Emission Factor Documentation for AP-42
Section 11.19.1

Sand and Gravel Processing

Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group

EPA Contract 68-D2-0159
Work Assignment No. II-01

MRI Project No. 4602-01

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NOTICE

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under Contract No. 68-D2-0159 to Midwest Research Institute. It has been subjected to the Agency's peer and administrative review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This report was prepared by Midwest Research Institute (MRI) for the Office of Air Quality Planning and Standards (OAQPS), U. S. Environmental Protection Agency (EPA), under Contract No. 68-D2-0159, Work Assignment No. II-01. Mr. Ron Myers was the requester of the work.

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1. INTRODUCTION

The document *Compilation of Air Pollutant Emission Factors* (AP-42) has been published by the U. S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State, and local air pollution control programs, and industry.

An emission 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. Emission factors usually are expressed as the weight of pollutant divided by the unit weight, volume, distance, or duration of the activity that emits the pollutant. The emission factors presented in AP-42 may be appropriate to use in a number of situations, such as making source-specific emission estimates for areawide inventories for dispersion modeling, developing control strategies, screening sources for compliance purposes, establishing operating permit fees, and making permit applicability determinations. The purpose of this report is to provide background information from test reports and other information to support a revision to AP-42 Section 8.19.1, Sand and Gravel Processing, which subsequently will be Section 11.19.1.

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a description of the sand and gravel industry. Included in the section are a characterization of the industry, an overview of the different process types, a description of emissions, and a description of the technology used to control emissions resulting from sand and gravel processing. Section 3 is a review of emissions data collection and analysis procedures. This section describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Section 4 details the development of pollutant emission factors for the AP-42 section, including the review of specific data sets, the results of data analysis, and a summary of changes to the AP-42 section. Section 5 presents the proposed AP-42 Section 11.19.1, Sand and Gravel Processing.

2. INDUSTRY DESCRIPTION[1-3]

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 products of the weathering of rocks and unconsolidated or poorly consolidated materials and consist of siliceous and calcareous components. Such deposits are common throughout the United States. Construction sand and gravel are made up of varying amounts of different rock types and are, therefore, of varying chemical composition. Silica, or silicon dioxide (SiO_2), is the major constituent of commercial sands. Lesser amounts of feldspar, mica, iron oxides, and heavy minerals are common. Industrial sand, often called silica sand, and industrial gravel differ from construction sand and gravel in that they contain high percentages of quartz, or silica, typically 95 to 99 percent.

Construction sand and gravel plants are classified under Standard Industrial Classification (SIC) code 1442, construction sand and gravel. Industrial sand and gravel plants are classified under SIC code 1446, industrial sand. Emission sources in construction sand and gravel processing are included under the Source Classification Code (SCC) 3-05-025. A new SCC for industrial sand and gravel of 3-05-027 has been created in the process of revising the AP-42 section.

2.1 CHARACTERIZATION OF THE INDUSTRY[4-5]

In 1989, 5,687 construction sand and gravel pits in the United States produced 814,000,000 megagrams (Mg) (897,300,000 tons) of construction sand and gravel with a value of approximately $3,249,100,000. This production level represents a 2.8 percent decrease from 1988 production. Construction sand and gravel was produced in every State. The 10 leading States were, in descending order of tonnage, California, Michigan, Ohio, Texas, Washington, Arizona, Minnesota, Illinois, New York, and Indiana. Their combined production represented 52.9 percent of the national total. By major geographic region, the production quantity was West--36.7 percent, Midwest--30.3 percent, South--20.9 percent, and Northeast--12.1 percent. The quantity and total value of construction sand and gravel sold or used in the United States, by State, is presented in Table 2-1.

The largest use of construction sand and gravel (about 28 percent) is as aggregate for the production of concrete. The second largest use (about 15 percent) is as base material for highways, railways, runways, etc. Other major uses include aggregate for hot mix asphalt (9 percent), and fill for highway, dam, and other recontouring (7 percent). Smaller volumes of construction sand and gravel are used in plaster and gunite sands, snow and ice control, and railroad ballast. About 39 percent of total U.S. production is reported as "unspecified uses--actual and estimated." A more detailed breakdown of the major uses of construction sand and gravel sold or used in the United States is presented in Table 2-2.

In 1989, 153 industrial sand and gravel operations in the United States produced 26,500,000 megagrams (Mg) (29,200,000 tons) of industrial sand and gravel with a value of approximately $396,000,000. This production level represents a 3 percent increase from 1988 production. The five leading States in the production of industrial sand and gravel were, in descending order of volume, Illinois, Michigan, California, New Jersey, and Texas. Their combined production represented 46 percent of the national total. By major geographic region, the production quantity was Midwest--42 percent, South--35 percent, West--14 percent. The quantity and total value of industrial sand and gravel sold or used in the United States, by State, is presented in Table 2-3.

TABLE 2-1. CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY STATE (1989)[a]

State	Quantity		Total value, $
	Mg	Tons	
Alabama	9,400,000	10,400,000	36,500,000
Alaska	15,400,000	17,000,000	48,500,000
Arizona	30,800,000	33,900,000	133,900,000
Arkansas	6,800,000	7,500,000	25,500,000
California	125,500,000	138,300,000	670,800,000
Colorado	23,000,000	25,300,000	104,000,000
Connecticut	5,300,000	5,800,000	24,700,000
Delaware	1,700,000	1,900,000	6,200,000
Florida	16,200,000	17,900,000	55,500,000
Georgia	5,500,000	6,100,000	18,900,000
Hawaii	500,000	600,000	3,200,000
Idaho	5,300,000	5,800,000	18,900,000
Illinois	29,900,000	33,000,000	108,900,000
Indiana	26,900,000	29,600,000	99,200,000
Iowa	11,600,000	12,800,000	37,800,000
Kansas	11,800,000	13,000,000	33,200,000
Kentucky	5,000,000	5,500,000	15,100,000
Louisiana	12,300,000	13,600,000	54,400,000
Maine	7,800,000	8,600,000	30,100,000
Maryland	15,300,000	16,900,000	84,500,000
Massachusetts	12,600,000	13,900,000	57,000,000
Michigan	43,500,000	48,000,000	132,000,000
Minnesota	30,600,000	33,700,000	82,600,000
Mississippi	14,200,000	15,600,000	51,500,000
Missouri	9,100,000	10,000,000	32,500,000
Montana	5,300,000	5,800,000	13,900,000
Nebraska	13,800,000	15,200,000	41,800,000
Nevada	18,100,000	20,000,000	70,000,000
New Hampshire	5,400,000	6,000,000	20,400,000

