ -6376**

Address: **9920 - 63 Ave. Suite 107, Edmonton, Alberta, Canada T6E 0G9**

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., 06/06/2005

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Jan 15, 2008	Scantek, Inc.	Jan 15, 2009
DS-360-SRS	Function Generator	33584	Jan 3, 2008	Davis Calibration / AClass	Jan 3, 2009
34401A-Agilent	Digital Voltmeter	US36120731	Aug 19, 2008	ACR Env. / A2LA	Aug 14, 2009
HM30-Thommen	Meteo Station	1040170/39633	Dec 21, 2007	Transcat / A2LA	Jun 21, 2009
8903-HP	Audio Analyzer	2514A05691	Jan 2, 2008	Transcat / A2LA	Jan 2, 2010
PC Program 1018 Norsonic	Calibration software	v.44	Validated May 2006	-	-
1253-Norsonic	Calibrator	22909	Aug 14, 2008	Scantek, Inc.	Aug 14, 2009
1203-Norsonic	Preamplifier	14059	Jan 4, 2008	Scantek, Inc./ NVLAP	Jan 4, 2009
4180-Bruel&Kjaer	Microphone	2246115	Mar 3, 2008	NPL (UK) / UKAS	Mar 7, 2010

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by	Javier Albarracin	**Checked by**	Mariana Buzduga
Signature	Jaf	Signature	lub
Date	10/16/2008	Date	10/16/08

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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Appendix II

THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

Sound Pressure Level

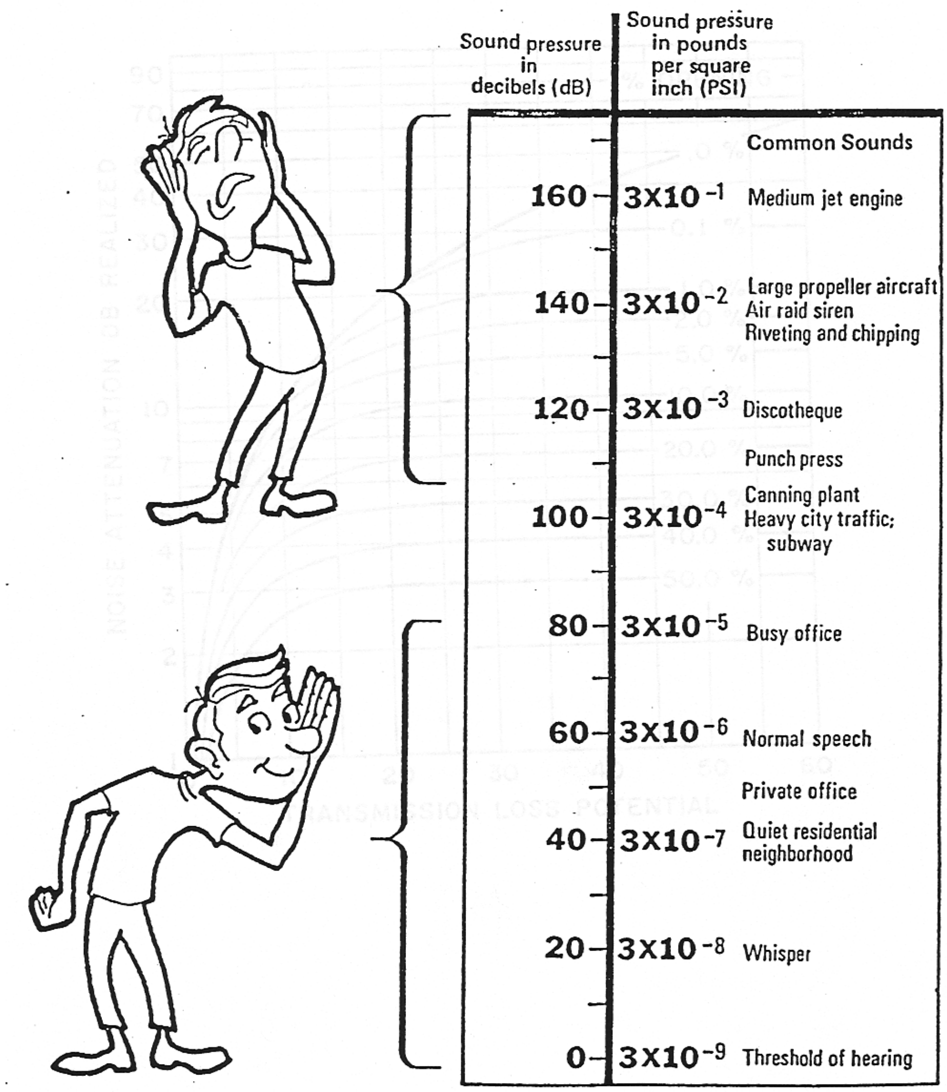
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we measure pressure we typically measure the RMS sound pressure.

