GUIDELINE FOR MODELING PM_{10} AMBIENT CONCENTRATION IN AREAS IMPACTED BY QUARRY OPERATION PRODUCING CRUSHED STONE

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I. Introduction

The purpose of this document is to provide written guidance for estimating the environmental impact of PM10 emissions from quarry operations. Since modeling has been to present date the primary approach for assuring acceptable concentrations of PM_{10}, this guideline will focus on modeling methodologies and procedures for the calculations of emissions from various sources.

II. Calculation of Emissions from Process Equipment

For purposes of conducting air quality modeling, the emission rates of PM_{10} from various crushed stone processing operations will be determined by applying the appropriate emission factor from Table 1 and Table 2 of this guidance. These emission factors have been extracted from EPA's AP-42 Section 11.19.2 as published in the most recent edition.

Table 1. Wet and Dry Emission Factors for Crushed Stone Processing Operations.

Operation	Uncontrolled Emission Factor [1]	Controlled Emission Factor [1]	Notes
Screening	0.0087	0.00074	Incorporates emissions from transfer of material to the screen, but not transfer of material from the screen.
Fines Screening	0.072	0.0022	Incorporates emissions from transfer of material to the screen, but not transfer of material from the screen. Applicable for screening of materials 3/16" diameter or less such as M10's, 9's or concrete sand.
Primary, Secondary and Tertiary Crushing	0.0024	0.00054	Incorporates emissions from transfer of material to the crusher and transfer of material from the crusher. Applicable for all dry, initial reduction crushing operations, crushing of materials 1" - 3" in diameter, and crushing of materials 3/16" - 1" in diameter.
Fines Crushing	0.0150	0.0012	Incorporates emissions from transfer of material to the crusher and transfer of material from the crusher. Applicable for crushing of materials 3/16" diameter or less such as M10's, 9's or concrete sand.
Conveyor Transfer Point	0.00110	4.6×10^{-5}	Incorporates emissions from continuous transfer of material from one belt conveyor. Also used for continuous type material transfers from a screen to a conveyor, or from chutes to other sources.
Drilling	----	8.0×10^{-5}	Assumes wet drilling of unfractured rock.

Operation	Uncontrolled Emission Factor [1]	Controlled Emission Factor [1]	Notes
Truck Loading and Unloading (front end loader, loading bin or shovel) [2]	$1.6x10^{-5}$		Incorporates emissions from batch transfer of material to and from trucks only.
Truck Loading [2] (conveyor)	0.00010		Incorporates emissions from continuous transfer of material to truck only.
Grizzly Screening/Feeding [3]	0.0087	0.00074	Incorporates emissions from transfer of material to the feeder, but not transfer of material from the feeder.
Transfer of Material by Vibrating Feeder [4]	0.00110	$4.6x10^{-5}$	Incorporates emissions from transfer of material to and from the feeder.
Surge Bin Transfer Point [4]	0.00110	$4.6x10^{-5}$	Incorporates emissions from transfer of material from the surge bin only.
Flow Splitter Transfer Point [4]	0.00110	$4.6x10^{-5}$	Incorporates emissions from transfer of material from the flow splitter only.

[1] Emission factors are in pounds per ton of material throughput. Dry emission factors are for uncontrolled processes, and wet emission factors are for those processes that employ wet suppression control technology

[2] From application of "truck unloading" emission factor from AP-42 since both truck loading and truck unloading operations are similar and each involves batch transfer of material.

[3] From application of "screening operations" emission factor from AP-42 since both operations involve the sizing of material by similar processes.

[4] From application of "conveyor transfer point" emission factor from AP-42 since both operations are similar and each involves continuous transfer of material with relatively short material drops.

The method for estimating PM_{10} emission rates from crushed stone operations with direct wet suppression (e.g. water sprays) will involve the use of the controlled emission factor.

The control efficiency for all wet process operations such as wet (wash) screening, wet classifying, and sand screw operations will be assumed to be 100%, since the material being processed is expected to be completely saturated or submerged during processing. The emission rate in these cases will be zero. This control efficiency will also be applied to all subsequent processing operations until a crushing operation, screening operation or stockpile is encountered in the process flow.

The expected emission rate from a process operation, which does not have direct wet suppression, but is subsequent to an operation with direct wet suppression, will be estimated using the controlled emission factor. This method will be applied for estimating the emission rate from each sequential process operation up to and including an ensuing crushing operation, screening operation or material stockpile/surge pile. This approach is based on the presumption that there will be no significant decrease in the level of surface moisture "carried over" from one operation to the next (in typical crushed stone processing operations) except in crushing and screening operations, or when the material is allowed the opportunity to dry out while in a surge pile or stockpile.

