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D.1 INTRODUCTION

As described in the Calculation Methodology presented in the Emission Inventory Information, Volume I, a 90% control efficiency is utilized during the calculation of fugitive dust emissions from regularly traveled unpaved haul roads servicing the open pit as well as from the general facility roads around the Rosemont Copper Project (RCP). Additionally, the RCP plans to implement reasonable dust control measures to prevent excessive fugitive emissions from open areas and storage piles created by the mining operations. This document constitutes the RCP's dust control plan for achieving a 90% control of fugitive dust emissions from unpaved roads and preventing excessive fugitive emissions from open areas.

D.2 FUGITIVE DUST EMISSIONS FROM UNPAVED ROADS

D.2.1 Unpaved Road Network

The RCP has a network of unpaved haul roads for transporting concentrating ore, leaching ore, and waste rock from the open pit mine to the primary crushing area, leaching area, and waste rock areas, respectively. Additionally, the RCP has general roads around the facility used by support vehicles. Site diagrams of the RCP are presented in Appendix D. Primary roads include: (a) haul roads located in the pit, (b) haul roads for transporting concentrating ore from the pit to the primary crusher/run of mine stockpile, (c) haul roads for transporting waste rock from the pit to the waste rock storage area and tailings buttress, and (d) general facility roads around the RCP for support vehicles.

The RCP dust control plan for unpaved roads includes the use of chemical dust suppressants and/or road watering. The control efficiency achieved by chemical dust suppressants depends upon the strength of the ground inventory, whereas the control efficiency achieved by watering depends upon the amount of water that is used (gallons/yd^2) and the traffic volume. Since the chemical dust suppressant usage does not depend on traffic volumes, the ground inventory value determined for a 90% control efficiency can be applied on a periodic basis to any unpaved road at the facility, regardless of the rate of vehicles traveling on the road. However, because the control efficiency achieved by unpaved road watering depends upon traffic volume, as illustrated in this dust control plan, the haul trucks traveling on haul roads during Year 9 operations at the RCP (the year when haul road travel rates are greatest) is used as an example in determining the application intensity of water used to control fugitive emissions. Additionally, the road network at the RCP is divided into four categories to account for each road network having a different maximum traffic volume.

During actual operation, the RCP will evaluate the haul truck traffic at different time periods throughout the life of the mine to correctly identify the application intensity needed for road watering to achieve a 90% control efficiency on haul roads. Also, the RCP will evaluate the amount of support vehicle traffic to determine the water application intensity needed to control the general unpaved facility roads to a 90% control efficiency.

The calculation methodology used to estimate traffic volume is presented in Appendix D1. The road network categories and the average hourly haul truck traffic rates at the maximum production, assuming operations of 24 hours per day, are presented below:

a) Roadways that will be used to transport ore and waste rock from the mining location inside the pit to the exit point of the pit. These roadways are expected to experience average heavy truck traffic of 135 vehicles per hour (based on annual VMTs per Year 9 of operations);

b) Roadways that will be used to transport ore from the exit of the pit to the primary crusher dump hopper / run of mine stockpile. These roadways are estimated to experience average heavy truck traffic of 32 vehicles per hour; and

c) Roadways that will be used to transport waste rock from the exit of the pit to the waste rock storage area or tailings buttress (Tailings). These roadways are estimated to experience average heavy truck traffic of 103 vehicles per hour.

D.2.2 Description of Dust Control Plans

Optimal dust control measures depend upon the characteristics of the road network and its use, and upon meteorological considerations. Additionally, dust control measures are continuously evolving with new products becoming available on a regular basis. In order to provide flexibility to change dust control measures while achieving the desired control efficiency, this document proposes three programs, each designed to achieve a 90% control of PM_{10} emissions. The RCP dust control plan includes the flexibility to alternate from one dust control program to another or to use a separate dust control program for an individual roadway system.

The RCP dust control plan ensures that at least a 90% control of PM_{10} emissions is achieved on the unpaved road network. The RCP is also required to maintain no greater than a 40% or 20% opacity for all non-point sources (see Table 4.1). A 90% control efficiency is considered sufficient to ensure that the 40% or 20% opacity limit will be met.