TABLE 2-1. (continued)

State	Quantity		Total value, $
	Mg	Ton	
New Jersey	13,800,000	15,200,000	68,400,000
New Mexico	10,700,000	11,800,000	45,400,000
New York	28,700,000	31,600,000	118,500,000
North Carolina	10,200,000	11,200,000	43,700,000
North Dakota	3,300,000	3,600,000	8,100,000
Ohio	40,300,000	44,400,000	148,700,000
Oklahoma	7,700,000	8,500,000	20,000,000
Oregon	13,100,000	14,400,000	49,700,000
Pennsylvania	17,700,000	19,500,000	94,600,000
Rhode Island	1,000,000	1,100,000	3,900,000
South Carolina	6,800,000	7,500,000	23,300,000
South Dakota	5,800,000	6,400,000	20,800,000
Tennessee	5,500,000	6,100,000	21,900,000
Texas	39,800,000	43,900,000	155,800,000
Utah	13,000,000	14,300,000	41,500,000
Vermont	6,300,000	6,900,000	20,400,000
Virginia	11,700,000	12,900,000	49,700,000
Washington	34,300,000	37,800,000	124,700,000
West Virginia	2,100,000	2,300,000	6,700,000
Wisconsin	19,700,000	21,700,000	56,400,000
Wyoming	4,100,000	4,500,000	15,400,000
Total[b]	814,000,000	897,300,000	3,249,100,000

[a]Reference 4.
[b]Data may not add to total due to independent rounding.

TABLE 2-2. CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY MAJOR USE (1988)[a]

Use	Quantity		Total value $	Value per ton $
	Mg	Tons		
Concrete aggregate (including concrete sand)	209,180,000	230,576,000	887,422,000	3.85
Plaster and gunite sands	8,371,000	9,227,000	43,226,000	4.68
Concrete products (blocks, bricks, pipe, decorative, etc.)	9,437,000	10,403,000	38,916,000	3.74
Hot mix asphalt aggregates and other bituminous mixtures	74,767,000	82,417,000	318,662,000	3.87
Road base and coverings	123,920,000	136,597,000	413,330,000	3.03
Road stabilization (cement)	2,168,000	2,390,000	6,452,000	2.70
Road stabilization (lime)	893,000	984,000	2,592,000	2.63
Fill	56,800,000	62,611,000	134,709,000	2.15
Snow and ice control	5,420,000	5,974,000	20,086,000	3.36
Railroad ballast	579,000	638,000	2,849,000	4.47
Roofing granules	565,000	623,000	2,517,000	4.04
Filtration	63,000	69,000	372,000	5.39
Other	18,668,000	20,578,000	72,443,000	3.52
Unspecified:				
Actual	216,750,000	238,924,000	828,733,000	3.47
Estimated	110,090,000	121,352,000	353,689,000	2.91
Total or average[b]	837,690,000	923,400,000	3,126,000,000	3.39

[a]Reference 4.
[b]Data may not add to totals due to independent rounding.

TABLE 2-3. INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY STATE (1989)[a]

State	Quantity		Total value, $
	Mg	Tons	
Alabama	730,000	805,000	8,092,000
Arizona	W	W	W
Arkansas	494,000	545,000	5,507,000
California	2,201,000	2,426,000	43,863,000
Colorado	W	W	W
Connecticut	W	W	W
Florida	618,000	681,000	7,768,000
Georgia	487,000	537,000	7,013,000
Idaho	416,000	459,000	5,037,000
Illinois	4,157,000	4,582,000	52,935,000
Indiana	W	W	W
Kansas	209,000	230,000	2,690,000
Kentucky	W	W	W
Louisiana	519,000	572,000	9,664,000
Maryland	W	W	W
Massachusetts	31,000	34,000	601,000
Michigan	2,599,000	2,865,000	24,577,000
Minnesota	W	W	W
Mississippi	W	W	W
Missouri	680,000	750,000	9,972,000
Montana	W	W	W
Nebraska	W	W	W
Nevada	651,000	718,000	W
New Jersey	1,630,000	1,797,000	26,138,000
New York	48,000	53,000	633,000
North Carolina	1,476,000	1,627,000	19,902,000
Ohio	1,265,000	1,394,000	24,662,000
Oklahoma	1,103,000	1,216,000	18,310,000
Pennsylvania	W	W	W

TABLE 2-3. (continued)

State	Quantity		Total value, $
	Mg	Tons	
Rhode Island	W	W	W
South Carolina	764,000	842,000	16,635,000
Tennessee	W	W	W
Texas	1,507,000	1,661,000	29,107,000
Utah	2,700	3,000	60,000
Virginia	W	W	W
Washington	W	W	W
West Virginia	W	W	W
Wisconsin	1,373,000	1,514,000	22,399,000
Other	3,530,000	3,891,000	74,630,000
Total[b]	26,494,000	29,205,000	410,200,000

[a]Reference 5. W = withheld to avoid disclosing company proprietary data; included with "Other."
[b]Data may not add to total due to independent rounding.

The largest use of industrial sand and gravel is for glassmaking. In 1989, 42 percent was consumed as glassmaking sand for use in the manufacture of containers, plate glass, specialty glass, and fiberglass. The second largest use (24 percent) was as foundry sand for molding and core facing, and as refractory material. Other important uses include abrasive sand (8 percent), hydraulic fracturing sand (5 percent), roofing granules and fillers, filtration, ceramics, and fillers. A more detailed breakdown of the major uses of industrial sand and gravel sold or used in the United States is presented in Table 2-4.

