# Response to Data Request #4 VR-1. Visual Impact of Fog Plume

To: Kami Ballard, Environmental & Permitting Advisor, Resolution Copper

From: Nate Tipple, Air Quality Engineer, Air Basics, Inc.

Date: June 25, 2020

This technical memorandum was prepared in response to Data Request #4 VR-1, submitted by the Tonto National Forest (TNF) on April 15, 2020:

*VR-1. Visual impact of fog plume*. Several comments were received concerning the potential for a fog plume to generate above the East Plant Site from the hot, moist mine exhaust (see GPO p. 103). To respond to this concern, we would like to assess:

- The conditions and frequency under which the fog plume could occur (expanding on the details contained in the GPO);
- An approximate visual simulation of the potential fog plume, from a number of the Key Observation Points (KOPs) identified in the Draft EIS (see figure 3.11.1-1). The following KOPs used for Alternative 2 (see table 3.11.4-5) are likely the most pertinent for this issue; KOPs 1,2,5,7,10,11.

Resolution Copper's General Plan of Operation states that ventilation air exiting the exhaust shafts will be at or near saturation, which will lead to the formation of a fog plume that may be visible at certain times. As the ventilation air cools, if the dew point of the ventilation air is reached, the water vapor will begin to condense and form a cloud-like water vapor plume (fog plume). Given the relatively warm and saturated conditions expected from the mine exhaust vents as well as the meteorological conditions at the East Plant, a fog plume is expected to form when ambient conditions are cool and humid. The conditions and frequency under which a fog plume is expected to occur are further detailed in the sections below.

## Conditions Conducive to Plume Formation

The conditions under which a fog plume will form can be estimated by using a psychrometric chart and the mine vent exhaust parameters. A visible plume can be expected to form in cool and humid conditions, lower than approximately 10°C (50°F), and higher than approximately 60% relative humidity. An analysis of the site-specific meteorological data from 2015 and 2016 demonstrates fog plume formation is more likely to occur during December and January when conditions are cooler and more humid. Warmer and drier conditions are not expected to result in a visible fog plume. This is consistent with observations from current site conditions and visibility of fog plume formation from existing shafts.

The presence of visible plumes can be predicted by plotting both the ambient and ventilation exhaust shaft conditions on a psychometric chart. For example, Figure 1 represents the site-specific conditions on December 31, 2016, at 11:00 am. The ambient temperature of 6.5°C (44°F) and 99.8% relative humidity indicate that a plume will be visible. By contrast, Figure 2 represents conditions on September 23, 2016, at 5:00 pm. The ambient temperature of 21.1°C (70°F) and 6.9% relative humidity indicate that no plume will be visible.



Figure 1. Psychometric Chart Predicting Visible Fog Plume

Figure 2. Psychometric Chart Predicting No Visible Fog Plume



### Plume Frequency and Size

A fog plume model that is commonly used to support environmental assessments was employed to evaluate the frequency and associated size of the estimated fog plumes. The model utilized vent shaft parameters (location, size, ventilation rate, temperature) as well as site-specific hourly meteorological data from 2015 and 2016, the same years that were used for the air quality modeling impact analysis. A wind frequency distribution diagram of the data is provided in Figure 3. The results of the plume model were used to inform the visual simulations prepared by Truescape in Appendix A.





The fog plume model estimated the frequency of visible plumes and approximate dimensions for each exhaust shaft. Two representative scenarios were selected, 1% and 10%. As shown in the visual simulations, the 1% scenario represents plumes most visible from the requested KOPs, however, plumes of this size are expected fewer than four days per year. The 10% scenario represents a more common occurrence and smaller overall plume size. This scenario is expected to occur fewer than 37 days per year. The maximum plume dimensions for each scenario are provided in Table 1.

#### Table 1. Plume Sizes

Scenario	Plume Height	Plume Length
	(m)	(m)
1%	110	200
10%	40	100

Approximate visual simulations of the fog plumes for both frequency scenarios were generated by Truescape and are attached as Appendix A. Plumes are not expected to be visible from KOPs 7 or 11 and are therefore not included in the visual simulations.

Appendix A – Approximate Visual Simulations of the Fog Plumes



Simulations - Existing & Proposed 6/25/2020

truescape.com

# Truescape®

## **Viewpoint Locations**

KOP 01 - FSR 2466 East of Subsidence Zone

KOP 02 - Arizona Trail - Montana Mountain

KOP 05 - Arizona Trail - Ridge

KOP 10 - US60, Milepost 219



1km



10km



KOP 01 - FSR 2466 East of Subsidence Zone - Existing View



KOP 01 - FSR 2466 East of Subsidence Zone - Proposed View (with Plumes - 1% / 4 days - North East Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 01 - FSR 2466 East of Subsidence Zone - Existing View



KOP 01 - FSR 2466 East of Subsidence Zone - Proposed View (with Plumes - 1% / 4 days - West South West Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 01 - FSR 2466 East of Subsidence Zone - Existing View



KOP 01 - FSR 2466 East of Subsidence Zone - Proposed View (with Plumes - 10% / 37 days - East Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 02 - Arizona Trail - Montana Mountain - Existing View



KOP 02 - Arizona Trail - Montana Mountain - Proposed View (with Plumes - 1% / 4 days - North East Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 02 - Arizona Trail - Montana Mountain - Existing View



KOP 02 - Arizona Trail - Montana Mountain - Proposed View (with Plumes - 1% / 4 days - West South West Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 02 - Arizona Trail - Montana Mountain - Existing View



KOP 02 - Arizona Trail - Montana Mountain - Proposed View (with Plumes - 10% / 37 days - East Wind Direction) - Plumes not visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 05 - Arizona Trail - Ridge - Existing View



KOP 05 - Arizona Trail - Ridge - Proposed View (with Plumes - 1% / 4 days - North East Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 05 - Arizona Trail - Ridge - Existing View



KOP 05 - Arizona Trail - Ridge - Proposed View (with Plumes - 1% / 4 days - West South West Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 05 - Arizona Trail - Ridge - Existing View



KOP 05 - Arizona Trail - Ridge - Proposed View (with Plumes - 10% / 37 days - East Wind Direction) - Plumes not visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 10 - US60, Milepost 219 - Existing View



KOP 10 - US60, Milepost 219 - Proposed View (with Plumes - 1% / 4 days - North East Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 10 - US60, Milepost 219 - Existing View



KOP 10 - US60, Milepost 219 - Proposed View (with Plumes - 1% / 4 days - West South West Wind Direction) - Plumes visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches





KOP 10 - US60, Milepost 219 - Existing View



KOP 10 - US60, Milepost 219 - Proposed View (with Plumes - 10% / 37 days - East Wind Direction) - Plumes not visible

For on-screen display: Scale bar to be 4 inches wide Viewing distance is 19.7 inches

