



MEMORANDUM

| | |
|-----------------|---|
| To: | Andy Novey |
| From: | Isaac Old |
| Subject: | Addendum: Siemens SWT 3.0-113 Sound Modeling Results for Canton Mountain Wind |
| Date: | May 22, 2012 |

NOTE: This memo is an addendum to the RSG report "Noise Modeling Study for Canton Wind Farm: Canton, Maine," dated December 2011.

Patriot Renewables requested that RSG perform sound propagation modeling for the Canton Mountain Wind Project, using eight Siemens SWT 3.0-113 turbines in the locations previously modeled using Gamesa G90 and GE 2.75-100 and 2.75-103 wind turbines. This memo includes a description of the acoustical characteristics and sound propagation modeling results using the Siemens wind turbine.

SIEMENS SWT 3.0-113 ACOUSTICAL EMISSIONS

SOUND POWER

The project proposes to use eight Siemens SWT 3.0-113 3.0 MW wind turbines with a hub height of 90 meters.

Sound emissions from a wind turbine are measured as *sound power*. The sound power level from a Siemens SWT 3.0-113 is 106 ± 1.5 dBA with wind speeds greater than 7 m/s (10-meter anemometer height). The modeled level in this report is 109.5 dBA, as it includes the manufacturer uncertainty factor of 1.5 dB plus a 2 dB modeling uncertainty factor. The octave band sound power levels are shown in Table 1. Compared to the GE 2.75-103, the Siemens turbine emits more high frequency sound and less low frequency sound. Since high frequency sound is attenuated more rapidly by the atmosphere than low frequency sound, sound levels from the Siemens turbine will be slightly higher close to the turbines, but lower further away, as compared with the GE and Gamesa turbines.

Table 1: Spectral Sound Power Levels (dBA)

| Turbine Model and 10-m Height Wind Speed | Nominal Sound Power (dBA) | 1/1 Octave Band Center Frequency | | | | | | | | |
|--|---------------------------|----------------------------------|-------|--------|--------|--------|-------|-------|-------|-------|
| | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| Siemens SWT 3.0-113 for 8 m/s to cutout | 106 | n/a | 84 | 89 | 99 | 100 | 100 | 90 | 92 | 75 |
| GE 2.75-103 for 7 m/s to cutout | 105 | 83 | 92 | 96 | 98 | 98 | 99 | 96 | 88 | 71 |

TONALITY

Because the Siemens SWT 3.0-113 is a new model, 1/3 octave band data is not yet available. However, Siemens has guaranteed that its turbine emits no tonal sound according to the Maine DEP definition.

MODELING

MODELING PARAMETERS

Modeling parameters for the Siemens turbine configuration were the same as with the other turbine configurations except where manufacturer specifications differed. That is, we modeled sound propagation in accordance with ISO 9613-2 for omnidirectional wind, using spectral ground attenuation and a ground absorption factor of 0.5 (to represent mixed ground). A 1.5 dB manufacturer’s confidence interval and a 2 dB modeling uncertainty margin were added to the sound power level of the wind turbines (See Table A1).

A 15-meter by 15-meter grid of receivers was set up in the model covering 32 square miles around the site. This accounts for a total of about 373,000 modeled receivers. A receiver is a point above the ground at which the computer model calculates a sound level. Separate discrete receivers were added to the model in addition to the grid to represent the 30 residences and camps located nearest to the proposed wind turbines and 30 residences and camps within 1 mile of the substation. Three receivers were placed to represent the worst case locations within a 500-foot radius of the three closest non-participating homes near the project. Grid receivers were modeled at a height of 1.5 meters, discrete receivers representing homes were modeled at a height of 4.0 meters, and discrete receivers representing other locations were modeled at a height of 1.5 meters. Given its extent, property boundaries were modeled using the receiver grid rather than discrete points.