2.2 PROCESS DESCRIPTION[1-6]

2.2.1 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 a 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 is 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 2-1. 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 sizes. The oversize material 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. Alternatively, oversize material may be used for erosion control, reclamation, or other uses.

The material that passes through the scalping screen is fed into a battery of sizing screens, which generally consist of horizontal or sloped, 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 are rarely used to size the sand. After classification, the sand is dewatered using screws, separatory cones, or hydroseparators. Material may also be rodmilled to produce smaller sized fractions, although this

TABLE 2-4. INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY MAJOR USE (1989)[a]

Use	Quantity		Total value $	Value per ton $
	Mg	Tons		
Sand:				
Glassmaking:				
Containers	7,129,000	7,858,000	96,782,000	12.32
Flat (plate and window)	2,349,000	2,589,000	30,198,000	11.66
Specialty	691,000	762,000	12,049,000	15.81
Fiberglass (unground)	759,000	837,000	15,539,000	18.57
Fiberglass (ground)	224,000	247,000	6,463,000	26.17
Foundry:				
Molding and core	6,123,000	6,749,000	72,776,000	10.78
Molding and core facing (ground)	W	W	W	26.93
Refractory	305,000	336,000	2,002,000	5.96
Metallurgical:				
Silicon carbide	W	W	W	11.70
Flux for metal smelting	41,000	45,000	285,000	6.33
Abrasives:				
Blasting	2,075,000	2,287,000	42,190,000	18.45
Scouring cleansers (ground)	W	W	W	26.51
Chemicals (ground and unground)	741,000	817,000	10,580,000	12.95
Fillers (ground):				
Rubber, paints, putty, etc.	144,000	159,000	10,454,000	65.75
Silica flour	62,000	68,000	1,781,000	26.19
Ceramic (ground):				
Pottery, brick, tile, etc.	216,000	238,000	7,537,000	31.67
Filtration	281,000	310,000	6,033,000	19.46

TABLE 2-4. (continued)

Use	Quantity		Total value $	Value per ton $
	Mg	Tons		
Traction (engine)	282,000	311,000	2,902,000	9.33
Coal washing	W	W	W	28.36
Roofing granules and fillers	717,000	790,000	13,453,000	17.03
Hydraulic fracturing	1,389,000	1,531,000	34,494,000	22.53
Other uses, unspecified	735,000	810,000	10,940,000	13.51
Total or average	25,237,000	27,819,000	395,807,000	14.23
Gravel:				
Metallurgical: Silicon, ferrosilicon	688,000	758,000	8,295,000	10.94
Filtration	44,000	48,000	591,000	12.31
Nonmetallurgical flux	461,000	508,000	4,311,000	8.49
Total or average	1,256,000	1,385,000	14,388,000	10.39
Grand total or average[b]	26,494,000	29,205,000	410,200,000	14.05

[a]Reference 5. W = Withheld to avoid disclosing company proprietary data.
[b]Data may not add to totals due to independent rounding.

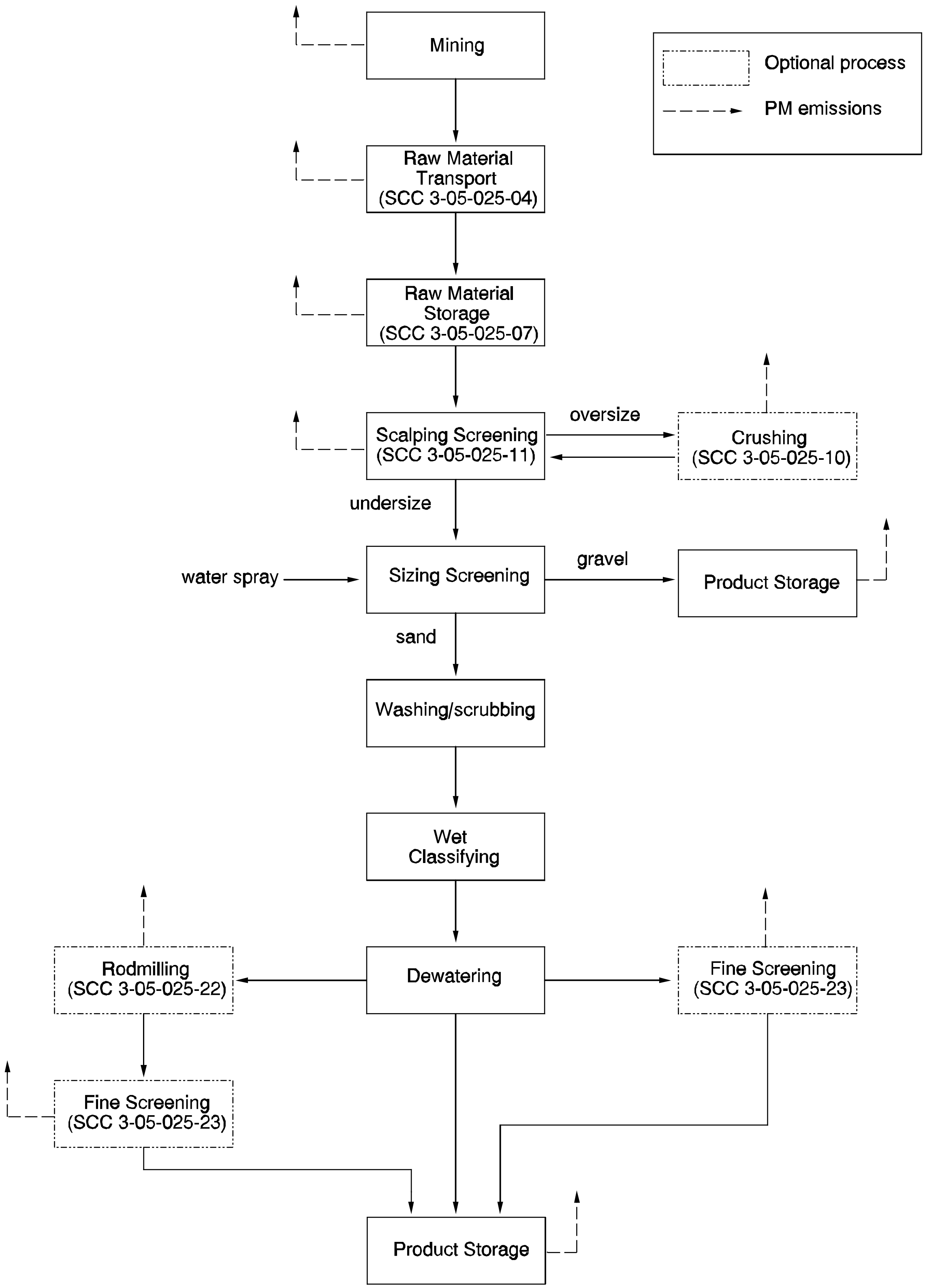

Figure 2-1. Process flow diagram for construction sand and gravel processing.