$$SPL = 10\log_{10}\left[\frac{P_{RMS}^{2}}{P_{ref}^{2}}\right] = 20\log_{10}\left[\frac{P_{RMS}}{P_{ref}}\right]$$

Where: SPL = Sound Pressure Level in dB
P_{RMS} = Root Mean Square measured pressure (Pa)
P_{ref} = Reference sound pressure level ($P_{ref} = 2\text{x}10^{-5}$ Pa = 20 μPa)

This reference sound pressure level is an internationally agreed upon value. It represents the threshold of human hearing for "typical" people based on numerous testing. It is possible to have a threshold which is lower than 20 μPa which will result in negative dB levels. As such, zero dB does not mean there is no sound!

In general, a difference of 1 – 2 dB is the threshold for humans to notice that there has been a change in sound level. A difference of 3 dB (factor of 2 in acoustical energy) is perceptible and a change of 5 dB is strongly perceptible. A change of 10 dB is typically considered a factor of 2. This is quite remarkable when considering that 10 dB is 10-times the acoustical energy!


Sound pressure in decibels (dB)
Sound pressure in pounds per square inch (PSI)
Common Sounds
160 – 3X10^-1 Medium jet engine
140 – 3X10^-2 Large propeller aircraft
Air raid siren
Riveting and chipping
120 – 3X10^-3 Discotheque
Punch press
100 – 3X10^-4 Canning plant
Heavy city traffic; subway
80 – 3X10^-5 Busy office
60 – 3X10^-6 Normal speech
Private office
40 – 3X10^-7 Quiet residential neighborhood
20 – 3X10^-8 Whisper
0 – 3X10^-9 Threshold of hearing

Frequency

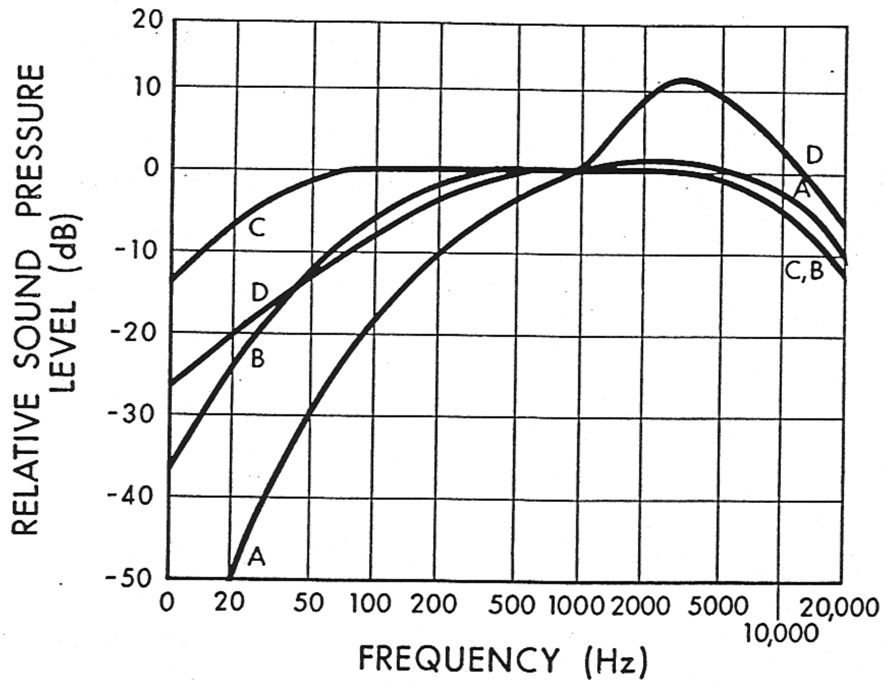
The range of frequencies audible to the human ear ranges from approximately 20 Hz to 20 kHz. Within this range, the human ear does not hear equally at all frequencies. It is not very sensitive to low frequency sounds, is very sensitive to mid frequency sounds and is slightly less sensitive to high frequency sounds. Due to the large frequency range of human hearing, the entire spectrum is often divided into 31 bands, each known as a 1/3 octave band.