The Siemens SWT 3.0-113 turbines produce a maximum power output of 3.0 MW and have 113-meter diameter rotors, which are mounted on 90-meter towers. In addition to the wind turbines, two 34.5/115 kV transformers were modeled. One transformer will support the proposed Canton Mountain Wind project and the other will support the already-permitted Saddleback Ridge Wind project.



RESULTS

Results from the modeling are shown graphically in Figure 1. Discrete receiver results are shown in Table A2. The highest modeled sound levels are shown in Table 2. Maine DEP noise level limits are met in all situations.

Table 2: Highest Modeled Sound Levels Compared to Maine DEP Noise Level Limits

| Location | Modeled Sound Level | Noise Standard |
|---|---------------------|-----------------------------|
| Nearest residence | 43 dBA | 55 dBA (day)/45 dBA (night) |
| 500 feet from nearest residence ¹ | 43 dBA | 45 dBA (night) |
| Property boundary of nearest residence ² | 51 dBA | 55 dBA (night) |
| Property boundary of project | 51 dBA | 75 dBA |

INFRASOUND AND LOW FREQUENCY SOUND RESULTS

The Maine DEP does not have a separate standard for infrasound or low frequency sound.

Criteria for noise induced building vibration at the interior of buildings can be found in ANSI S12.2-2008, "Criteria for evaluating room noise." The criteria for "moderately perceptible vibration and rattle likely" is 65 dB at 16 and 31.5 Hz, and 70 dB at 63 Hz octave bands.

To assess whether low frequency sound may have the potential to cause interior low-frequency noise issues, we modeled the 63 Hz octave band. Of all the non-participating residences evaluated, the highest sound level outside at 63 Hz is 52 dBA. This modeled sound level is below the noise-induced vibration threshold. The 16 Hz and 31.5 Hz octave band sound power is not available for this turbine. However, most wind turbines have a flat spectrum in this range, thus, it is expected that exterior sound levels at 16 Hz and 31.5 Hz will similarly be below the ANSI S12.2 criteria.

Modeling at infrasound frequencies was not conducted, as modern wind turbines typically do not generate problematic infrasound levels.

CONCLUSIONS

Sound propagation modeling was performed for the proposed Canton Mountain Wind Project, using eight Siemens SWT 3.0-113 turbines, in the same locations previously modeled with Gamesa G90 and GE 2.75-100 and 2.75-103 wind turbines. Results are as follows:

¹ A map of surveyed property boundaries outside of the Project is not available. This it is assumed that the full 500 foot buffer around each residence is owned by that residence and is a protected location.