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.

2.2.2 Industrial Sand and Gravel

Industrial sand and gravel typically is 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 2-2 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 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 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 to a moisture content of less than 0.5 percent in rotary or fluidized bed dryers. 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.

2.3 EMISSIONS[1]

Emissions from the production of sand and gravel consist primarily of particulate matter (PM) and PM less than 10 micrometers (PM-10) in aerodynamic diameter that 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, CO_2, 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.

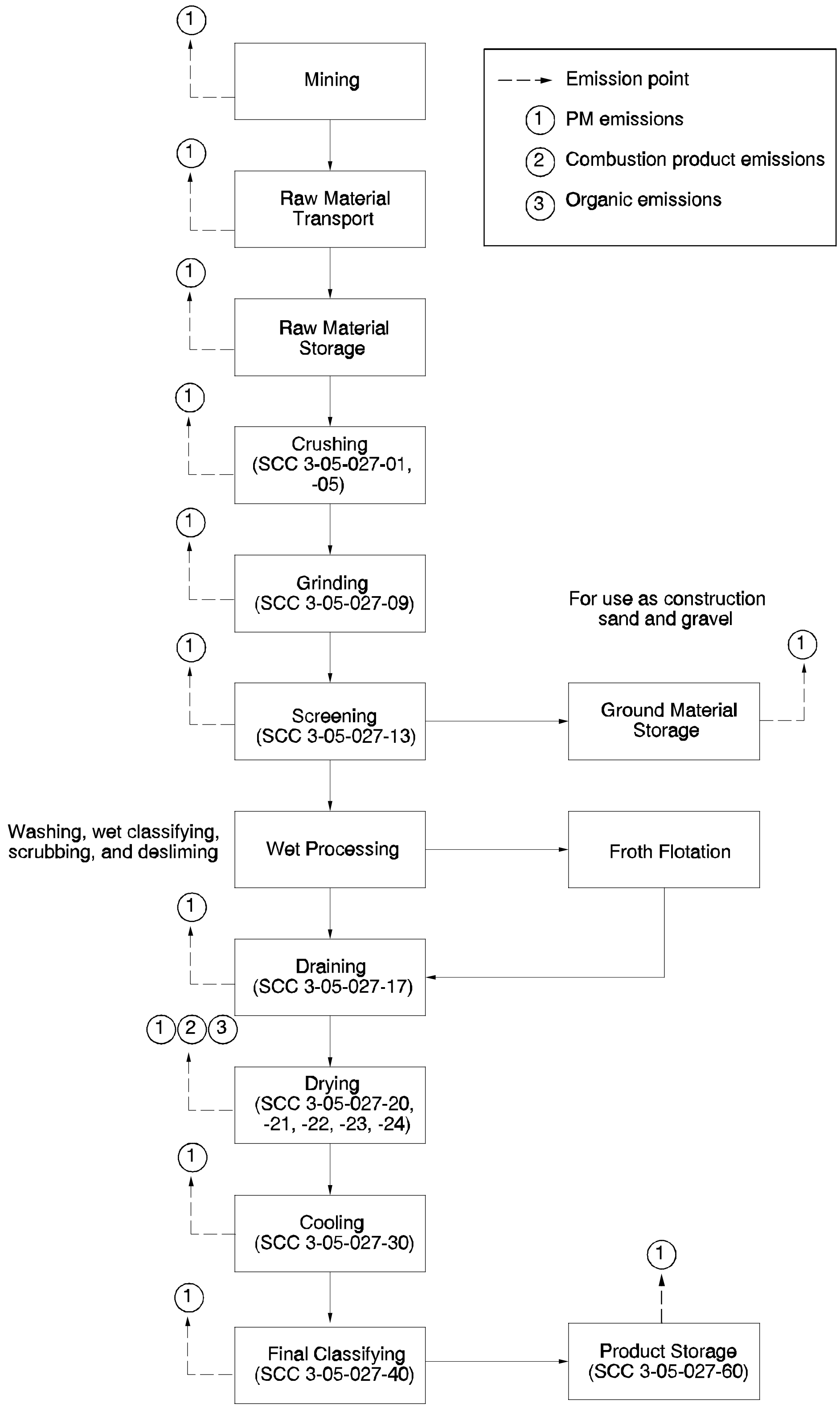

Figure 2-2. Flow diagram for industrial sand and gravel processing.

2.4 CONTROL TECHNOLOGY[1,3,6-14]

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 application of dust suppressants, paving, route modifications, and soil stabilization; for conveyors, covering and wet suppression; for storage piles, wet suppression, windbreaks, enclosure, and soil stabilizers; and 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 processes, 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.

REFERENCES FOR SECTION 2

1. *Air Pollution Control Techniques For Nonmetallic Minerals Industry*, EPA-450/3-82-014, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1982.

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13. *Compliance Stack Sampling Report for Richard Ricci Company, Port Norris, NJ*, Recon Systems, Inc., Three Bridges, NJ, July 31, 1987.

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3. GENERAL DATA REVIEW AND ANALYSIS

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from a number of sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. The docket for the development of new source performance standards (NSPS) for calciners and dryers in the mineral industries was reviewed for information on the industry, processes, and emissions. The Factor Information and Retrieval (FIRE), Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF) and VOC/PM Speciation Data Base Management System (SPECIATE) data bases were searched by SCC for identification of the potential pollutants emitted and emission factors for those pollutants. A general search of the Air CHIEF CD-ROM also was conducted to supplement the information from these two data bases.