Due to the absence of a reasonably applicable and acceptable scientific method for quantifying the level or effect of carry-over surface moisture through crushing or screening operations, it will be assumed that there is no carry-over surface moisture through these operations. Process operations subsequent to crushing operations, screening operations and material storage piles, where the material is not water sprayed when exiting the crusher, screen or storage pile, will therefore be assumed to be uncontrolled. This assumption will apply to each sequential process operation until an operation with direct wet suppression is encountered.

Potential PM_{10} emissions for each process operation will be estimated by multiplying the appropriate emission factor by the maximum expected process input weight rate and the maximum number of permitted operating hours. Because emissions from crushing operations, screening operations and most material transfer points between various pieces of processing equipment could reasonably be collected and exhausted through a stack, as a general rule all such emissions will be considered pertinent for both PSD and Title V applicability determinations. Emissions from drilling, truck unloading, all non-enclosed truck loading and/or dump hopper loading, as well as all non-point source emissions from haul roads and material piles will also be considered pertinent.

III. Calculation of Non-Point Source Emissions

For purposes of conducting both air quality permit reviews and modeling of crushed stone facilities, PM_{10} emissions will be considered from all non-point emission sources. Emissions from drilling, truck unloading, all non-enclosed truck loading and/or dump hopper loading will be quantified by application of the appropriate emission factor, as described in the above section *Calculation of Emissions from Process Equipment*.

PM_{10} emissions from blasting and public roadways, however, will not be considered in either air quality permit reviews or modeling due to a current lack of acceptable emission factors or evaluation techniques. While a blasting plume may contain a high PM_{10} concentration and be very visible, the contribution to the 24-hour average concentration of PM_{10} is expected to be very small, considering the intermittent nature of the blasting operation and the offset in emissions resulting from the fact that the entire quarry and stone processing operations are shut down for a period prior to and just after each blast. Based on the above observations, it has been decided that emissions from blasting operations will not be considered in conducting permit reviews and modeling of crushed stone facilities at this time. Should acceptable emission factors for blasting operations in the crushed stone industry become available at some future date, the decision to disregard emissions from blasting operations will be revisited at that time.

<u>Unpaved Roads</u>

Uncontrolled PM_{10} emission rates in pounds per vehicle mile traveled (VMT) from unpaved haul roads will be estimated by application of Equation 1 from AP-42 Section 13.2.2.2, dated 11/06.

As more information becomes available regarding use of the procedures in AP-42, the Air Protection Branch reserves the right to implement an updated version at some future date.

$$E = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$ AP-42 Section 13.2.2.2 Equation (1)

The values in the following table will be used as default values for each of the terms in Equation (1) unless acceptable site-specific information is provided by the applicant.

Term	Default Value	Reference
E	Emission Rate - to be calculated (lb/VMT)	----
k	1.5	AP-42 Section 13.2.2.2 (1/95)
s	7.0%	Test results from Martin Marietta and Vulcan Materials
W	50 tons for 35 ton capacity quarry trucks 66 tons for 50 ton capacity quarry trucks 22 tons for 21 ton capacity customer trucks	manufacturers information manufacturers information estimate
a	0.9	AP-42 Figure 13.2.2-2 11/06
b	0.45	AP-42 Figure 13.2.2-2 11/06

Separate emission rates will be calculated for quarry trucks and customer trucks, and this way the equation yields values of:

E = 2.62 lb of PM10/VMT for 35 tons capacity quarry trucks,
E = 3.46 lb of PM10/VMT for 50 tons capacity quarry trucks, and
E = 1.15 lb of PM10/VMT for customer trucks.

These values should be used by the applicant unless, as stated above, site-specific data can be provided to substitute any of the parameters in the formula.

Monitored water application to unpaved roadways by either water truck or fixed spray systems will be required by permit condition at minimum application intensity and will be assumed to obtain a control efficiency of 90%.

Overall PM_{10} emissions from unpaved roadways will therefore be calculated by multiplying the maximum expected number of vehicle miles traveled by the applicable uncontrolled emission rate calculated by Equation (1) from AP-42 Section 13.2.2.2, as of 11/06. The aforementioned control efficiency of 90.0% will then be applied to the resulting value.