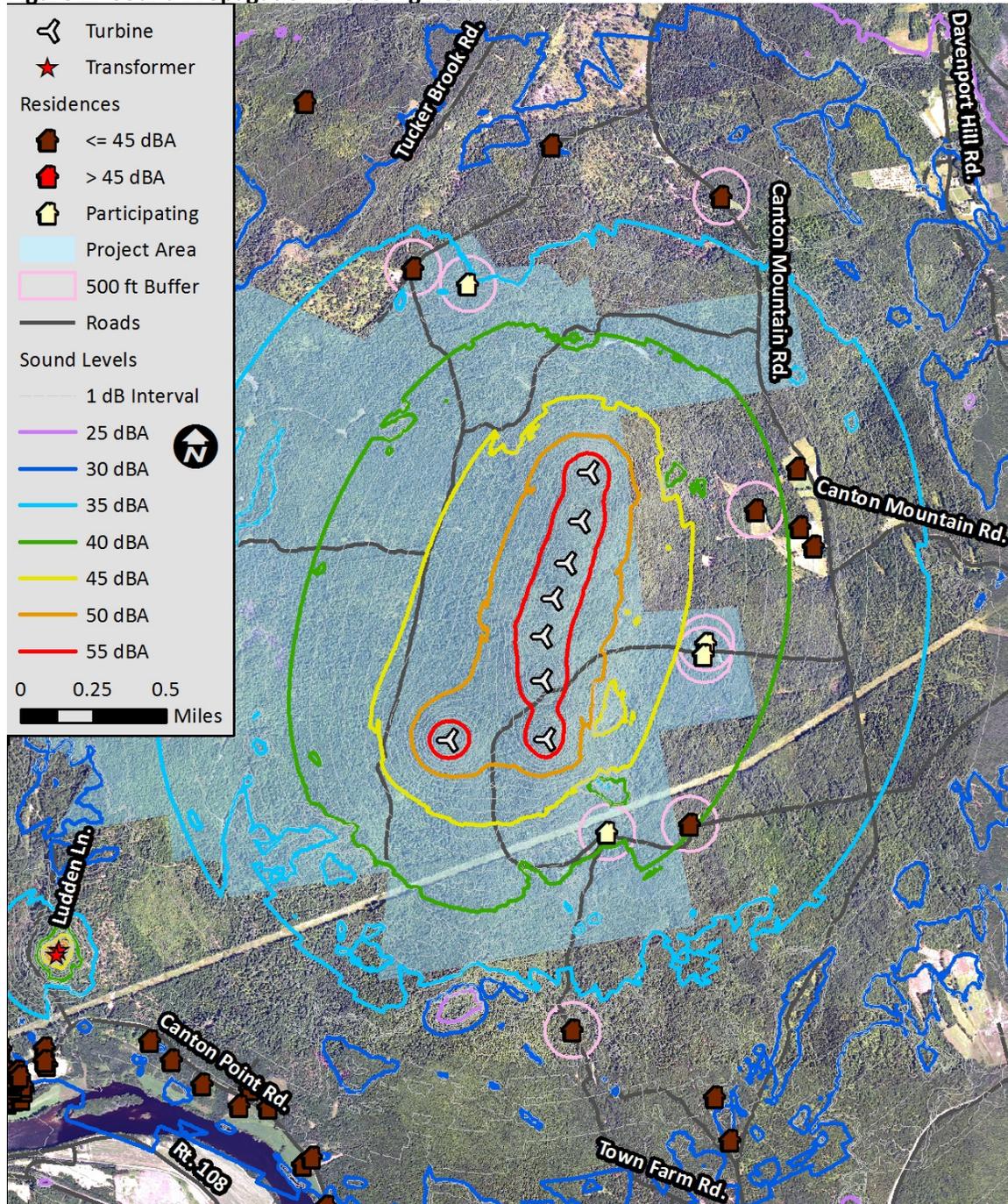
² A map of surveyed property boundaries is not available outside of the Project parcel. Therefore, it is assumed that all areas outside of the project are protected locations.



- At residential protected locations, a noise standard of 55 dBA during the day is applied. At night, a noise level of 45 dBA must be met within 500 feet of any residence (or its property line, whichever is closer), according to Maine DEP Chapter 375.10 regulations. At all other locations outside of the project property, a standard of 75 dBA must be met.
- The Siemens SWT 3.0-113 turbine has a sound power of 106 ± 1.5 dBA. Turbines were modeled with a ground factor of $G = 0.5$ and 3.5 dB added to account for uncertainty in sound power and modeling. The total modeled sound power was 109.5 dBA for each wind turbine.
- Siemens has guaranteed that the SWT 3.0-113 wind turbine will not emit tonal sound according to the Maine DEP definition.
- The highest sound level modeled at and within 500 feet of a non-participating residence was 43 dBA (receivers 9 and 9B), complying with the Maine DEP nighttime standard for residential protected locations.
- The highest sound level modeled outside of the 500 foot buffers is 51 dBA, complying with the Maine DEP daytime standard for protected locations and all other locations.
- The modeled levels of low frequency sound will not create perceptible building vibration.
- With no additional mitigation, the modeled results described in this report for the Canton Mountain Wind project are within the noise standards set out by the Maine Department of Environmental Protection.