Information on the industry, including number of plants, plant location, and annual production capacities, was obtained from the *Minerals Yearbook* and *Census of Manufactures*. The Aerometric Information Retrieval System (AIRS) data base also was searched for data on the number of plants, plant location, and estimated annual emissions of criteria pollutants.

A number of sources of information were investigated specifically for emission test reports and data. A search of the Test Methods Storage and Retrieval (TSAR) data base was conducted to identify test reports for sources within the sand and gravel processing industry. Copies of these test reports were obtained from the files of the Emission Monitoring and Analysis Division (EMAD). The EPA library was searched for additional test reports. A list of plants that have been tested within the past 5 years was compiled from the AIRS data base. Using this information and information obtained on plant location from the *Minerals Yearbook* and *Census of Manufactures*, State and Regional offices were contacted about the availability of test reports. However, the information obtained from these offices was limited. Publications lists from the Office of Research and Development (ORD) and Control Technology Center (CTC) were also searched for reports on emissions from the sand and gravel processing industry. In addition, representative trade associations were contacted for assistance in obtaining information about the industry and emissions.

To reduce the amount of literature collected to a final group of references from which emission factors could be developed, the following general criteria were used:

1. Emission data must be from a primary reference:

a. Source testing must be from a referenced study that does not reiterate information from previous studies.

b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, the document was eliminated.

2. The referenced study must contain test results based on more than one test run.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions. A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.2 EMISSION DATA QUALITY RATING SYSTEM[1]

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;

2. Test series representing incompatible test methods (i.e., comparison of EPA Method 5 front half with EPA Method 5 front and back half);

3. Test series of controlled emissions for which the control device is not specified;

4. Test series in which the source process is not clearly identified and described; and

5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by EIB for preparing AP-42 sections. The data were rated as follows:

A--Multiple tests that were performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B--Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

C--Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D--Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. <u>Sampling procedures</u>. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well

documented. When this occurred, an evaluation was made of the extent to which such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and were given a lower rating.

4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM[1]

The quality of the emission factors developed from analysis of the test data was rated utilizing the following general criteria:

A--Excellent: Developed only from A-rated test data from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B--Above average: Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. The source category is specific enough so that variability within the source category population may be minimized.

C--Average: Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D--Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E--Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent on the individual reviewer. Details of the rating of each candidate emission factor are provided in Section 4 of this report.

REFERENCE FOR SECTION 3

1. *Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections*, EPA-454/B-93-050, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1993.

4. AP-42 SECTION DEVELOPMENT

4.1 INTRODUCTION

This section describes how the revised AP-42 section on sand and gravel processing was developed. First, descriptions of data sets reviewed for this revision are presented, followed by a discussion of how candidate emission factors were developed from the data. Finally, the proposed changes to the existing AP-42 section on sand and gravel processing are summarized.

4.2 REVIEW OF SPECIFIC DATA SETS

Fifteen references were documented and reviewed in the process of revising the section on sand and gravel processing. References 1 through 5 were taken from the existing background file for the section. These documents are discussed in Section 4.2.3 of this report. References 6 through 14 contain information not used in previous AP-42 sections on sand and gravel processing. Reference 15 was not used to develop emission factors; the reference included the results of tests that each consisted of only a single test run, and the results are not comparable to other tests due to the unusual sampling train configuration used. The documents that were used to develop emission factors for the revised AP-42 section are described in the following paragraphs.

4.2.1 Reference 6

This document presents background information that was used in the development of an NSPS for calciners and dryers for several mineral products industries. Appendix C of the document summarizes the results of emission tests conducted at four industrial processing facilities. The individual test reports for those tests were not available. Filterable PM emission data are presented for tests on four fluidized bed dryers located at four facilities and one rotary dryer. Two of the fluidized bed dryers were fired with propane, one dryer was fired with natural gas, and the remaining dryer was fired with No. 2 fuel oil. Particle size data also are presented for one fluidized bed and one rotary dryer, both of which were located at the same facility. Because the process rates for two of the tested facilities are considered confidential, emission factors were developed only for the average of the four fluidized bed dryers.

A rating of B was assigned to the test data. Although the document is not the primary reference for the data, it includes emission data on a run-by-run basis and descriptions of the tests and test methods used. The methodology appeared to be sound and no problems were reported.

4.2.2 Reference 7

This report documents measurements of filterable PM emissions from a combination rotary sand dryer and shaker screen. Emissions also were sampled for CO and total organic compounds (TOC) but these pollutants were not detected in the exhaust stream. The test was conducted in November 1988 to demonstrate compliance with State regulations.

The sources tested were located at a concrete batching plant, and emissions were controlled with the combination of a cyclone and fabric filter. Although not specified in the report, it is assumed that the cyclone is used for product recovery and was not considered as an additional control device. In addition, the report included no information on the type of screen tested or the relative contribution of the screen to overall emissions from the stack tested. However, it is assumed that the dryer was the primary contributor to the filterable PM emissions. Process rates were provided on the basis of production. The report also does not specify the test method used, but apparently the test was conducted in accordance with New Jersey Air Test Method 1 (NJATM 1), which is equivalent to EPA Method 5. Three filterable PM runs were conducted.

An emission factor was developed for controlled filterable PM emissions from the dryer and screen. The emission data are rated B. The test methodology was sound, and no problems were reported. However, the report lacked adequate details on the sources tested to warrant a higher rating.

4.2.3 Reference 8

This report documents measurements of emissions of polycyclic aromatic hydrocarbons (PAH) and formaldehyde from a diesel-fired rotary sand dryer. The test was conducted in November 1991; the report does not state the purpose of the test.

During the test, the dryer was drying what is referred to as "specialty sand," but the report provides no other information about the type of sand. It is assumed that the sand can be considered to be industrial sand. The basis for the process rates provided in the report is unclear; it is assumed that the rates were for production. The dryer is equipped with a low-NO_x burner and PM emissions are controlled with a pulse-jet fabric filter.