The internationally agreed upon center frequencies and upper and lower band limits for the 1/1 (whole octave) and 1/3 octave bands are as follows:

Lower Band Limit	Whole Octave Center Frequency	Upper Band Limit
11	**16**	22
22	**31.5**	44
44	**63**	88
88	**125**	177
177	**250**	355
355	**500**	710
710	**1000**	1420
1420	**2000**	2840
2840	**4000**	5680
5680	**8000**	11360
11360	**16000**	22720

Lower Band Limit	1/3 Octave Center Frequency	Upper Band Limit
14.1	**16**	17.8
17.8	**20**	22.4
22.4	**25**	28.2
28.2	**31.5**	35.5
35.5	**40**	44.7
44.7	**50**	56.2
56.2	**63**	70.8
70.8	**80**	89.1
89.1	**100**	112
112	**125**	141
141	**160**	178
178	**200**	224
224	**250**	282
282	**315**	355
355	**400**	447
447	**500**	562
562	**630**	708
708	**800**	891
891	**1000**	1122
1122	**1250**	1413
1413	**1600**	1778
1778	**2000**	2239
2239	**2500**	2818
2818	**3150**	3548
3548	**4000**	4467
4467	**5000**	5623
5623	**6300**	7079
7079	**8000**	8913
8913	**10000**	11220
11220	**12500**	14130
14130	**16000**	17780
17780	**20000**	22390

Human hearing is most sensitive at approximately 3500 Hz which corresponds to the ¼ wavelength of the ear canal (approximately 2.5 cm). Because of this range of sensitivity to various frequencies, we typically apply various weighting networks to the broadband measured sound to more appropriately account for the way humans hear. By default, the most common weighting network used is the so-called "A-weighting". It can be seen in the figure that the low frequency sounds are reduced significantly with the A-weighting.



Combination of Sounds

When combining multiple sound sources the general equation is:

$$\Sigma SPL_n = 10\log_{10}\left[\sum_{i=1}^{n} 10^{\frac{SPL_i}{10}}\right]$$

Examples:

- Two sources of 50 dB each add together to result in 53 dB.
- Three sources of 50 dB each add together to result in 55 dB.
- Ten sources of 50 dB each add together to result in 60 dB.
- One source of 50 dB added to another source of 40 dB results in 50.4 dB

It can be seen that, if multiple similar sources exist, removing or reducing only one source will have little effect.

Sound Level Measurements

Over the years a number of methods for measuring and describing environmental noise have been developed. The most widely used and accepted is the concept of the Energy Equivalent Sound Level (L_{eq}) which was developed in the US (1970's) to characterize noise levels near US Air-force bases. This is the level of a steady state sound which, for a given period of time, would contain the same energy as the time varying sound. The concept is that the same amount of annoyance occurs from a sound having a high level for a short period of time as from a sound at a lower level for a longer period of time.
The L_{eq} is defined as:

$$L_{eq} = 10\log_{10}\left[\frac{1}{T}\int_0^T 10^{\frac{dB}{10}}\, dT\right] = 10\log_{10}\left[\frac{1}{T}\int_0^T \frac{P^2}{P_{ref}^2}\, dT\right]$$

We must specify the time period over which to measure the sound. i.e. 1-second, 10-seconds, 15-seconds, 1-minute, 1-day, etc. **An L_{eq} is meaningless if there is no time period associated**.