Figure 1: Sound Propagation Modeling Results



APPENDIX A: SOURCE AND RECEIVER INFORMATION



Figure A1: Receiver Locations

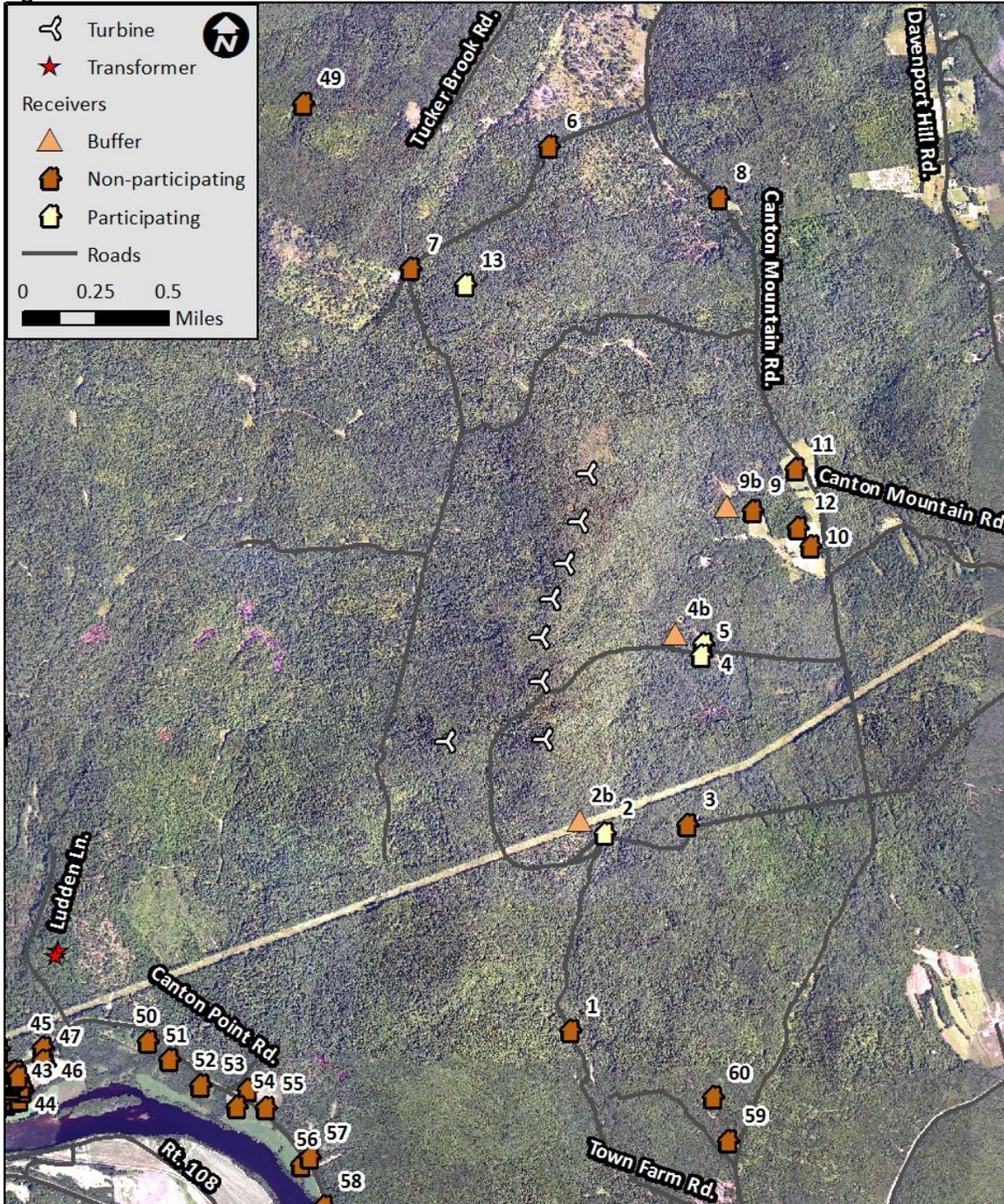


Table A1: Source Information

| Source ID | Modeled Sound Power (dBA) | Nominal Turbine Sound Power (dB) | Source Height (m) | Coordinates at Source Height (UTM NAD83 Z19N) | | |
|---|---------------------------|----------------------------------|-------------------|---|---------|-------|
| | | | | X (m) | Y (m) | Z (m) |
| T1 | 109.5 | 106 | 90 | 396625 | 4930556 | 545 |
| T2 | 109.5 | 106 | 90 | 396576 | 4930287 | 551 |
| T3 | 109.5 | 106 | 90 | 396500 | 4930057 | 555 |
| T4 | 109.5 | 106 | 90 | 396425 | 4929860 | 555 |
| T5 | 109.5 | 106 | 90 | 396364 | 4929651 | 544 |
| T6 | 109.5 | 106 | 90 | 396365 | 4929406 | 550 |
| T7 | 109.5 | 106 | 90 | 396382 | 4929083 | 560 |
| T8 | 109.5 | 106 | 90 | 395844 | 4929075 | 495 |
| Transformer - Canton Mountain Wind Project | 93 | 93 | 3 | 393699 | 4927916 | 168 |
| Transformer - Saddleback Ridge Wind Project | 93 | 93 | 3 | 393683 | 4927887 | 166 |



Table A2: Discrete Receiver Results

| Receiver ID | Status | Sound Pressure Level (dBA) | Relative Height (m) | Coordinates at Source Height (UTM NAD83 Z19N) | | |
|-------------|-------------------|----------------------------|---------------------|---|---------|-------|
| | | | | X (m) | Y (m) | Z (m) |
| 1 | Non-participating | 35 | 4 | 396535 | 4927470 | 192 |
| 2 | Participating | 42 | 4 | 396726 | 4928565 | 290 |
| 3 | Non-participating | 42 | 4 | 397183 | 4928611 | 279 |