Emissions of PAH and formaldehyde were quantified using California Air Resources Board (CARB) Methods 429 and 430, respectively, and three test runs were conducted. The samples were analyzed for 16 PAH, and 3 were found in quantities above the detection limit; naphthalene was above the detection limit in all three runs, and fluoranthene and phenanthrene were above the detection limit for two of the three runs.

Emission factors were developed for formaldehyde, naphthalene, fluoranthene, and phenanthrene emissions from the dryer. To estimate the factors for fluoranthene and phenanthrene, one half the detection limit was used for the run that was below the detection limit.

The emission data are rated B. The test methodology was sound, and no problems were reported. However, the report lacked adequate details on the sources tested to warrant a higher rating.

4.2.4 Reference 9

This report documents measurements of filterable PM emissions from the handling, transfer, and storage of foundry sand. The exhaust stream sampled included emissions from conveyor belts and an elevator that transfers sand from a sand dryer to storage silos. Emissions generated within the silos also were included in the exhaust stream. The emissions from the sources are controlled with a wet scrubber. Production rates were provided on the basis of the rate of sand exiting the dryer. The test was conducted in March 1990 to demonstrate compliance with State regulations.

The test was conducted in accordance with NJATM 1, which is equivalent to EPA Method 5. Three filterable PM runs were conducted, and an emission factor for filterable PM was developed from the data.

The emission data are rated B. The test methodology was sound, and no problems were reported. However, the report lacked adequate details on the sources tested to warrant a higher rating.

4.2.5 Reference 10

This report documents measurements of NO_x emissions from a No. 2 fuel oil-fired fluidized bed dryer and a cooler in parallel. The dryer/cooler was processing industrial sand, and emissions were controlled with a fabric filter. The report included no information on the relative contribution of the cooler to overall emissions, but it is assumed that the dryer was the sole contributor of the NO_x emissions. Process rates were provided on the basis of production. The test was conducted in November 1989 to demonstrate compliance with State regulations.

Nitrogen oxide emissions were measured using Method 7E, and three test runs were conducted. The concentrations of CO_2 in the exhaust stream were measured by Orsat and also were reported.

Emission factors were developed for emissions of NO_x and CO_2 from the dryer/cooler. The emission data are rated B. The test methodology was sound, and no problems were reported. However, the report lacked adequate details on the sources tested to warrant a higher rating.

4.2.6 Reference 11

This report documents measurements of filterable PM emissions from the same oil-fired fluidized bed dryer/cooler that is the subject of Reference 10. The exhaust stream also was sampled for NO_x emissions, but none were detected. Emissions from the dryer/cooler were controlled with a fabric filter. The report included no information on the relative contribution of the cooler to overall emissions, but it is assumed that the dryer was the primary contributor to the filterable PM emissions. Process rates were provided on the basis of both feed and production. The test was conducted in November 1989 to demonstrate compliance with State regulations.

Filterable PM emissions were measured using NJATM 1, and three test runs were conducted. Emission factors were developed for emissions of filterable PM from the dryer/cooler. The emission data are rated A. The test methodology was sound, no problems were reported, and the test was well documented.

4.2.7 Reference 12

This report documents measurements of filterable PM emissions from a gas-fired rotary sand dryer. Emissions from the dryer are controlled with a combination of cyclone and wet scrubber. Although not specified in the report, it is assumed that the cyclone is used for product recovery and was not considered as an additional control device. The test was conducted in November 1987 to demonstrate compliance with State regulations.

The report does not specify process rates, but includes the operating capacity of the dryer and states that the dryer was operated at permit conditions. Therefore, for the purposes of developing emission factors, it was assumed that the dryer was operated at capacity during the test.

Filterable PM emissions were measured using NJATM 1, and three test runs were conducted. Emission factors were developed for uncontrolled and controlled emissions of filterable PM from the dryer. The emission data are rated C. The test methodology was sound, and no problems were reported. However, because of the uncertainty of the process rates, a higher rating was not warranted.

4.2.8 Reference 13

This report documents measurements of filterable PM emissions from a No. 2 fuel oil-fired rotary sand dryer. Emissions from the dryer are controlled with a combination of cyclone and wet scrubber. Although not specified in the report, it is assumed that the cyclone is used for product recovery and was not considered as an additional control device. Process rates were provided on the basis of production. The test was conducted in July 1987 to demonstrate compliance with State regulations.

Filterable PM emissions were measured using NJATM 1, and three test runs were conducted. The concentrations of CO_2 in the exhaust stream were measured by Orsat and also were reported. Emission factors were developed for emissions of filterable PM and CO_2 from the dryer. The emission data are rated A. The test methodology was sound, no problems were reported, and the report was adequately documented.

4.2.9 Reference 14

This report documents measurements of filterable PM emissions from industrial sand screening. Emissions from the screening system are controlled with a venturi scrubber. Process rates were provided on the basis of production. The test was conducted in April 1987 to demonstrate compliance with State regulations.

Filterable PM emissions were measured using Method 17, and three test runs were conducted. An emission factor was developed for emissions of filterable PM from the screens. The emission data are rated B. The test methodology was sound, and no problems were reported. However, the report lacked adequate documentation to warrant a higher rating.

4.2.10 Review of Emission Factor Data Bases

The FIRE, XATEF, and SPECIATE data bases do not include emission factors for sand and gravel processing.

4.2.11 Review of Test Data in AP-42 Background File

The background file includes five references that address emissions from construction sand and gravel processing. These references are referred to in this report as References 1 to 5. References 1, 2, and 5 form the basis for the emission factors presented in the previous version of AP-42 Section 8.19.1, Sand and Gravel Processing. However, as explained in the following paragraphs, only the data from Reference 2 were used in this revision to AP-42.

Reference 1 contains a review of emission factors presented in several documents including AP-42. Appendix C of the report presents data on emissions from screening. However, the sources tested were located at stone crushing plants. These data were used to develop emission factors for AP-42 Section 11.19.2, Crushed Stone Processing, and are not presented here.