In general there a few very common L_{eq} sample durations which are used in describing environmental noise measurements. These include:

- L_{eq}24 - Measured over a 24-hour period
- L_{eq}Night - Measured over the night-time (typically 22:00 – 07:00)
- L_{eq}Day - Measured over the day-time (typically 07:00 – 22:00)
- L_{DN} - Same as L_{eq}24 with a 10 dB penalty added to the night-time

Statistical Descriptor

Another method of conveying long term noise levels utilizes statistical descriptors. These are calculated from a cumulative distribution of the sound levels over the entire measurement duration and then determining the sound level at xx % of the time.

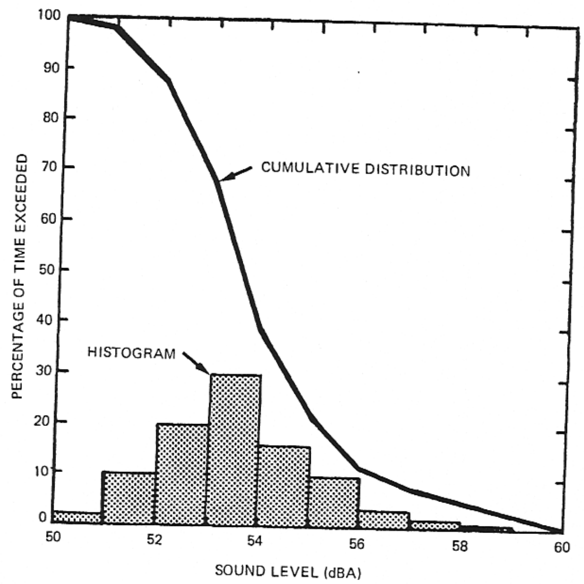


Figure 16.6 Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

Industrial Noise Control, Lewis Bell, Marcel Dekker, Inc. 1994

The most common statistical descriptors are:

L_{min} - minimum sound level measured
L_{01} - sound level that was exceeded only 1% of the time
L_{10} - sound level that was exceeded only 10% of the time.
- Good measure of intermittent or intrusive noise
- Good measure of Traffic Noise

L_{50} - sound level that was exceeded 50% of the time (arithmetic average)
- Good to compare to L_{eq} to determine steadiness of noise

L_{90} - sound level that was exceeded 90% of the time
- Good indicator of typical “ambient” noise levels

L_{99} - sound level that was exceeded 99% of the time
L_{max} - maximum sound level measured

These descriptors can be used to provide a more detailed analysis of the varying noise climate:
- If there is a large difference between the L_{eq} and the L_{50} (L_{eq} can never be any lower than the L_{50}) then it can be surmised that one or more short duration, high level sound(s) occurred during the time period.
- If the gap between the L_{10} and L_{90} is relatively small (less than 15 – 20 dBA) then it can be surmised that the noise climate was relatively steady.

Sound Propagation

In order to understand sound propagation, the nature of the source must first be discussed. In general, there are three types of sources. These are known as 'point', 'line', and 'area'. This discussion will concentrate on point and line sources since area sources are much more complex and can usually be approximated by point sources at large distances.

Point Source

As sound radiates from a point source, it dissipates through geometric spreading. The basic relationship between the sound levels at two distances from a point source is:

$$\therefore SPL_1 - SPL_2 = 20\log_{10}\left(\frac{r_2}{r_1}\right)$$

Where: SPL_1 = sound pressure level at location 1, SPL_2 = sound pressure level at location 2
r_1 = distance from source to location 1, r_2 = distance from source to location 2

Thus, the reduction in sound pressure level for a point source radiating in a free field is **6 dB per doubling of distance**. This relationship is independent of reflectivity factors provided they are always present. Note that this only considers geometric spreading and does not take into account atmospheric effects. Point sources still have some physical dimension associated with them, and typically do not radiate sound equally in all directions in all frequencies. The directionality of a source is also highly dependent on frequency. As frequency increases, directionality increases.

Examples (note no atmospheric absorption):

- A point source measuring 50 dB at 100m will be 44 dB at 200m.
- A point source measuring 50 dB at 100m will be 40.5 dB at 300m.
- A point source measuring 50 dB at 100m will be 38 dB at 400m.
- A point source measuring 50 dB at 100m will be 30 dB at 1000m.