<u>Paved Roads</u>
Uncontrolled PM_{10} emission rates in pounds per vehicle mile traveled (VMT) from paved customer roads will be estimated by application of Equation (1) from AP-42 Section 13.2.1.3.

$$E = k\,(sL)^{0.91}\,(W)^{1.02}$$ AP-42 Section 13.2.1.3 Equation (1)

The following values will be used as default values for each of the terms in Equation (1) unless acceptable site-specific information is provided by the applicant.

Term	Default Value	Reference
E	Emission Rate - to be calculated (lbs/VMT)	----
k	0.0022(lb/VMT)	AP-42 Table 13.2.1-1
sL	8.2 (grams/m^2)	AP-42 Table 13.2.1-3
W	22 tons for 21 ton capacity customer trucks	estimate

It is assumed that no quarry trucks will travel in paved customer roads, thus equation (1) of AP-42 Section 13.2.1.3 yields a value of:

E = 0.32 lb of PM10/VMT for customer trucks.

This value should be used by the applicant unless site-specific data can be provided to substitute any of the parameters in the formula.

Monitored water application to paved roadways by water truck or fixed water spray system will be required by permit condition assuming a control efficiency of 95.0%.

Overall PM_{10} emissions from paved roadways will therefore be calculated by multiplying the maximum expected number of vehicle miles traveled by the uncontrolled emission rate calculated by Equation (1) from AP-42 Section 13.2.1.3. A control efficiency of 95.0% will be applied to the resulting value.

<u>Stockpiles</u>
Uncontrolled PM_{10} emission rates in pounds per day per acre from material surge and stockpiles due to wind erosion will be estimated by application of Equation (4-9) from EPA-450/3-88-008 Section 2.1.2, "Control of Open Fugitive Dust Sources", and the conversion factor of 0.5 PM_{10}/TSP (from the same document).

$$E = 1.7\left(\frac{s}{1.5}\right)\left(\frac{365-p}{235}\right)\left(\frac{f}{15}\right)$$ EPA 450 / 3-88-008 Equation (4-9)

The following values will be used as default values for each of the terms in Equation (4-9) unless acceptable site-specific information is provided by the applicant.

Term	Default Value	Reference
E	Emission Rate - to be calculated (lbs/TSP/day/acre)	----
s	1.6 %	Table 4-1 from EPA-450/3-88-008 Section 4.1
p	120 days	Figure 13.2.2-1 from AP-42
f	18.8 %	USAF Climate Survey for period 1946-1957 conducted at Dobbins AFB, Marietta, GA.

This way, Equation (4-9) from EPA-450/3-88-008 Section 2.1.2 would yield an emission rate of

E = 2.37 lbs of TSP/(acre * day)

After applying the conversion factor of 0.5 PM_{10}/TSP the emission rate will be of

E = 1.184711 lbs of PM_{10} / (acre * day)

This value should be used by the applicant as the emission rate input value for the model, regardless of the size of the stockpile, unless site-specific data can be provided to substitute any of the parameters in the formula.

A control efficiency of 90.0% will be applied to the resulting value for material surge and stockpiles with fixed water spray systems. Emissions due to transfer of material to and from material surge piles or stockpiles will be estimated by application of the Conveyor Transfer Point and/or appropriate Truck Loading (by front end loader, loading bin or shovel, or alternately, by conveyor) emission factor(s), using the methods described in the section titled *Calculation of Emissions from Process Equipment*.

IV. Modeling of Crushed Stone Facilities

Following are the procedures and major assumptions that will be used when conducting an air quality modeling analysis of any crushed stone facility. This document was developed as a supplement to the Guideline on Air Quality Models (Revised) (EPA 450/2-78-027R) and the User's Guide for the Industrial Source Complex (ISC3) Dispersion Model (EPA 454/B-95-003a), in order to address situations and procedures not explicitly dealt with in these references.

For all new or revised modeling of crushed stone facilities, the most recent version of the Industrial Source Complex Short Term (ISCST3) model or AMS/EPA Regulatory Model (AERMOD) will be used. At the time of the release of this guidance, the latest version of the ISCST3 model being used is v. 02035, and AERMOD model is v. 12345. The specific procedures and major assumptions to be used in the model have been divided into three main categories: source information, receptors and meteorological data.

A. Source Information

1. The model will include all quantifiable PM10 emission sources (e.g. asphalt plants, RAP crushing plants and ready mix plants) boundary receptors, as well as all significant, existing PM10 emission sources located in close proximity to the quarry.

2. All non-stack emissions from the quarry, with the exception of material surge piles and material stockpiles, will be modeled as volume sources. Material surge piles and stockpiles will be modeled as area sources at one-half of the normal pile height. Any non-stack emission points such as crushers or screens that are contained in an enclosure will be modeled as volume sources. The building wake effect option in the model will be used for point sources.