Reference 2 includes the results of a sampling program designed to quantify total dust emissions from the various constituent sources associated with a representative aggregate storage operation. This testing program was conducted at a sand and gravel pit located in the Midwest. The test program consisted of 11 24-hour runs and 8 12-hour runs during a 1-month period. Conventional high volume (Hi-Vol) samplers with wind direction activators were used to measure dust emissions. A 180-degree sector of sampling was employed. Wind erosion, vehicle traffic in the vicinity of the piles, and material loading all contributed to the emissions sampled. Because emissions were measured during a continous 1-month period, sampling took place during the weekends and at night when there was no activity in the vicinity of the storage piles. By segregating the daily readings for the nonworking days, separate emission factors were developed for active storage piles (8 to 12 hours of activity per day), inactive storage piles (no activity), and a mix of active and inactive storage piles (five active days per week). The data are assigned a C rating. The test methodology appeared to be sound, no problems were reported during the valid test runs, and adequate detail was provided. However, no vertical profiling of the plume was conducted, and the samplers were not operated isokinetically.

Data from Reference 3 were not included in the revised section because the only information in the document relevant to sand and gravel processing is an equation that was developed in Reference 2 for calculating fugitive dust emissions from sand and gravel storage piles. Data from Reference 4 were not incorporated into the revised section because they are based on uncontrolled fugitive dust emission factors for sand and gravel storage piles taken from the 1972 version of AP-42. Reference 5 presents data on emissions from stone crushing, screening, transfer, and loading at five plants. However, all the plants tested were stone crushing plants. Therefore, the data were not addressed in this report.

4.3 DEVELOPMENT OF CANDIDATE EMISSION FACTORS

Tables 4-1 and 4-2 summarize the available test data for construction sand and gravel processing and for industrial sand and gravel processing, respectively. Table 4-3 presents the candidate emission factors for sand and gravel processing. The emission factor ratings assigned to the factors for the revised AP-42 section are based on the guidelines presented in Section 3.3 of this report. The main criteria used in rating the factors are as follows:

1. Factors based on C- or D-rated data generally must be assigned a rating of E; and

2. Factors based on B-rated data or a combination of A- and B-rated data, generally cannot be assigned a rating higher than C, and, if the data are from a small number of facilities, and are unlikely to represent a random sample of the industry, the factor generally is assigned a D-rating.

The following paragraphs describe how the data were used to develop the candidate emission factors for sand and gravel processing.

4.3.1 Construction Sand and Gravel

The only data available for construction sand and gravel processing were found in Reference 2, which presented the results of measurements of filterable PM emissions from gravel storage piles. The factors presented in Reference 2 actually represent emissions from a combination of storage pile wind erosion, material handling, and vehicle traffic. Consequently, those emission factors overestimate emissions from storage piles alone. Furthermore, Reference 2 does not include the

TABLE 4-1. SUMMARY OF TEST DATA FOR CONSTRUCTION SAND AND GRAVEL PROCESSING (a)

Source	Pollutant	No. of runs	Data rating	Emission factor (b)			
				kg/Mg	lb/ton	kg/ha/day	lb/ac/day
Active storage piles (c)	Total suspended particulate	19	C	0.21	0.42	14.8	13.2
Inactive storage piles (d)	Total suspended particulate	19	C	0.055	0.11	3.9	3.5
Active/inactive storage piles (e)	Total suspended particulate	19	C	0.17	0.33	11.7	10.4

(a) Reference 2; for uncontrolled emissions.
(b) Factors in units of kg/Mg (lb/ton) of material stored and kg per hectare per day (lb per acre per day).
(c) Based on 8 to 12 hours of activity per 24-hour period; includes emissions from wind erosion, vehicle traffic, and material handling.
(d) Emissions due to wind erosion during inactive periods.
(e) Five active days per week.

TABLE 4-2. SUMMARY OF TEST DATA FOR INDUSTRIAL SAND AND GRAVEL PROCESSING

Process	APCD	Pollutant	No. of runs	Data rating	Emission factor						Ref. No.
					kg/Mg			lb/ton			
					Minimum	Maximum	Average	Minimum	Maximum	Average	
Fluidized bed dryer, misc. fuels (a)	WS	filterable PM	12 (b)	B	0.0064	0.058	0.019	0.013	0.12	0.038	6
Dryer/ shaker screens	FF	filterable PM	3	B	0.0026	0.0063	0.0044	0.0053	0.013	0.0089	7
Dryer, diesel fired	FF	formaldehyde	3	B	8.5E-05	0.0047	0.0021	0.00017	0.0093	0.0043	8
		fluoranthene	3	B	8.9E-07	4.1E-06	3.0E-06	1.8E-06	8.3E-06	6.0E-06	8
		naphthalene	3	B	2.0E-05	4.3E-05	2.9E-05	4.0E-05	8.7E-05	5.9E-05	8
		phenanthrene	3	B	8.9E-07	1.1E-05	7.5E-06	1.8E-06	2.2E-05	1.5E-05	8
Sand handling, transfer, and storage	WS	filterable PM	3	B	0.00030	0.00087	0.00064	0.00059	0.0015	0.0013	9
Fluidized bed dryer/ cooler, oil-fired	FF	NOx	3	B	0.014	0.016	0.016	0.029	0.033	0.031	10
		CO2	3	B	11	18	15	21	37	29	10
Fluidized bed dryer/ cooler, oil-fired	FF	filterable PM	3	A	0.0021	0.0083	0.0061	0.0041	0.017	0.012	11
Rotary dryer, gas-fired	none	filterable PM	3	C	0.94	1.1	0.98	1.9	2.1	2.0	12
	WS	filterable PM	3	C	0.089	0.13	0.11	0.18	0.26	0.22	12
Rotary dryer, oil-fired	WS	filterable PM	3	A	0.020	0.022	0.021	0.040	0.043	0.041	13
		CO2	3	A	12	13	13	24	26	25	13
Screening, general	VS	filterable PM	3	B	0.0038	0.0050	0.0042	0.0075	0.010	0.0083	14

APCD = air pollution control device; WS = wet scrubber; FF = fabric filter; VS = venturi scrubber.