| 4 | Participating | 45 | 4 | 397273 | 4929612 | 271 |
| 5 | Participating | 45 | 4 | 397261 | 4929546 | 270 |
| 6 | Non-participating | 32 | 4 | 396419 | 4932369 | 280 |
| 7 | Non-participating | 38 | 4 | 395653 | 4931689 | 350 |
| 8 | Non-participating | 36 | 4 | 397358 | 4932082 | 279 |
| 9 | Non-participating | 43 | 4 | 397547 | 4930349 | 241 |
| 10 | Non-participating | 40 | 4 | 397867 | 4930150 | 226 |
| 11 | Non-participating | 41 | 4 | 397782 | 4930579 | 238 |
| 12 | Non-participating | 41 | 4 | 397793 | 4930254 | 230 |
| 13 | Participating | 38 | 4 | 395957 | 4931599 | 364 |
| 14 | Non-participating | 21 | 4 | 392501 | 4926924 | 146 |
| 16 | Non-participating | 28 | 4 | 392817 | 4927103 | 143 |
| 17 | Non-participating | 27 | 4 | 392918 | 4927107 | 141 |
| 18 | Non-participating | 29 | 4 | 393117 | 4927231 | 143 |
| 19 | Non-participating | 30 | 4 | 393238 | 4927258 | 139 |
| 20 | Non-participating | 29 | 4 | 393311 | 4927258 | 139 |
| 21 | Non-participating | 32 | 4 | 393377 | 4927368 | 144 |
| 22 | Non-participating | 31 | 4 | 393379 | 4927211 | 140 |
| 23 | Non-participating | 30 | 4 | 393338 | 4927199 | 139 |
| 24 | Non-participating | 31 | 4 | 393343 | 4927181 | 139 |
| 25 | Non-participating | 31 | 4 | 393381 | 4927185 | 139 |
| 26 | Non-participating | 31 | 4 | 393350 | 4927160 | 139 |
| 27 | Non-participating | 31 | 4 | 393397 | 4927143 | 139 |
| 28 | Non-participating | 31 | 4 | 393352 | 4927132 | 139 |
| 29 | Non-participating | 31 | 4 | 393418 | 4927105 | 137 |
| 30 | Non-participating | 30 | 4 | 393357 | 4927069 | 136 |



