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Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors

An **emissions factor** is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).

The general equation for emissions estimation is:

$$E = A \times EF \times (1 - ER/100)$$

where:

E = emissions;
 A = activity rate;
 EF = emission factor, and
 ER = overall emission reduction efficiency, %

AP-42, *Compilation of Air Pollutant Emission Factors*, has been published since 1972 as the primary compilation of EPA's emission factor information. It contains emission factors and process information for more than 200 air pollution source categories. A source category is a specific industry sector or group of similar emitting sources. The emission factors have been developed and compiled from source test data, material balance studies, and engineering estimates. The Fifth Edition of AP-42 was published in January 1995. Since then EPA has published supplements and updates to the fifteen chapters available in ***Volume I, Stationary Point and Area Sources***. The latest emissions factors are available below on this website. Use the [AP 42 Chapter webpage links below to access the document by chapter.](#)

Access to these emissions factors and other EPA reviewed stationary point and area source factors is also [available from the WebFIRE application](#). WebFIRE provides fast and complete access to the Agency's air emissions factors information.

For information about emissions factors from highway vehicles and nonroad mobile sources, visit the [Office of Transportation and Air Quality](#) web site.

AP 42, Fifth Edition
Compilation of Air Pollutant Emission Factors,
Volume 1: Stationary Point and Area Sources

Proposed and final rules related to emissions factors

October 14, 2009 - The [Emissions Factors Program Improvements - Advanced notice of proposed rulemaking](#) is available on the www.regulations.gov website [EXIT Disclaimer](#), and the EPA's [OAR and Policy Guidance Recent Additons webpage](#) (PDF 290K). The comment period ended December 14, 2009.

AP 42 FAQs

[Answers to frequently asked questions about AP 42](#)

Drafts

[Draft Sections Under Review](#)

AP 42 listing of supplements and updates.

[Supplements A through F \(1996 - 2000\)](#)

[Updates 2001 to present](#)

Older editions of AP-42, Volume 1

[This information is available for historical purposes only.](#) For the most recent emissions factors, supported by the EPA, please see the table of contents below.

Emissions Factors Procedures

[Procedures for the Development of Emissions Factors from Stationary Sources.](#) This page includes both the existing procedures and the review draft for the proposed new procedures.

Table of Contents, AP 42, Volume I, Fifth Edition

Cover page and Contents	Cover page, detailed Table of Contents, Publications in Series, Insertion Instructions, and Key Word Index (PDF 128K). This is current through the Fifth Edition, Supplement C of AP 42. For sections and chapters added after November 1997, see the chapter web pages below.
Introduction	Introduction to AP 42, Volume I, Fifth Edition - January 1995 (PDF 40K)
Chapter 1	External Combustion Sources
Chapter 2	Solid Waste Disposal
Chapter 3	Stationary Internal Combustion Sources
Chapter 4	Evaporation Loss Sources
Chapter 5	Petroleum Industry
Chapter 6	Organic Chemical Process Industry
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Chapter 10	<u>Wood Products Industry</u>	http://www.epa.gov/ttnchie1/ap42/ Last updated on Tuesday, February 08, 2011
Chapter 11	<u>Mineral Products Industry</u>	
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Appendix A	<u>Miscellaneous Data & Conversion Factors</u> -- September 1985 (PDF 103K)	
Appendix B.1	<u>Particle Size Distribution Data and Sized Emission Factors for Selected Sources</u> -- October 1986 (PDF 2M)	
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Appendix C.1	<u>Procedures for Sampling Surface/Bulk Dust Loading</u> -- July 1993 (PDF 65K)	
Appendix C.2	<u>Procedures for Laboratory Analysis of Surface/Bulk Dust Loading Samples</u> -- July 1993 (PDF 42K)	

Draft Sections Under Review

After the comment period, can I use a draft section? (TXT 1K)

Chapter & Section	Description	Comments Requested by:
Chapter 15	<u>Ordnance Detonation</u>	December 7, 2009
Section 4.12	<u>Manufacture of Rubber Products</u>	February 2, 2009
Section 2.4	<u>Municipal Solid Waste Landfills</u>	May 5, 2009

For current information on AP 42 updates and the activities of the Measurement Policy Group, you can subscribe to the [CHIEF Listserv](#).