Line Source

A line source is similar to a point source in that it dissipates through geometric spreading. The difference is that a line source is equivalent to a long line of many point sources. The basic relationship between the sound levels at two distances from a line source is:

$$SPL_1 - SPL_2 = 10\log_{10}\left(\frac{r_2}{r_1}\right)$$

The difference from the point source is that the '20' term in front of the 'log' is now only 10. Thus, the reduction in sound pressure level for a line source radiating in a free field is **3 dB per doubling of distance**.

Examples (note no atmospheric absorption):

- A line source measuring 50 dB at 100m will be 47 dB at 200m.
- A line source measuring 50 dB at 100m will be 45 dB at 300m.
- A line source measuring 50 dB at 100m will be 44 dB at 400m.
- A line source measuring 50 dB at 100m will be 40 dB at 1000m.

Atmospheric Absorption

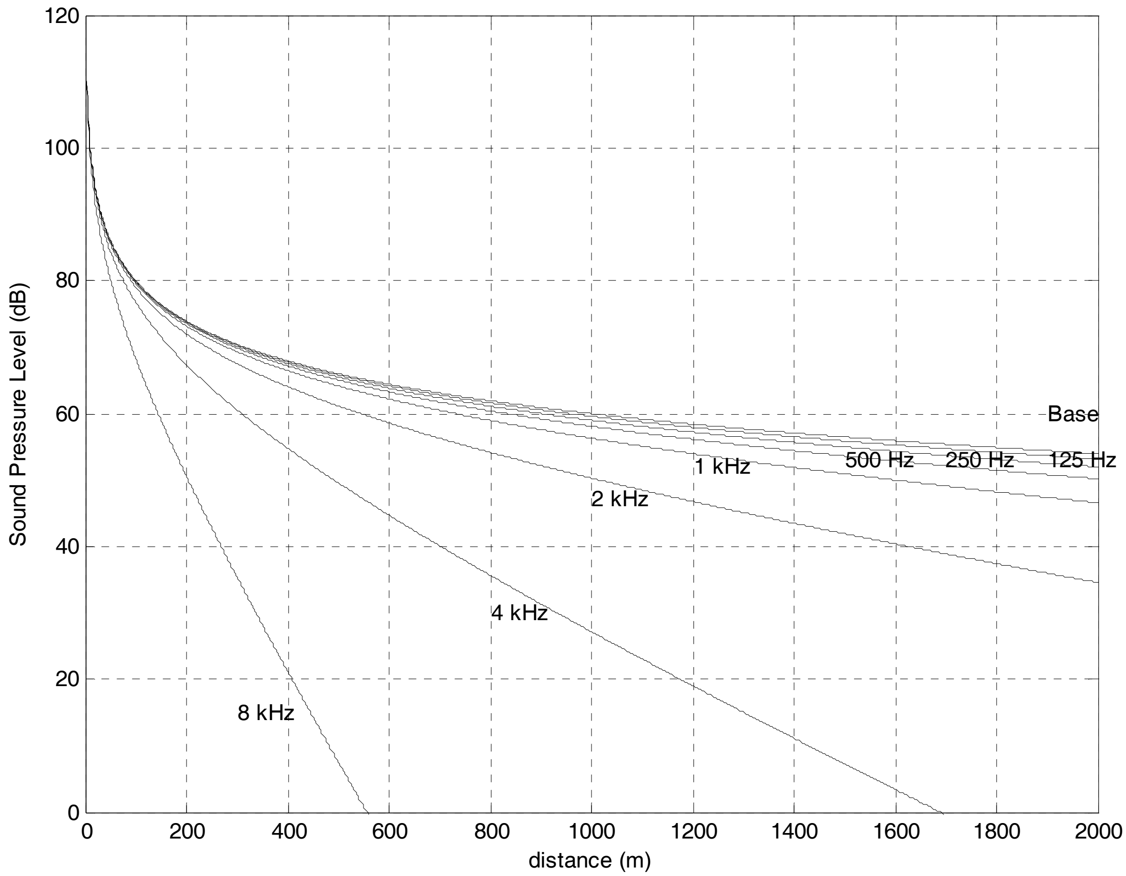
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

1) **Viscous Effects** - Dissipation of acoustic energy due to fluid friction which results in thermodynamically irreversible propagation of sound.
2) **Heat Conduction Effects** - Heat transfer between high and low temperature regions in the wave which result in non-adiabatic propagation of the sound.
3) **Inter Molecular Energy Interchanges** - Molecular energy relaxation effects which result in a time lag between changes in translational kinetic energy and the energy associated with rotation and vibration of the molecules.