| Receiver ID | Status | Sound Pressure Level (dBA) | Relative Height (m) | Coordinates at Source Height (UTM NAD83 Z19N) | | |
|-------------|-------------------|----------------------------|---------------------|---|---------|-------|
| | | | | X (m) | Y (m) | Z (m) |
| 31 | Non-participating | 31 | 4 | 393414 | 4927068 | 135 |
| 32 | Non-participating | 30 | 4 | 393366 | 4927048 | 134 |
| 33 | Non-participating | 31 | 4 | 393455 | 4927087 | 135 |
| 34 | Non-participating | 31 | 4 | 393449 | 4927126 | 137 |
| 35 | Non-participating | 30 | 4 | 393487 | 4927093 | 133 |
| 36 | Non-participating | 31 | 4 | 393503 | 4927139 | 136 |
| 37 | Non-participating | 31 | 4 | 393496 | 4927162 | 137 |
| 38 | Non-participating | 31 | 4 | 393446 | 4927149 | 138 |
| 39 | Non-participating | 31 | 4 | 393442 | 4927173 | 139 |
| 40 | Non-participating | 31 | 4 | 393432 | 4927191 | 139 |
| 41 | Non-participating | 31 | 4 | 393421 | 4927210 | 140 |
| 42 | Non-participating | 32 | 4 | 393411 | 4927239 | 141 |
| 43 | Non-participating | 32 | 4 | 393464 | 4927244 | 139 |
| 44 | Non-participating | 32 | 4 | 393479 | 4927218 | 139 |
| 45 | Non-participating | 32 | 4 | 393615 | 4927374 | 139 |
| 46 | Non-participating | 32 | 4 | 393630 | 4927281 | 137 |
| 47 | Non-participating | 32 | 4 | 393618 | 4927302 | 138 |
| 48 | Non-participating | 32 | 4 | 393376 | 4929110 | 159 |
| 49 | Non-participating | 26 | 4 | 395060 | 4932606 | 309 |
| 50 | Non-participating | 33 | 4 | 394198 | 4927414 | 131 |
| 51 | Non-participating | 32 | 4 | 394320 | 4927308 | 134 |
| 52 | Non-participating | 32 | 4 | 394490 | 4927171 | 134 |
| 53 | Non-participating | 32 | 4 | 394750 | 4927147 | 128 |
| 54 | Non-participating | 32 | 4 | 394693 | 4927051 | 126 |
| 55 | Non-participating | 32 | 4 | 394853 | 4927042 | 129 |
| 56 | Non-participating | 32 | 4 | 395044 | 4926729 | 126 |
| 57 | Non-participating | 32 | 4 | 395093 | 4926769 | 129 |
| 58 | Non-participating | 30 | 4 | 395172 | 4926499 | 127 |
| 59 | Non-participating | 32 | 4 | 397407 | 4926861 | 163 |
| 60 | Non-participating | 33 | 4 | 397324 | 4927102 | 192 |
| 2b | Buffer | 43 | 1.5 | 396587 | 4928636 | 334 |



| Receiver ID | Status | Sound Pressure Level (dBA) | Relative Height (m) | Coordinates at Source Height (UTM NAD83 Z19N) | | |
|-------------|--------|----------------------------|---------------------|---|---------|-------|
| | | | | X (m) | Y (m) | Z (m) |
| 4b | Buffer | 45 | 1.5 | 397112 | 4929664 | 280 |
| 9b | Buffer | 43 | 1.5 | 397396 | 4930372 | 247 |