11.19.1 Sand And Gravel Processing

11.19.1.1 Process Description¹⁻⁶

Deposits of sand and gravel, the unconsolidated granular materials resulting from the natural disintegration of rock or stone, are generally found in near-surface alluvial deposits and in subterranean and subaqueous beds. Sand and gravel are siliceous and calcareous products of the weathering of rocks and unconsolidated or poorly consolidated materials. Such deposits are common throughout the country. The six-digit Source Classification Code (SCC) for construction sand and gravel processing is 3-05-025, and the six-digit SCC for industrial sand and gravel is 3-05-027.

Construction Sand And Gravel -

Sand and gravel typically are mined in a moist or wet condition by open pit excavation or by dredging. Open pit excavation is carried out with power shovels, draglines, front end loaders, and bucket wheel excavators. In rare situations, light charge blasting is done to loosen the deposit. Mining by dredging involves mounting the equipment on boats or barges and removing the sand and gravel from the bottom of the body of water by suction or bucket-type dredges. After mining, the materials are transported to the processing plant by suction pump, earth mover, barge, truck, belt conveyors, or other means.

Although significant amounts of sand and gravel are used for fill, bedding, subbase, and basecourse without processing, most domestic sand and gravel are processed prior to use. The processing of sand and gravel for a specific market involves the use of different combinations of washers, screens, and classifiers to segregate particle sizes; crushers to reduce oversized material; and storage and loading facilities. A process flow diagram for construction sand and gravel processing is presented in Figure 11.19.1-1. The following paragraphs describe the process in more detail.

After being transported to the processing plant, the wet sand and gravel raw feed is stockpiled or emptied directly into a hopper, which typically is covered with a "grizzly" of parallel bars to screen out large cobbles and boulders. From the hopper, the material is transported to fixed or vibrating scalping screens by gravity, belt conveyors, hydraulic pump, or bucket elevators. The scalping screens separate the oversize material from the smaller, marketable sizes. Oversize material may be used for erosion control, reclamation, or other uses, or it may be directed to a crusher for size reduction, to produce crushed aggregate, or to produce manufactured sands. Crushing generally is carried out in one or two stages, although three-stage crushing may also be performed. Following crushing, the material is returned to the screening operation for sizing.

The material that passes through the scalping screen is fed into a battery of sizing screens, which generally consists of either horizontal or sloped, and either single or multideck, vibrating screens. Rotating trommel screens with water sprays are also used to process and wash wet sand and gravel. Screening separates the sand and gravel into different size ranges. Water is sprayed onto the material throughout the screening process. After screening, the sized gravel is transported to stockpiles, storage bins, or, in some cases, to crushers by belt conveyors, bucket elevators, or screw conveyors.

The sand is freed from clay and organic impurities by log washers or rotary scrubbers. After scrubbing, the sand typically is sized by water classification. Wet and dry screening is rarely used to size the sand. After classification, the sand is dewatered using screws, separatory cones, or