D.2.2.1 Dust Control Program A

Dust Control Program A consists of the application of sufficient chemical dust suppressant to achieve a ground inventory of 0.25 gallons/yard^2 with a reapplication frequency of 1-month (where reapplication frequency refers to the time interval between applications used to maintain a specific ground inventory). The term “ground inventory” represents the residual accumulation of a dust suppressant from previous applications. (For a detailed definition of “ground inventory” see page 3-20 of *Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures*, EPA-450/2-92-004, in Appendix D2). Dust suppressants which could be used for this purpose include, among others, lignosulfonates, petroleum resins, asphalt emulsions, and acrylic cement.

D.2.2.2 Dust Control Program B

Dust Control Program B consists of periodic watering in sufficient amounts to achieve 90% control for PM_{10}. The program will be applied only during days with precipitation of less than 0.01 inches. The water application intensities necessary to achieve a 90% particulate control efficiency during daylight and nighttime hours are presented in Tables D.2.1 and D.2.2, respectively. The roadway network categories are presented in Section D.2.1, and a description on how the application intensities are calculated is presented in Section D.4.2.

Table D.2.1 Average Hourly Watering Requirements During Daylight Hours for Dust Control Program B

Roadway System Category	Traffic Volume (vehicles/hour)	Average Hourly Application Intensity During Daylight Hours Required to Achieve a 90% Control Efficiency for Fugitive Dust Emissions [a]	
		liters/meter^2	gallons/yard^2
From Mining Location to Pit Boundary	135	5.46	1.21
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	32	1.30	0.29
From Pit Boundary to Waste Rock Storage Area / Tailings	103	4.16	0.92

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

Table D.2.2 Average Hourly Watering Requirements During Nighttime Hours for Dust Control Program B

Roadway System Category	Traffic Volume (vehicles/hour)	Average Hourly Application Intensity During Daylight Hours Required to Achieve a 90% Control Efficiency for Fugitive Dust Emissions [a]	
		liters/meter^2	gallons/yard^2
From Mining Location to Pit Boundary	135	2.74	0.60
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	32	0.65	0.14
From Pit Boundary to Waste Rock Storage Area / Tailings	103	2.08	0.46

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

D.2.2.3 Dust Control Program C

Dust Control Program C consists of the application of sufficient chemical dust suppressant to achieve a ground inventory of 0.05 gallons/yard^2 with a 1-month reapplication frequency (the ground inventory of 0.05 gallons/yard^2 provides a base control efficiency of 62%.) plus periodic watering to increase the base control efficiency achieved by chemical dust suppressants alone to 90%. A summary of the roadway traffic volume and corresponding annual average watering requirements of Dust Control Program C is presented in Table D.2.3 (Daylight Hours) and Table D.2.4 (Nighttime Hours). If any type of water adhesion enhancing material, such as a surfactant, is used with Dust Control Program C, application intensities will be re-evaluated.

Table D.2.3 Average Hourly Watering Requirements During Daylight Hours for Dust Control Program C

Roadway System Category	Traffic Volume (vehicles/hour)	Average Hourly Application Intensity During Daylight Hours Required to Achieve a 90% Control Efficiency for Fugitive Dust Emissions [a]	
		liters/meter²	gallons/yard²
From Mining Location to Pit Boundary	135	2.08	0.46
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	32	0.49	0.11
From Pit Boundary to Waste Rock Storage Area / Tailings	103	1.58	0.35

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

Table D.2.4 Average Hourly Watering Requirements During Nighttime Hours for Dust Control Program C

Roadway System Category	Traffic Volume (vehicles/hour)	Average Hourly Application Intensity During Daylight Hours Required to Achieve a 90% Control Efficiency for Fugitive Dust Emissions [a]	
		liters/meter²	gallons/yard²
From Mining Location to Pit Boundary	135	1.04	0.23
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	32	0.25	0.05
From Pit Boundary to Waste Rock Storage Area / Tailings	103	0.79	0.18

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

D.3 PLAN FOR THE CONTROL OF FUGITIVE DUST EMISSIONS FROM OPEN AREAS AND STORAGE PILES

D.3.1 Open Areas and Storage Piles

Open areas and storage piles include mined areas, overburden storage areas, as well as waste rock storage areas. Open areas and storage areas which are subject to generating fugitive emissions exclude ore, waste rock, and other similar areas because these areas are characterized by a low silt content and therefore, are not dust producing areas. Consequently, dust control measures are not necessary for such areas.