3. Deposition will not be considered in the model due to a lack of reliable, site-specific data.

4. Worst case conditions for each specific emission source with respect to process input weight rates, meteorological conditions, etc., within the specific limitations of the Air Quality Permit, will be used for modeling the facility. ISCST3 and AERMOD allow a variable emission rates, therefore an emission rate of zero can be used for periods when the various sources at the plant are not permitted to operate.

5. Table 1-6 of the ISC3 User's Guide, Volume II, will be used as guidance for determining the initial lateral dimensions σ_{yo} and initial vertical dimensions σ_{zo}.

6. Generally, complex terrain modeling will not be utilized since most emission sources are near or at ground-level. If complex terrain modeling is required, AERMOD will be the preferred model. If ISCST3 is used, an approved screening model (such as VALLEY) must be used in addition to the ISCST3 model in order to evaluate the effects of complex terrain on air quality. Alternatively, all sources may be modeled at an elevation of 0 feet above ground (unless they are intended to operate at an elevation above ground). All receptor should be modeled at an elevation of 0 feet above ground.

7. Roadways within 200 feet of any property boundary will be modeled as a series of separate volume sources, each having maximum lateral dimensions of 20 feet by 20 feet (therefore representing a maximum total road surface area of 400 square feet). Each volume source will be centered on the portion of roadway it represents and have an assumed width of 10 feet. Thus, roadways within 200 feet of the property boundary would be modeled as a series of five 20' x 20' (400 ft^2 surface area) volume sources, each centered on the 10' x 40' (400 ft^2 surface area) segment of roadway it represents. All other roadways (which are not within 200 feet of any property boundary) will be modeled as a series of separate volume sources, each having maximum lateral dimensions of 10 feet by 100 feet (therefore representing a maximum total road surface area of 1000 square feet). As before, each volume source will be centered on the portion of roadway it represents. For example, a section of roadway with a length of 500 feet would be modeled as a series of five 10' x 100' volume sources, each centered on the 10' x 100' segment of roadway it represents. Initial lateral dimensions (σ_{yo}) of 9.32 and 14.70 feet, respectively, should be used for the 10' x 40' and 10' x 100' roadway segments.

   If AERMOD (with volume sources) is chosen for the air quality modeling analysis, the applicant should make sure that no receptors fall within the volume source exclusion zone (the region "2.15 σ_{yo} + 1 meter" from the center of the volume source). If they do, the applicant should select the area source option instead of volume source option, or reduce the width of volume source dimensions so that no ambient air receptors fall within the volume source exclusion zone. Details can be found at http://www.epa.gov/ttn/scram/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf.

8. An initial vertical dimension (σ_{zo}) of 5.58 feet should be used for roadway volume sources based on a height of 12 feet. As recommended in the ISC3 User's Guide, however, the effective emission height for surface-based sources should be set to zero in the model. The effective height of roadway volume sources should be estimated as 8 feet above ground for a 12-foot tall truck (two-thirds of the total height of the release).

9. The regulatory default option of ISCST3 or AERMOD will be used, with "switches" set as for any other new source review.

10. For emissions from haul roads below the level of surrounding terrain, a pit retention of up to 30% is allowed. However, emission sources taking credit for pit retention should be modeled at the elevation of the mean top of the pit, not at elevations below plant grade.

11. The average height of a material pile will be approximated as one half of its total height.

B. Receptors

1. Receptors will be located along the circumference of the facility property, beginning within 5 meters of the customer entrance road and proceeding in a clockwise direction, with a maximum interval of 100 meters between any two adjacent receptors. To facilitate adjustments to modeled concentrations impacted by calm-condition processing within the model, boundary receptors should be spaced as close to 100 m as possible. This reduces the number of superfluous receptors requiring manual post-processing of calm-influenced concentrations.

2. Receptor locations will be chosen on a worst case basis, such that, in instances where the property boundary protrudes in the direction of an emission source, a receptor will be located at the point on the property boundary which is nearest the emission source.

3. In cases where stacks or emission sources other than the stone processing facility exist, receptors will be located in a grid network which will demonstrate that pollutant concentrations decrease with increasing distance from the source of emissions, and which provides assurance that the resulting maximum concentration has been determined. If actual elevations are simulated for sources and receptors, gridded receptors must be used offsite.

4. In cases where a portion of the facility property has been designated for use by the public (e.g., a park, fishing lake, golf course), receptors will be located along the boundary between the area open to the public and the existing crushed stone facility.