The following table illustrates the attenuation coefficient of sound at standard pressure (101.325 kPa) in units of dB/100m.

Temperature ^{o}C	Relative Humidity (%)	Frequency (Hz)					
		125	250	500	1000	2000	4000
30	20	0.06	0.18	0.37	0.64	1.40	4.40
	50	0.03	0.10	0.33	0.75	1.30	2.50
	90	0.02	0.06	0.24	0.70	1.50	2.60
20	20	0.07	0.15	0.27	0.62	1.90	6.70
	50	0.04	0.12	0.28	0.50	1.00	2.80
	90	0.02	0.08	0.26	0.56	0.99	2.10
10	20	0.06	0.11	0.29	0.94	3.20	9.00
	50	0.04	0.11	0.20	0.41	1.20	4.20
	90	0.03	0.10	0.21	0.38	0.81	2.50
0	20	0.05	0.15	0.50	1.60	3.70	5.70
	50	0.04	0.08	0.19	0.60	2.10	6.70
	90	0.03	0.08	0.15	0.36	1.10	4.10

- As frequency increases, absorption tends to increase
- As Relative Humidity increases, absorption tends to decrease
- There is no direct relationship between absorption and temperature
- **The net result of atmospheric absorption is to modify the sound propagation of a point source from 6 dB/doubling-of-distance to approximately 7 – 8 dB/doubling-of-distance (based on anecdotal experience)**



Atmospheric Absorption at 10°C and 70% RH

Meteorological Effects

There are many meteorological factors which can affect how sound propagates over large distances. These various phenomena must be considered when trying to determine the relative impact of a noise source either after installation or during the design stage.

Wind
- Can greatly alter the noise climate away from a source depending on direction
- Sound levels downwind from a source can be increased due to refraction of sound back down towards the surface. This is due to the generally higher velocities as altitude increases.
- Sound levels upwind from a source can be decreased due to a “bending” of the sound away from the earth’s surface.
- Sound level differences of ±10dB are possible depending on severity of wind and distance from source.
- Sound levels crosswind are generally not disturbed by an appreciable amount
- Wind tends to generate its own noise, however, and can provide a high degree of masking relative to a noise source of particular interest.

Temperature
- Temperature effects can be similar to wind effects
- Typically, the temperature is warmer at ground level than it is at higher elevations.
- If there is a very large difference between the ground temperature (very warm) and the air aloft (only a few hundred meters) then the transmitted sound refracts upward due to the changing speed of sound.
- If the air aloft is warmer than the ground temperature (known as an *inversion*) the resulting higher speed of sound aloft tends to refract the transmitted sound back down towards the ground. This essentially works on Snell’s law of reflection and refraction.
- Temperature inversions typically happen early in the morning and are most common over large bodies of water or across river valleys.
- Sound level differences of ±10dB are possible depending on gradient of temperature and distance from source.

Rain
- Rain does not affect sound propagation by an appreciable amount unless it is very heavy
- The larger concern is the noise generated by the rain itself. A heavy rain striking the ground can cause a significant amount of highly broadband noise. The amount of noise generated is difficult to predict.
- Rain can also affect the output of various noise sources such as vehicle traffic.

Summary
- In general, these wind and temperature effects are difficult to predict
- Empirical models (based on measured data) have been generated to attempt to account for these effects.
- Environmental noise measurements must be conducted with these effects in mind. Sometimes it is desired to have completely calm conditions, other times a “worst case” of downwind noise levels are desired.

Topographical Effects

Similar to the various atmospheric effects outlined in the previous section, the effect of various geographical and vegetative factors must also be considered when examining the propagation of noise over large distances.