D.3.2 Description of Dust Control Plan

Open areas and storage piles which are in active use and subject to generating fugitive emissions will be controlled by the application of water as required by Title 18, Chapter 2, Article 6 of the A.A.C. and Chapter 17.16, Article III of the P.C.C. Open areas and storage piles which are not actively used will be controlled by applying the methods required by A.A.C. R18-2-604 and R18-2-607 and P.C.C. Sections 17.16.080 and 17.16.110, respectively. This includes the application of sufficient chemical dust suppressant and/or water to develop and maintain a visible crust. Periodic inspections of the open areas will be performed to evaluate the condition of the visible crust and, if necessary, additional chemical dust suppressant and/or water will be applied. Other means which may be applied include use of an adhesive soil stabilizer, paving covering, landscaping, detouring, or other acceptable means. Access to such areas will also be minimized by the construction of berms or other barriers to prevent re-disturbance of the areas.

D.4 DEMONSTRATION THAT THE DUST CONTROL PLAN WILL PROVIDE A 90% CONTROL EFFICIENCY

D.4.1 Dust Control Program A

The control efficiency of a chemical dust suppressant is dependent upon the ground inventory of the dust suppressant and the frequency between applications. A model developed by EPA, and published in *Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures* (see Appendix D2), provides the relationship between these parameters and PM_{10} control performance for dust suppressants in general. A graph representing this model is presented in Figure D.4.1.

The sufficiency of Dust Control Program A to achieve a control efficiency of 90% for PM_{10} is verified by considering this figure. Using a chemical dust suppressant, a ground inventory of 0.25 gallons/yd^2 with a 1-month reapplication frequency will provide a control efficiency for PM_{10} of 90%. It should be noted that the model for PM_{10} control efficiency of petroleum-based dust suppressants published in the AP-42, Section 13.2.2 (11/06), agrees with the EPA model used to determine the sufficiency of Dust Control Program A.

The control efficiencies in the above mentioned models are averages and not maximums. Therefore, it can be assumed that using a chemical dust suppressant with a ground inventory of 0.25 gallons/yd^2 could result in control efficiencies higher than 90%.

