MEMO

ARCADIS Design & Consultancy for natural and built assets

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Subject:

Review of Yellow Haze Phenomenon and Diavik's Continuous Air Quality Monitoring Program

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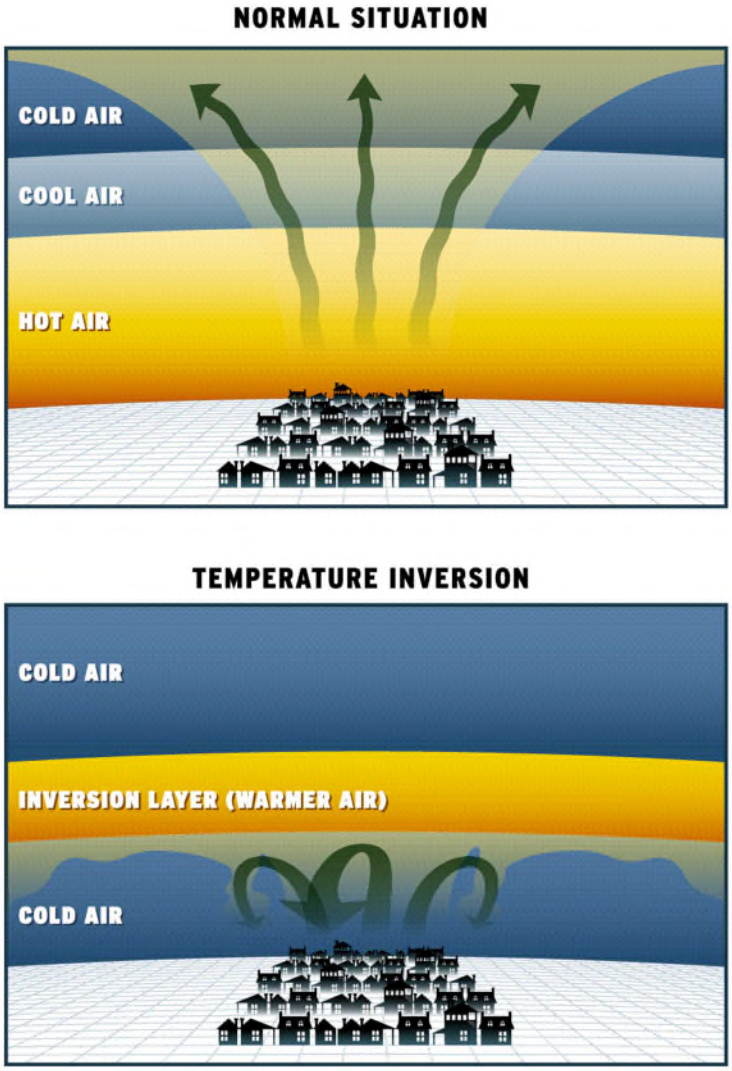
Arcadis Canada Inc. (ACI) has been requested by Environmental Monitoring Advisory Board (EMAB) to review the issue of "yellow-haze" which has been raised as an air quality concern for the Diavik Site since 2018. During the December 2020 annual meeting discussion, these concerns were noted for observations of yellow haze events at the Diavik Site. Without the specific details associated with these events, it is suspected that the haze events are due to air pollution particularly related to combustion gases (primarily nitrogen oxides (NOx)). Nitrogen oxides (NOx) is a collective term used to refer to nitrogen monoxide (nitric oxide or NO) and nitrogen dioxide (NO_2). Fuel combustion gases, primarily released to the air from site activities both from mobile and stationary sources (vehicle exhaust, generators, boilers etc.). Although naturally produced nitrogen oxides outweigh man-made emissions, NOx from natural sources are typically found at altitudes higher than 5km. Man-made emissions, due to fossil fuel combustion either from stationary sources and mobile sources are typically found near the sources at near surface elevation, especially during temperature inversion conditions.