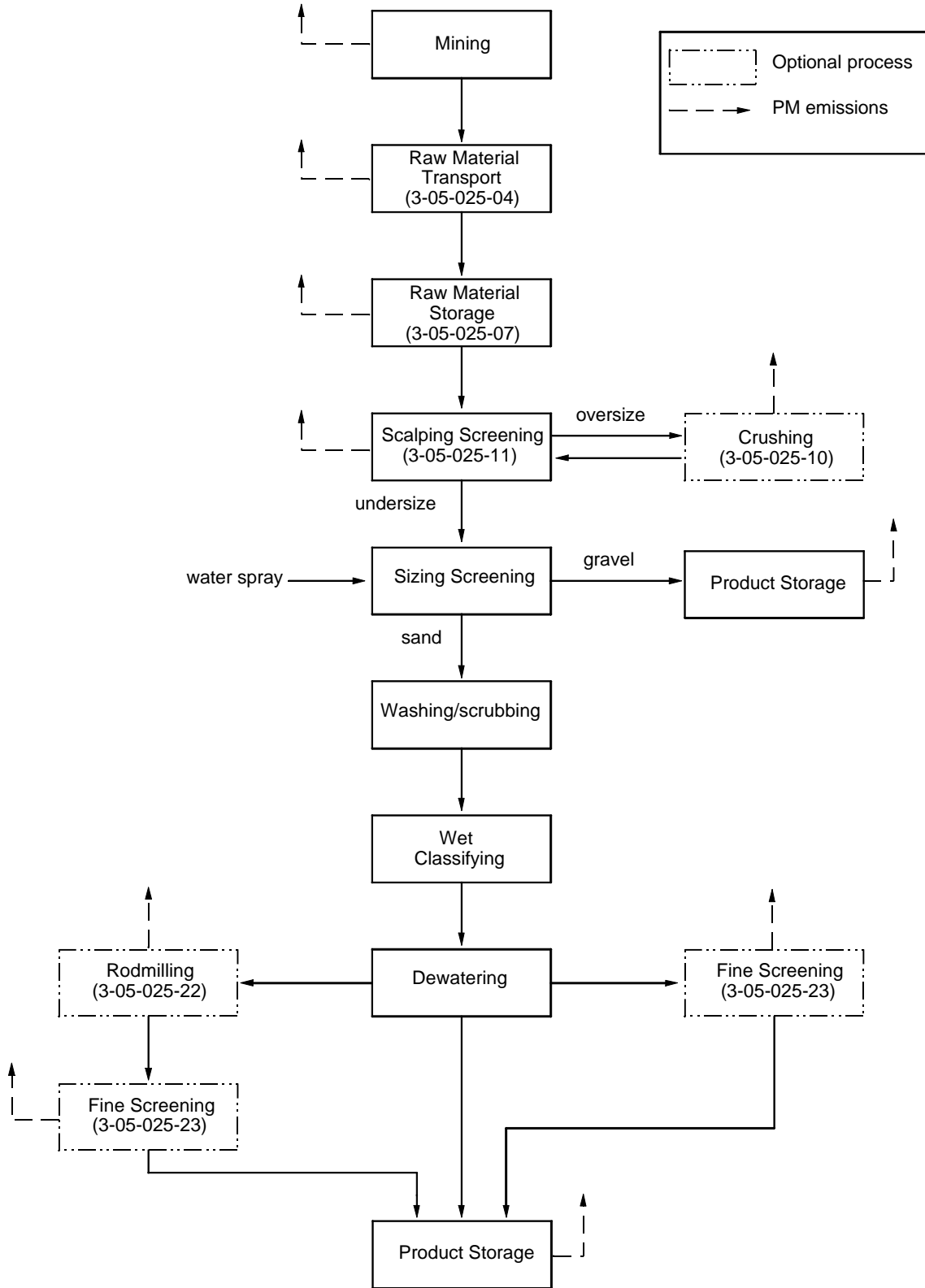


Figure 11.19.1-1. Process flow diagram for construction sand and gravel processing.
(Source Classification Codes in parentheses.)

hydroseparators. Material may also be rod-milled to produce smaller sized fractions, although this practice is not common in the industry. After processing, the sand is transported to storage bins or stockpiles by belt conveyors, bucket elevators, or screw conveyors.

Industrial Sand And Gravel -

Industrial sand and gravel typically are mined from open pits of naturally occurring quartz-rich sand and sandstone. Mining methods depend primarily on the degree of cementation of the rock. In some deposits, blasting is required to loosen the material prior to processing. The material may undergo primary crushing at the mine site before being transported to the processing plant. Figure 11.19.1-2 is a flow diagram for industrial sand and gravel processing.

