



MEMORANDUM

To: REF. No.: 009348

FROM: *mb* DATE: October 17, 2014

RE: Radionuclides Air Dispersion Modelling

This memorandum has been prepared by Conestoga-Rover & Associates (CRA) to provide a summary of the air dispersion modelling and comparison to regulatory criteria for the Lafarge Canada Inc. – Brookfield Cement Plant (Lafarge) located at 87 Cement Plant Road in Brookfield, Nova Scotia (site).

Lafarge recently used fracking wastewater in their process operations and conducted a stack test to evaluate any changes in emissions. Prior to using the fracking wastewater, it was filtered to remove the radionuclides and then filtered a second time through reverse osmosis to remove the salts. The stack test showed that emissions were similar using the waste water as compared to baseline operation. Lafarge contacted CRA to conduct dispersion modeling using the stack test data to evaluate radiation exposure levels at the maximum point of impingement from the stack plume in the Brookfield surrounding area.

The air dispersion modelling was completed using the United States Environmental Protection Agency (USEPA) SCREEN3 air dispersion model. The SCREEN 3 air dispersion model is a single source Gaussian plume model that provides the maximum ground level concentration at discrete distances. Modelling was completed for a 5 km radius around the site. The maximum ground level concentration occurred at 774 meters from the source. Discrete modelling was completed for the six residences within 800 meters of the site.

The source test results and source parameters were used as inputs in the air dispersion model to estimate the maximum ground level concentration of Alpha, Beta, and Radium 236 radionuclides at the six nearest residential receptors. A summary of the ground level concentrations for each parameter are summarized in Table 1.

The dispersion modelling results were converted to a dose value to determine the potential health impact on the six neighboring residences. It should be noted that the average Canadian receives a typical annual dose of approximately 2.0 milliSievert (mSv) from background radiation¹. The Health Canada "*Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM)*" uses the figure of 1 mSv to determine whether or not a person has been exposed to radiation. For this analysis, Conestoga Rovers used the criteria of 1 mSv as the maximum exposure level to stay below.

¹ <http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/norm-mrn/index-eng.php#a1.4.1>

The air dispersion modelling results were converted from a Becquerel (activity) to a Sievert (biological effect or dose) following the Health Canada document "*Investigating Human Exposure to Contaminants in the Environment – A Handbook for Exposure Calculations*".

The committed dose was estimated based on a person being exposed for 24 hours per day, 7 days per week, for 52 weeks per year. This is a conservative approach as it is not expected that Lafarge would be operating the plant for 365 days a year nor would a person be outside their house at a stationary spot for an entire year.

The dose conversion factor used for the calculation assumed that all the radionuclide (alpha, beta, gamma, and Radium 236) were Curium 250 as this element has the highest dose coefficient of the roughly 650 published values. Note – The majority of the radionuclides have dose coefficients that are 10,000 times less harmful. This dose conversion factor is for ingestion and is the worst case dose conversion factor for all compounds listed in the "*Compendium of Dose Coefficients based on ICRP Publication 60*" (2012). It is not expected that all the radionuclides are Curium and based on the nature of the operations the dominant route of exposure for any radionuclide would be through inhalation.

Based on the source test results, the maximum ground level concentration, and the conservative conversion from activity to dose the sum of all radionuclide compounds is 7.46E-02 mSv at the most impacted receptor. This is 13 times lower than the Health Canada exposure level of 1 mSv.

Should you have any questions on the above, please do not hesitate to contact us.

TABLE 1

**AIR DISPERSION MODELLING RESULTS
LAFARGE CANADA INC.
BROOKFIELD, NOVA SCOTIA**

	<i>Neighbour 1 (North)</i>	<i>Neighbour 2 (North)</i>	<i>Neighbour 3 (North)</i>	<i>Kolstee Neighbour</i>	<i>Neighbour 1 (South)</i>	<i>Neighbour 2 (South)</i>
Distance to neighbour (miles)	0.41	0.37	0.37	0.51	0.43	0.43
Distance to neighbour (m)	660	595	595	821	692	692
Alpha MAX GLC (Bq/m ³)	1.65E-03	1.25E-03	1.25E-03	1.87E-03	1.78E-03	1.78E-03
Beta MAX GLC (Bq/m ³)	1.36E-04	1.03E-04	1.03E-04	1.54E-04	1.47E-04	1.47E-04
Gamma MAX GLC (Bq/m ³)	-	-	-	-	-	-
Radium 236 MAX GLC (Bq/m ³)	1.33E-06	1.00E-06	1.00E-06	1.51E-06	1.43E-06	1.43E-06
Alpha Emission Rate (Bq/sec)	323					
Beta Emission Rate (Bq/sec)	26.6					
Gamma Emission Rate (Bq/sec)	-					
Radium 236 Emission Rate (Bq/sec)	0.26					

Notes:

MAX GLC - Maximum Ground Level Concentration

Emission rates taken from ATS Source Test Report Dated September 25, 2014

MAX GLC are based on SCREEN3 Dispersion model, inputs taken from ATS Source Test Report and Information provided by Lafarge Canada Inc.

MAX GLC are provided as 1 hour maximum ground level concentrations.