C. Meteorological Data

1. Five years of meteorological data from the most representative of the following surface/upper air stations will be used as input data to the ISCST3 model: Atlanta/Athens, Athens/Athens, Augusta/Athens, Jacksonville/Waycross, Macon/Centreville, Columbus/Centreville, Macon/Waycross, Tallahassee/Waycross, Chattanooga/Greensboro, and Savannah/Waycross. The Georgia Environmental Protection Division, Air Protection Branch will designate the five-year meteorological data set to be used. These data can be downloaded at GA EPD web site (http://epd.georgia.gov/air/georgia-isc-meteorological-data). Mixing heights calculated to be less than 30 meters may be set equal to 30 m if the procedure for this modification is documented, and, if performed by a utility program, the source code of that program is made available for review. If AERMOD is chosen, five years of AERMOD meteorological data for all counties in GA can also be downloaded from the above GA EPD site (http://epd.georgia.gov/air/georgia-aermet-meteorological-data).

2. Actual anemometer heights, coinciding with the specific surface meteorological data input to the model, will be used in place of the default value of 10 meters.

D. Modeling PM10 concentration

The values obtained from the ISCST3 or AERMOD model corresponding to the highest 6^{th} high 24-hour PM_{10} concentration from the entire five years modeling analysis must be added to the appropriate background concentrations in order to determine if an exceedance of the NAAQS is predicted. Background concentrations of PM_{10} in the State of Georgia have been determined from a recent study, which utilized data from TSP monitors located in rural locations throughout the state. Based on the results of the study, the background 24-hour PM_{10} concentration was determined to be 38 $\mu g/m^3$. In cases where the sum of the maximum H6H PM_{10} concentration predicted by the ISCST3 or AERMOD model and the corresponding background PM_{10} concentration exceed the NAAQS, no Air Quality Permit or amendment to an Air Quality Permit will be recommended. The PM_{10} annual NAAQS was vacated in 2006; therefore, no annual PM_{10} modeling analysis is required.

A crushed stone facility will only be allowed to consider limitations such as operational limits and/or control efficiencies claimed from dust suppression devices for purposes of modeling in cases where the limitations are specified or required as part of a federally or practically enforceable Air Quality Permit.

V. General Procedures for Requiring Modeling

A. New Quarry

A new quarry is defined as any quarry or proposed quarry without an existing permit. New crushed stone quarries with a primary crushing capacity greater than 350 tons/hr will generally be required to submit a modeling analysis demonstrating compliance with the NAAQS as part of the initial permit application.

B. Change in Ownership

If there is no increase in production or change in the method of operation, modeling is generally not required regardless of size and whether modeling was previously conducted.

C. Modification to Existing Plant

For increases in primary crusher production capacity, modeling is required if: (1) modeling has never been conducted and the resulting production is greater than 350 ton/hr, or (2) modeling was previously conducted and the increase in production exceeds the modeling buffer. The modeling buffer is defined as the available percentage of the unconsumed NAAQS, less background, as determined by previous modeling.

An increase in hours of sales, hours of operation or haul road length will also require modeling if the increase in emissions due to the increase in vehicular traffic results is exceeding the modeling buffer.

D. Portable Plants at Quarries

A portable crushing plant, to be located at a quarry, is treated the same as any other crusher (i.e. as a modification to the quarry for modeling and permitting purposes). An increase in production capacity, due to the portable crushing plant, could trigger modeling as described under C above.

A portable plant may be used to replace primary crusher capacity that is not available on a temporary basis, as long as its capacity is not greater than that of the existing primary crusher.

E. Additional Comments

1. Modifications to secondary equipment will not generally require modeling.

2. Notwithstanding the general criteria for determining the requirements for modeling rock quarries, the Air Protection Branch reserves the right to require modeling at our discretion.

References:

1986, Guideline on Air Quality Models (Revised), EPA-450/2-78-027R, July 1986

1995, User's guide for the Industrial Source Complex (ISC3) Dispersion Models Volume I – User Instructions, EPA 454/B-95-003a. September 1995.

1995, User's guide for the Industrial Source Complex (ISC3) Dispersion Models Volume II – Description of Model Algorithms, EPA 454/B-95-003b. September 1995.

2002, User Instructions for the Revised ISCST3 Model (Version 02035), February 4, 2002.

2004, User's Guide for the AMS/EPA Regulatory Model – AERMOD, EPA-454/B-03-001, September 2004.

2012, Haul Road Workgroup Final Report, http://www.epa.gov/ttn/scram/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf, March 2012.