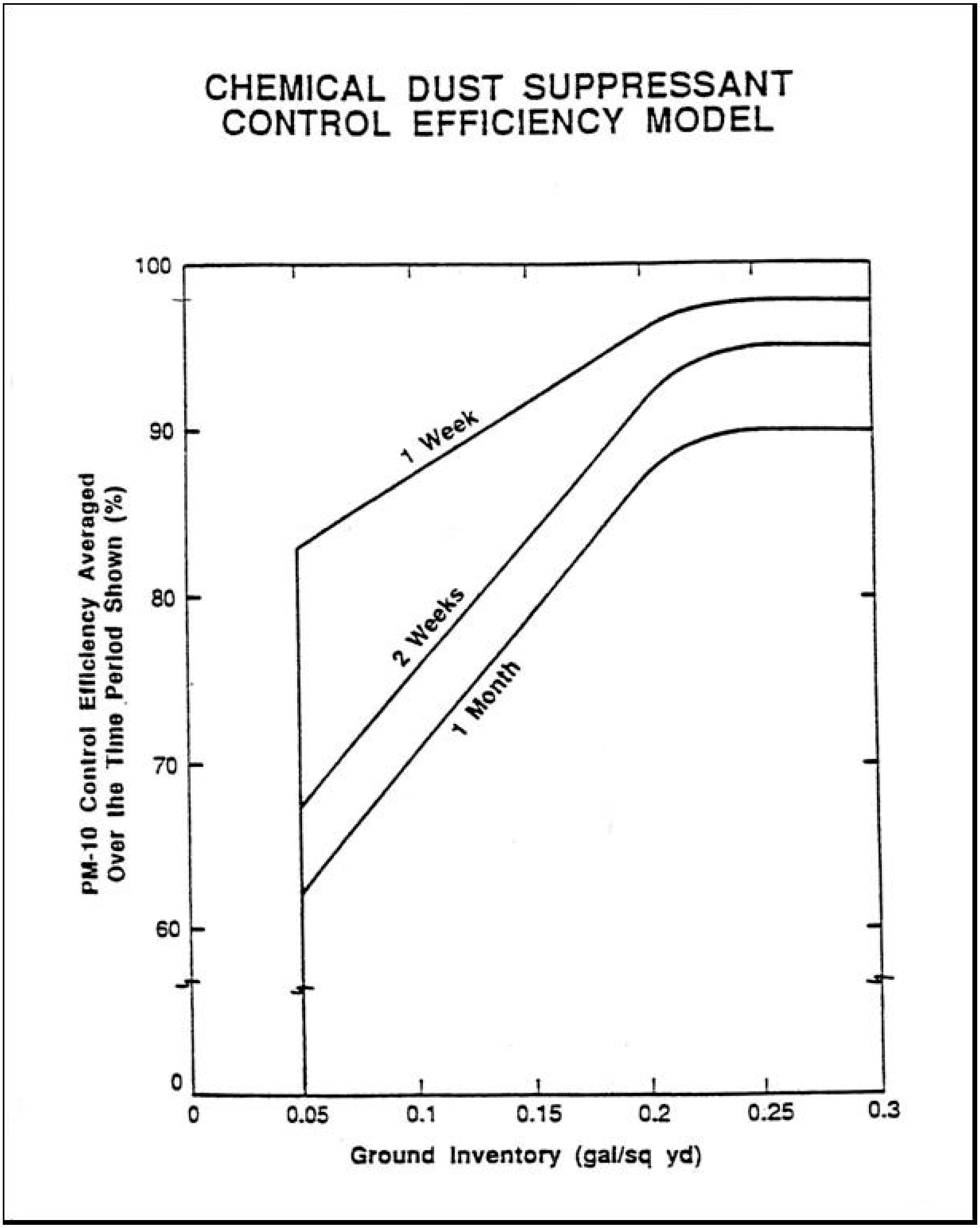

Figure D.4.1 Model for Control Efficiency of PM_{10} when Using Chemical Dust Suppressants.

D.4.2 Dust Control Program B

The application intensity of water during daylight and nighttime hours required to achieve a 90% control efficiency for each road category is calculated using an empirical model developed by EPA (*Control of Open Fugitive Sources*, EPA-U50/3-88-008, September, 1988, presented in Appendix D3). The following equations were derived from this model:

$$i = \frac{0.8 \times p \times d \times t}{(100 - W_c)} \qquad \text{Equation 1}$$

$$p = 0.0049 \times PER \qquad \text{Equation 2}$$

where:

- i = application intensity (liters/m^2);
- p = potential average hourly daytime evaporation rate (mm/hr, 0.507 for Tucson, AZ);
- d = average hourly daytime traffic (vehicles/hr; see Section D.2.1);
- t = time between applications (hours, 1 for hourly applications)
- W_c = average particulate control efficiency (%, 90 in this case); and
- PER = mean annual pan evaporation rate (inches/year, 103.51 for Tucson, AZ from Western Region Climate Center data from 1894-2005).

As shown by Equation 1, the application intensity is dependent upon the pan evaporation rate. Because the pan evaporation rate differs between daytime and nighttime conditions, as well as meteorological conditions, application intensities will also vary with daylight hours and nighttime hours and with meteorological conditions. Nighttime hour application intensities are calculated assuming the average hourly nighttime pan evaporation rate is equal to 50% of the average hourly daytime pan evaporation rate.

The application intensity required to achieve a 90% control efficiency is calculated using Equation 1. However, the application intensities are for illustration purposes due to the varying conditions of evaporation rates and traffic volumes. A summary of the input variables and resulting application intensities during daylight hours and nighttime hours derived from the above equation are presented in Tables D.4.1 and D.4.2, respectively.

The application intensities in Tables D.4.1 and D.4.2 are based upon an hourly frequency of application. The RCP may reduce the frequency of application by increasing the application intensity. A frequency of once every two hours, for example, would require that the application intensities in Tables D.4.1 and D.4.2 to be increased by a factor of 2.