Topography

- One of the most important factors in sound propagation.
- Can provide a natural barrier between source and receiver (i.e. if berm or hill in between).
- Can provide a natural amplifier between source and receiver (i.e. large valley in between or hard reflective surface in between).
- Must look at location of topographical features relative to source and receiver to determine importance (i.e. small berm 1km away from source and 1km away from receiver will make negligible impact).

Grass

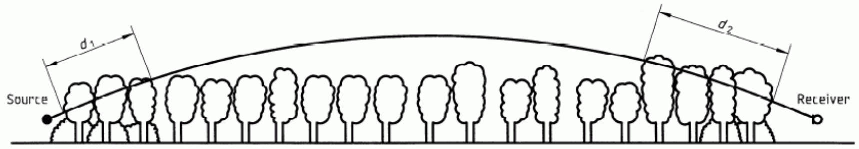
- Can be an effective absorber due to large area covered
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of thumb based on empirical data is:

$$A_g = 18\log_{10}(f) - 31 \qquad (dB/100m)$$

Where: A_g is the absorption amount

Trees

- Provide absorption due to foliage
- Deciduous trees are essentially ineffective in the winter
- Absorption depends heavily on density and height of trees
- No data found on absorption of various kinds of trees
- Large spans of trees are required to obtain even minor amounts of sound reduction
- In many cases, trees can provide an effective visual barrier, even if the noise attenuation is negligible.



NOTE — $d_f = d_1 + d_2$

For calculating d_1 and d_2, the curved path radius may be assumed to be 5 km.

Figure A.1 — Attenuation due to propagation through foliage increases linearly with propagation distance d_f through the foliage

Table A.1 — Attenuation of an octave band of noise due to propagation a distance d_f through dense foliage

Propagation distance d_f	Nominal midband frequency Hz							
m	63	125	250	500	1 000	2 000	4 000	8 000
	Attenuation, dB:							
$10 \leq d_f \leq 20$	0	0	1	1	1	1	2	3
	Attenuation, dB/m:							
$20 \leq d_f \leq 200$	0,02	0,03	0,04	0,05	0,06	0,08	0,09	0,12

Tree/Foliage attenuation from ISO 9613-2:1996

Bodies of Water

- Large bodies of water can provide the opposite effect to grass and trees.
- Reflections caused by small incidence angles (grazing) can result in larger sound levels at great distances (increased reflectivity, Q).
- Typically air temperatures are warmer high aloft since air temperatures near water surface tend to be more constant. Result is a high probability of temperature inversion.
- Sound levels can “carry” much further.

Snow

- Covers the ground for approximately 1/2 of the year in northern climates.
- Can act as an absorber or reflector (and varying degrees in between).
- Freshly fallen snow can be quite absorptive.
- Snow which has been sitting for a while and hard packed due to wind can be quite reflective.
- Falling snow can be more absorptive than rain, but does not tend to produce its own noise.
- Snow can cover grass which might have provided some means of absorption.
- Typically sound propagates with less impedance in winter due to hard snow on ground and no foliage on trees/shrubs.

Appendix III

SOUND LEVELS OF FAMILIAR NOISE SOURCES

Used with Permission Obtained from ERCB Guide 38: Noise Control Directive User Guide (February 2007)

Source[1]	**Sound Level (dBA)**
Bedroom of a country home	30
Soft whisper at 1.5 m	30
Quiet office or living room	40
Moderate rainfall	50
Inside average urban home	50
Quiet street	50
Normal conversation at 1 m	60
Noisy office	60
Noisy restaurant	70
Highway traffic at 15 m	75
Loud singing at 1 m	75
Tractor at 15 m	78-95
Busy traffic intersection	80
Electric typewriter	80
Bus or heavy truck at 15 m	88-94
Jackhammer	88-98
Loud shout	90
Freight train at 15 m	95
Modified motorcycle	95
Jet taking off at 600 m	100
Amplified rock music	110
Jet taking off at 60 m	120
Air-raid siren	130

[1] Cottrell, Tom, 1980, *Noise in Alberta*, Table 1, p.8, ECA80 - 16/1B4 (Edmonton: Environment Council of Alberta).