The mined rock is transported to the processing site and stockpiled. The material then is crushed. Depending on the degree of cementation, several stages of crushing may be required to achieve the desired size reduction. Gyratory crushers, jaw crushers, roll crushers, and impact mills are used for primary and secondary crushing. After crushing, the size of the material is further reduced to 50 micrometers (μm) or smaller by grinding, using smooth rolls, media mills, autogenous mills, hammer mills, or jet mills. The ground material then is classified by wet screening, dry screening, or air classification. At some plants, after initial crushing and screening, a portion of the sand may be diverted to construction sand use.

After initial crushing and screening, industrial sand and gravel are washed to remove unwanted dust and debris and are then screened and classified again. The sand (now containing 25 to 30 percent moisture) or gravel then goes to an attrition scrubbing system that removes surface stains from the material by rubbing in an agitated, high-density pulp. The scrubbed sand or gravel is diluted with water to 25 to 30 percent solids and is pumped to a set of cyclones for further desliming. If the deslimed sand or gravel contains mica, feldspar, and iron bearing minerals, it enters a froth flotation process to which sodium silicate and sulfuric acid are added. The mixture then enters a series of spiral classifiers where the impurities are floated in a froth and diverted to waste. The purified sand, which has a moisture content of 15 to 25 percent, is conveyed to drainage bins where the moisture content is reduced to about 6 percent. The material is then dried in rotary or fluidized bed dryers to a moisture content of less than 0.5 percent. The dryers generally are fired with natural gas or oil, although other fuels such as propane or diesel also may be used. After drying, the material is cooled and then undergoes final screening and classification prior to being stored and packaged for shipment.

11.19.1.2 Emissions And Controls⁶⁻¹⁴

Emissions from the production of sand and gravel consist primarily of particulate matter (PM) and particulate matter less than 10 micrometers (PM-10) in aerodynamic diameter, which are emitted by many operations at sand and gravel processing plants, such as conveying, screening, crushing, and storing operations. Generally, these materials are wet or moist when handled, and process emissions are often negligible. A substantial portion of these emissions may consist of heavy particles that settle out within the plant. Other potentially significant sources of PM and PM-10 emissions are haul roads. Emissions from dryers include PM and PM-10, as well as typical combustion products including CO, CO₂, and NO_x. In addition, dryers may be sources of volatile organic compounds (VOC) or sulfur oxides (SO_x) emissions, depending on the type of fuel used to fire the dryer.

With the exception of drying, emissions from sand and gravel operations primarily are in the form of fugitive dust, and control techniques applicable to fugitive dust sources are appropriate. Some successful control techniques used for haul roads are dust suppressant application, paving, route