Table D.4.1 Summary of Data Used to Verify Dust Control Program B During Daylight Hours

Roadway System Category	Variables				Average Hourly Water Application Intensity (i) [a]	
	Wc (%)	p (mm/h)	d (vehicles/ hour)	t (hours)	liters/ meter^2	gallons/ yard^2
From Mining Location to Pit Boundary	90	0.507	135	1.0	5.46	1.21
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	90	0.507	32	1.0	1.30	0.29
From Pit Boundary to Waste Rock Storage Area / Tailings	90	0.507	103	1.0	4.16	0.92

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

Table D.4.2 Summary of Data Used to Verify Dust Control Program B During Nighttime Hours

Roadway System Category	Variables				Average Hourly Water Application Intensity (i) [a]	
	Wc (%)	p (mm/h)	d (vehicles/ hour)	t (hours)	liters/ meter^2	gallons/ yard^2
From Mining Location to Pit Boundary	90	0.254	135	1.0	2.74	0.60
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	90	0.254	32	1.0	0.65	0.14
From Pit Boundary to Waste Rock Storage Area / Tailings	90	0.254	103	1.0	2.08	0.46

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

It should be noted that the pan evaporation rates used to calculate the application intensities in Tables D.4.1 and D.4.2 represent annual averages which, when used with Equation 1, will result in an application intensity that is too high for winter months and too low for summer months. Actual application intensities will be determined based on pan evaporation rates representative of the different climatological periods of the year. Additionally, the calculated intensities are based on the maximum mine production rates. Lower production rates, resulting in less traffic, will be characterized by lower application intensities. If any type of water adhesion enhancing material, such as a surfactant, is used with Dust Control Plan B, application intensities will be reevaluated.

D.4.3 Dust Control Program C

The sufficiency of Dust Control Program C to achieve a control efficiency of 90% for fugitive dust emissions is verified by considering Figure D.4.1. Using a chemical dust suppressant, a ground inventory of 0.05 gallons/yard^2 with a 1-month reapplication frequency provides a control efficiency of 62% for PM_{10}. The additional 28% control necessary to increase the control efficiency to 90% will be attained through periodic watering. The control efficiency of the watering program, W_c, necessary to increase the chemical dust suppressant control efficiency, CDS_c, of 62% to a combined dust suppressant/watering control efficiency of 90% is derived from the following equation:

$$W_c = \left(\frac{\text{Additional Control Necessary (\%)}}{(100\% - CDS_c)} \right) \times 100\% \qquad \text{Equation 3}$$

$$W_c = \left(\frac{28\%}{(100\% - 62\%)} \right) \times 100\%$$

$$W_c = 73.7\%$$

This value, 73.7%, is used in conjunction with the model described in Section D.4.2 to determine the average application intensity of watering that is necessary to achieve a 73.7% control efficiency. A summary of the input variables and resulting hourly application intensities during daylight and nighttime hours derived from the model is given in Tables D.4.3 and D.4.4, respectively.

Table D.4.3 Summary of Data Used to Verify Dust Control Program C During Daylight Hours

Roadway System Category	Variables				Average Hourly Water Application Intensity (i) [a]	
	Wc (%)	p (mm/h)	d (vehicles/ hour)	t (hours)	liters/ meter^2	gallons/ yard^2
From Mining Location to Pit Boundary	73.7	0.507	135	1	2.08	0.46
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	73.7	0.507	32	1	0.49	0.11
From Pit Boundary to Waste Rock Storage Area / Tailings	73.7	0.507	103	1	1.58	0.35

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

Table D.4.4 Summary of Data Used to Verify Dust Control Program C During Nighttime Hours

Roadway System Category	Variables				Average Hourly Water Application Intensity (i) [a]	
	Wc (%)	p (mm/h)	d (vehicles/ hour)	t (hours)	liters/ meter^2	gallons/ yard^2
From Mining Location to Pit Boundary	73.7	0.254	135	1	1.04	0.23
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	73.7	0.254	32	1	0.25	0.05
From Pit Boundary to Waste Rock Storage Area / Tailings	73.7	0.254	103	1	0.79	0.18

[a] The model predicts a 90% control efficiency regardless whether the water application intensity is met with a single hourly application, multiple applications during the 1-hour period, or greater application intensities for less frequent applications.

D.5 DEMONSTRATION OF COMPLIANCE WITH THE REQUIREMENTS OF ARTICLE 6 OF THE A.A.C. AND CHAPTER 17.16, ARTICLE III OF THE P.C.C.

Section R18-2-604 of the A.A.C. and Section 17.16.080 of the P.C.C. require, in part, that fugitive dust from open areas be kept to a minimum by good modern practices, such as using an approved dust suppressant.