BACKGROUND

During extended periods of high pressure in winter months, solar radiation reaches the ground and warms it up. At night, the lack of cloud cover means the ground loses heat rapidly and the air in contact with the ground becomes colder. The warmer air rises and acts as a lid trapping the colder air close to the ground. Combustion gases from shorter stacks and from road traffic is also trapped in the process, so the air layer closest to the ground becomes substantially polluted. This continues until the prevailing meteorological conditions change. [https://www.eea.europa.eu/media/infographics/temperature-inversion-traps-pollution-at/view].

A visual representation of the temperature inversion phenomenon is shown below in Figure 1:

Figure 1: Temperature Inversion Phenomenon



Source: University of Alaska Fairbanks

SAMPLING METHODOLOGIES – PASSIVE AND ACTIVE

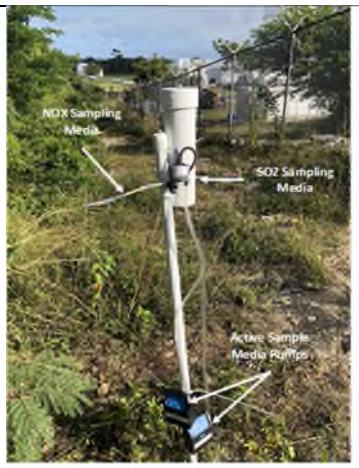
In order to confirm the source of the yellow-haze observations with the emissions from the site activities, sampling of NO_2 in and around the vicinity of the Site is a potential consideration. Monthly passive NO_2

samples could provide useful longer-term information and are typically low cost and its lack of power requirements makes it the ideal tool for determining the concentration of selected ambient gases at desired sampling locations. It can provide an effective means of determining the gradients in pollutant levels across an urban and/ or background area through “saturation” sampling at many sites. Furthermore, they can be used as a personal sampler to assess the average exposure of individuals to selected pollutants, for example, NOx over an 8- or 24-hour period. The implementation of the sampler does not require highly skilled personnel, making it feasible to establish even large air sampling networks with minimal training without the need for conventional analyzer maintenance. In terms of sampler configurations, the passive sampler is composed of a plastic body with an air inlet on either side. It is possible to sample more than one gas simultaneously, since the two inlets are separated by the solid body section. The dual-sided body is usually mounted on a clip that can be fastened to a person or installed in a protective outdoor shelter. Please refer to the Figure 2 below of a particular sampler.

Figure 2: Example setup of passive samplers including personal badge

However, if the concern is to quantify the air concentrations during these inversion conditions and the potential health effects associated with these specific conditions, shorter term measurements should then be considered. Active sampling methods, such as sorbent tubes following USEPA Method 6014 (please refer to Figure 3 below) or installation of a continuous NO_2 monitoring system (could be added to the existing monitoring shelters network) throughout the Site. The continuous NO_2 monitoring system are fully integrated air monitoring station offering near USEPA reference levels of performance. They are typically a size of a small suitcase and can be configured to measure up to 20 different gaseous and particulate pollutants and environmental parameters simultaneously including ozone (O_3), nitrogen dioxide (NO_2), nitrogen oxides (NOx), carbon monoxide (CO), sulphur dioxide (SO_2), volatile organic compounds (VOC), hydrogen sulphide (H_2S), carbon dioxide (CO_2), particulate matter (TSP, PM_{10}, $PM_{2.5}$, PM_1), noise and meteorological parameters such as rainfall, temperature, humidity, pressure, wind speed and direction.

Figure 3: Example Setup of Active Samplers



Linked together in a network, and coupled with remote data acquisition, they are versatile as air pollution monitoring system. With recent technological advancements, there are various options available that lets operators access data, assess performance, schedule calibrations and diagnose faults remotely. Safety alerts in the form of email and SMS alerts can also be configured to pin-point and correlate to a certain observation or conditions such as a “yellow-haze”. Given the versatility, the methodology is relatively expensive to deploy and operate.

RECOMMENDATION

Given the two potential sampling choices, the end goals do vary to what level of comprehensive data is needed to understand the observations at the Site. With the noted concerns, it is in Arcadis opinion, that EMAB should consider a shorter duration of active sampling using a continuous NO_2 monitoring including combustion gases at the Site. This recommended approach will be able to better pin-point to the phenomenon in real time where and when one occurs.