SOUND LEVELS GENERATED BY COMMON APPLIANCES

Used with Permission Obtained from ERCB Guide 38: Noise Control Directive User Guide (February 2007)

Source[1]	**Sound level at 3 feet (dBA)**
Freezer	38-45
Refrigerator	34-53
Electric heater	47
Hair clipper	50
Electric toothbrush	48-57
Humidifier	41-54
Clothes dryer	51-65
Air conditioner	50-67
Electric shaver	47-68
Water faucet	62
Hair dryer	58-64
Clothes washer	48-73
Dishwasher	59-71
Electric can opener	60-70
Food mixer	59-75
Electric knife	65-75
Electric knife sharpener	72
Sewing machine	70-74
Vacuum cleaner	65-80
Food blender	65-85
Coffee mill	75-79
Food waste disposer	69-90
Edger and trimmer	81
Home shop tools	64-95
Hedge clippers	85
Electric lawn mower	80-90

[1] Reif, Z. F., and Vermeulen, P. J., 1979, "Noise from domestic appliances, construction, and industry," Table 1, p.166, in Jones, H. W., ed., *Noise in the Human Environment*, vol. 2, ECA79-SP/1 (Edmonton: Environment Council of Alberta).

Appendix IV

NOISE MODELING PARAMETERS

Mining Equipment Sound Power Levels (Re 10^{-12} Watts)

Item	dBA		32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Scraper (Topsoil Removal/Replacement) [Cat 637 G]	119		113	113	118	121	116	114	111	105	99
Dragline (Overburden Removal)	107		116	115	110	103	103	103	100	91	79
Dozer (Overburden Removal/Replacement) [Cat D10]	118		111	111	116	120	115	113	109	103	97
Loaders [Cat 993]	119		113	113	118	121	116	114	111	105	99
Haul Truck [Cat 785]	117		117	118	116	113	114	113	110	104	100
Grader (Topsoil Replacement) [Cat 16M]	114		108	108	113	116	111	109	106	100	94
Water Truck (Dust Control)	114		108	108	113	116	111	109	106	100	94

Power Plant Sound Power Levels (Re 10^{-12} Watts)

Item	dBA		32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Power Plant (Main Building)	121		129	125	121	122	119	115	110	103	94
Power Plant (Chillers)	118		126	122	118	119	116	112	107	100	91

Compressor Station Sound Power Levels (Re 10^{-12} Watts)

Gas Turbine Air Inlet (5 m elevation)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Unsilenced Combustion Air Inlet SPL @ 15 m	76	82	88	89	90	92	95	120	112	121
Inlet Pulse Cleaning Up-Draft Filter Insertion Loss	-2	-4	-8	-9	-13	-26	-27	-27	-33	
Subtotal	74	78	80	80	77	66	68	93	79	
Taurus 60 Inlet Silencer Insertion Loss	-1	-2	-3	-4	-17	-32	-46	-47	-31	
Subtotal	73	76	77	76	60	34	22	46	48	
Combustion Air Inlet SWL	**108**	**111**	**112**	**111**	**95**	**69**	**57**	**81**	**83**	**104**

Gas Turbine Exhaust (13 m elevation)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Unsilenced Combustion Exhaust SPL @ 15 m	88	91	88	91	95	87	80	72	64	94
Taurus 60 Exhaust Silencer Insertion Loss	-1	-2	-6	-12	-17	-21	-19	-14	-10	
Subtotal	87	89	82	79	78	66	61	58	54	
Combustion Air Inlet SWL	**122**	**124**	**117**	**114**	**113**	**101**	**96**	**93**	**89**	**112**

Gas Turbine Casing (3 m elevation)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Enclosed Casing SPL @ 15 m	72	65	66	67	68	64	64	60	53	70
Casing Noise SWL	**107**	**100**	**101**	**102**	**103**	**99**	**99**	**95**	**88**	**105**

Lube Oil Cooler (3 m elevation)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Lube Oil Cooler SPL @ 15 m	73	80	77	70	65	62	58	54	49	68
Lube Oil Cooler SWL	**108**	**115**	**112**	**105**	**100**	**97**	**93**	**89**	**84**	**104**

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