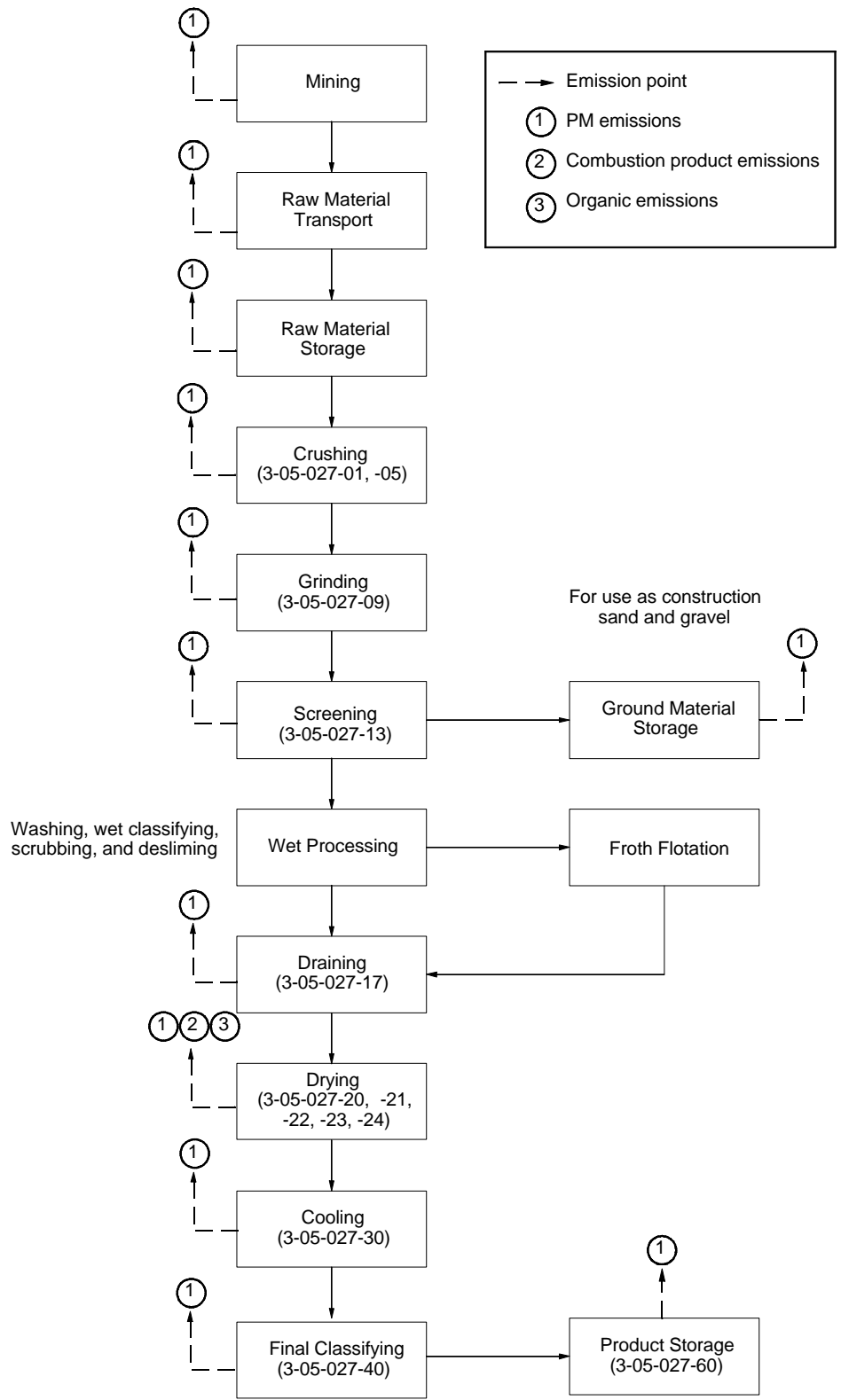


Figure 11.19.1-2. Process flow diagram for industrial sand and gravel processing. (Source Classification Codes in parentheses.)

modifications, and soil stabilization; for conveyors, covering and wet suppression; for storage piles, wet suppression, windbreaks, enclosure, and soil stabilizers; for conveyor and batch transfer points, wet suppression and various methods to reduce freefall distances (e. g., telescopic chutes, stone ladders, and hinged boom stacker conveyors); and for screening and other size classification, covering and wet suppression.

Wet suppression techniques include application of water, chemicals and/or foam, usually at crusher or conveyor feed and/or discharge points. Such spray systems at transfer points and on material handling operations have been estimated to reduce emissions 70 to 95 percent. Spray systems can also reduce loading and wind erosion emissions from storage piles of various materials 80 to 90 percent. Control efficiencies depend upon local climatic conditions, source properties and duration of control effectiveness. Wet suppression has a carryover effect downstream of the point of application of water or other wetting agents, as long as the surface moisture content is high enough to cause the fines to adhere to the larger rock particles.

In addition to fugitive dust control techniques, some facilities use add-on control devices to reduce emissions of PM and PM-10 from sand and gravel processing operations. Controls in use include cyclones, wet scrubbers, venturi scrubbers, and fabric filters. These types of controls are rarely used at construction sand and gravel plants, but are more common at industrial sand and gravel processing facilities.