Section D.3 of this document describes the control measures for wind-blown fugitive dust from open areas and storage piles at the RCP. By developing and maintaining a visible crust on the soil in all open areas and applicable storage piles, implementing best management practices (e.g., watering), and minimizing access to these areas, the RCP Dust Control Plan complies with the requirements of Article 6 of the A.A.C and Chapter 17.16, Article III of the P.C.C. for the control of fugitive dust emissions from open areas and storage piles.

D.6 PERIODIC REAPPLICATION

D.6.1 Chemical Dust Suppressants

Dust control programs that utilize chemical dust suppressants require periodic application of the chemical dust suppressant in order to replenish dust suppressants that are removed from the road due to the abrasion of the vehicles on the treated road surface. Each successive application will correspond to:

a) The manufacturer's recommendation if available; or

b) If manufacturer's recommendations are not available, the amount necessary to completely replenish the initial ground inventory every six months.

D.6.2 Road Watering

The frequency of reapplication of water used in Dust Control Programs B and C will depend upon the operational plans of the RCP. The frequency can be hourly, less frequent or more frequent, depending upon the traffic density, meteorological conditions, and operational considerations. The application intensities for water should be treated as annual averages as some days will require a greater water application whereas others will require a lesser water application due to seasonal climatic condition changes. The models introduced in Sections D.4.2 and D.4.3 predict the same control efficiency independent of whether the water is applied during one pass per hour of the water truck or during multiple passes during the 1-hour period. Additionally, watering will not be required for days when natural precipitation equals or exceeds 0.01 inches or when roads are moist due to recent rain, as the control efficiency during such days is assumed to be 100% by AP-42. Additionally, watering will not be required on roads that are moist from the application of previous control water.

D.7 RECORD KEEPING REQUIREMENTS

D.7.1 Records of the Application of Chemical Dust Suppressants

Records will be maintained demonstrating the RCP's compliance with the initial chemical dust suppressant ground inventory required by Dust Control Programs A and C by recording the information necessary to demonstrate a 90% control efficiency.

D.7.2 Records of Reapplication of Chemical Dust Suppressants

Records will be maintained demonstrating the RCP's compliance with the periodic reapplication of dust suppressants to replace losses as identified in Section D.6.1. Records will be maintained concurrently with the records described in Section D.7.1.

D.7.3 Records of Application of Water

Records will be maintained demonstrating the RCP's compliance with the watering requirements of Dust Control Programs B and C by recording the information necessary to demonstrate a 90% control efficiency.

APPENDIX D1

ROADWAY NETWORK TRAFFIC VOLUME CALCULATION METHODOLOGY

D1. ROADWAY SYSTEM TRAFFIC VOLUME CALCULATION METHODOLOGY

Because the control efficiency of unpaved road watering is dependent upon traffic volume, the roadway system at the RCP was divided into three road network categories based on average hourly traffic rates. Traffic volume estimates for the road network categories are calculating by dividing the anticipated hourly amount of material transferred by the haul trucks on each road network category by the average haul truck load (260 tons) and multiplying this number by two to account for the haul trucks returning empty to the mining location. This methodology is shown in the following equation:

$$\text{Traffic Volume}\left(\frac{\text{vehicles}}{\text{hour}}\right) = \left(\text{Material Transferred by Haul Trucks}\left(\frac{\text{tons}}{\text{hour}}\right)\times\frac{1\text{ trip}}{260\text{ tons}}\times\frac{2\text{ passes}}{\text{trip}}\right)$$

The process rates and resulting traffic volume estimates for each roadway system are listed in Table D1.1. The traffic volumes in this table are presented for Year 9 operations at the RCP. However, since process rates vary (hourly, daily, and annually), the traffic volumes will be monitored on an on-going basis so that accurate water application intensities are determined and a 90% control efficiency will be met.

Table D1.1 Summary of Data Used to Calculate Roadway System Traffic Volume (Year 9)

Roadway System Category	Maximum Daily Process Rate[1] (tons/hour)	Traffic Volume (vehicles/hour)
From Mining Location to Pit Boundary	17,500	135
From Pit Boundary to Primary Crusher Dump Hopper / Run of Mine Stockpile	4,167	32
From Pit Boundary to Waste Rock Storage Area / Tailings	13,333	103

[1] Based on maximum daily throughput stated in Permit No. 67001 Attachment B, Condition II.A.2.f.