Emission factors for criteria pollutant emissions from industrial sand and gravel processing are presented in Table 11.19.1-1 (metric and English units), and emission factors for organic pollutant emissions from industrial sand and gravel processing are presented in Table 11.19.1-2 (metric and English units). Although no emission factors are presented for construction sand and gravel processing, emission factors for the crushing, screening, and handling and transfer operations associated with stone crushing can be found in Section 11.19.2, "Crushed Stone Processing." In the absence of other data, the emission factors presented in Section 11.19.2 can be used to estimate emissions from corresponding sand and gravel processing sources. The background report for this AP-42 section also presents factors for the combined emissions of total suspended particulate from construction gravel storage pile wind erosion, material handling, and vehicle traffic. However, because the applicability of those emission factors to other storage piles is questionable, they are not presented here. To estimate emissions from fugitive sources, refer to AP-42 Chapter 13, "Miscellaneous Sources". The emission factors for industrial sand storage and screening presented in Table 11.19.1-1 are not recommended as surrogates for construction sand and gravel processing, because they are based on emissions from dried sand and may result in overestimates of emissions from those sources. Construction sand and gravel are processed at much higher moisture contents.

Table 11.19.1-1 (Metric And English Units).
EMISSION FACTORS FOR INDUSTRIAL SAND AND GRAVEL PROCESSING^a

EMISSION FACTOR RATING: D

Source	Total PM		NO _x		CO ₂	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Sand dryer (SCC 3-05-027-20)	0.98 ^{b,c}	2.0 ^{b,c}	0.016 ^d	0.031 ^d	14 ^e	27 ^e
Sand dryer with wet scrubber (SCC 3-05-027-20)	0.019 ^{b,f}	0.039 ^{b,f}	g	g	g	g
Sand dryer with fabric filter (SCC 3-05-027-20)	0.0053 ^{b,h}	0.010 ^{b,h}	g	g	g	g
Sand handling, transfer, and storage with wet scrubber (SCC 3-05-027-60)	0.00064 ^j	0.0013 ^j	ND	ND	ND	ND
Sand screening with venturi scrubber (SCC 3-05-027-13)	0.0042 ^k	0.0083 ^k	ND	ND	ND	ND

^a Factors represent uncontrolled emissions unless noted. Dryer emission factors in units of kg/Mg and lb/ton of dried material produced; other factors in units of kg/Mg and lb/ton of material stored or screened. SCC = Source Classification Code.

^b Factors are for filterable PM only. Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. Condensable organic and inorganic PM emission factors are not available. Factors presented can be considered a conservative underestimate of total PM.

^c Reference 12. EMISSION FACTOR RATING: E.

^d Reference 10.

^e References 10,13.

^f References 5,13. EMISSION FACTOR RATING: C.

^g Control device has no effect on emissions. See factor for uncontrolled emissions.

^h References 7,11.

^j Reference 9. For dried sand.

^k Reference 14. Screening of dried sand.

Table 11.19.1-2 (Metric And English Units).
EMISSION FACTORS FOR INDUSTRIAL SAND AND GRAVEL PROCESSING--
ORGANIC POLLUTANTS^a

EMISSION FACTOR RATING: D

Source	Pollutant		Emission factor	
	CASRN ^b	Name	kg/Mg	lb/ton
Diesel-fired rotary sand dryer with fabric filter (SCC 3-05-027-22)	50-00-0	Formaldehyde	0.0021	0.0043
	206-44-0	Fluoranthene	3.0 x 10 ⁻⁶	6.0 x 10 ⁻⁶
	91-20-3	Naphthalene	2.9 x 10 ⁻⁵	5.9 x 10 ⁻⁵
	85-01-8	Phenanthrene	7.5 x 10 ⁻⁶	1.5 x 10 ⁻⁵

^a Reference 8. Factors represent uncontrolled emissions unless noted. Dryer emission factors in units of kg/Mg and lb/ton of material dried. SCC = Source Classification Code.

^b Chemical Abstract Service Registry Number.

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