NS = not specified.

(a) Two propane-fired, one natural gas-fired, and one No. 2 fuel oil-fired.

(b) Average of four 3-run tests conducted on four dryers.

TABLE 4-3. SUMMARY OF CANDIDATE EMISSION FACTORS FOR SAND AND GRAVEL PROCESSING (a)

Process	Type of control	Pollutant	No. of tests	Average emission factor kg/Mg	lb/ton	Rating	References
INDUSTRIAL SAND AND GRAVEL PROCESSING							
Sand dryer	none	filterable PM	1	0.98	2.0	E	12
Sand dryer	wet scrubber	filterable PM	5	0.019	0.039	C	6, 13
Sand dryer	fabric filter	filterable PM	2	0.0053	0.010	D	7, 11
Sand dryer	none	NOx	1	0.016	0.031	D	10
Sand dryer	none	CO2	2	14	27	D	10, 13
Sand dryer, diesel fired	fabric filter	formaldehyde	1	0.0021	0.0043	D	8
Sand dryer, diesel fired	fabric filter	fluoranthene	1	3.0E-06	6.0E-06	D	8
Sand dryer, diesel fired	fabric filter	naphthalene	1	2.9E-05	5.9E-05	D	8
Sand dryer, diesel fired	fabric filter	phenanthrene	1	7.5E-06	1.5E-05	D	8
Sand handling, transfer, and storage (b)	wet scrubber	filterable PM	1	0.00064	0.0013	D	9
Sand screening (b)	venturi scrubber	filterable PM	1	0.0042	0.0083	D	14

(a) Emission factors for storage in units kg/Mg (lb/ton) of material stored; emission factors for dryers in units of kg/Mg (lb/ton) of dried material produced; emission factors for screening in units of kg/Mg (lb/ton) of material screened.

(b) Dried sand.

necessary data from which comparisons can be made between measured emission rates and the emission rates estimated using the predictive fugitive dust equations presented in AP-42 Section 13.2. For these reasons, the factors developed from the data in Reference 2 were not incorporated in the revised AP-42 section for sand and gravel processing.

Although no other data for construction sand and gravel processing were located in the course of this review, the reader should note that emission factors for crushing, screening, and handling and transfer can be found in Section 11.19.2 of AP-42. In the absence of other data, the emission factors presented in that section can be used to estimate emissions from corresponding sand and gravel processing sources. Emission factors for industrial sand storage and screening, as described below, appear to be based on emissions from dried sand and are not recommended as surrogates for construction sand and gravel processing because they may result in overestimates of emissions from those sources.

4.3.2 Industrial Sand and Gravel

For industrial sand and gravel processing, a total of 15 data sets were available from which emission factors could be developed. From these data sets, candidate emission factors were developed for sand dryers, storage silos, and screening.

4.3.2.1 Sand Dryers. For industrial sand dryers, data were available on emissions for two types of dryers (fluidized bed and rotary) fired with four different fuels (natural gas, propane, oil, and diesel). The pollutants quantified included filterable PM (8 data sets), NO_x (1 data set), CO_2 (2 data sets), and four organic compounds (1 data set each). Multiple data sets were available for the following combinations of sources and controls: wet scrubber-controlled filterable PM emissions, fabric filter-controlled filterable PM emissions, and uncontrolled CO_2 emissions. A review of these data sets indicates that there does not appear to be justification for differentiating between fuel and dryer types with respect to emissions of these pollutants. For example, the filterable PM emission factors for wet scrubber-controlled emissions were determined to be 0.019 kg/Mg (0.038 lb/ton) (fluidized bed dryer, miscellaneous fuels) and 0.021 kg/Mg (0.041 lb/ton) (rotary dryer, oil-fired); for fabric filter-controlled filterable PM, emission factors were 0.0044 kg/Mg (0.0089 lb/ton) (unspecified dryer, fuel) and 0.0061 kg/Mg (0.012 lb/ton) (fluidized bed dryer/cooler, oil-fired); and the CO_2 emission factors were 13 kg/Mg (25 lb/ton) (rotary dryer, oil-fired) and 15 kg/Mg (29 lb/ton) (fluidized bed dryer/cooler, oil-fired). Therefore, these data were combined wherever possible to yield general emission factors for dryers, regardless of dryer type and fuel used. The one exception to this decision is for the data from Reference 8 for organic pollutant emissions from a diesel-fired dryer, as explained below. The following paragraphs describe how the emission factors were developed for the revised AP-42 section.

For uncontrolled filterable PM emissions, there is one C-rated data set (Reference 12) for a gas-fired rotary dryer. This data set was used to develop an E-rated emission factor of 0.98 kg/Mg (2.0 lb/ton).

For wet scrubber-controlled filterable PM emissions, data were available from Reference 6 for four fluidized bed dryers fired with three different fuels (0.019 kg/Mg [0.038 lb/ton]) and from Reference 13 for an oil-fired rotary dryer (0.021 kg/Mg [0.041 lb/ton]). These data were combined to yield a candidate filterable PM emission factor of 0.019 kg/Mg (0.039 lb/ton). Because this emission factor is based on relatively consistent B-rated data from 5 emission tests, it is assigned a rating of C.

For fabric filter-controlled filterable PM emissions, data were available from Reference 7 for an unspecified dryer and screen (0.0044 kg/Mg [0.0089 lb/ton]) and from Reference 11 for an oil-fired fluidized bed dryer/cooler (0.0061 kg/Mg [0.012 lb/ton]). In both cases, it is assumed that the dryers were the primary emission sources. These data were combined to yield a candidate filterable PM emission factor of 0.0053 kg/Mg (0.010 lb/ton). Because this emission factor is based on only two A-/B-rated emission tests, it is assigned a rating of D.

For NO_x emissions from industrial sand dryers, there is one B-rated data set (Reference 10) for an oil-fired fluidized bed dryer/cooler with a fabric filter (0.016 kg/Mg [0.031 lb/ton]). Because fabric filters have negligible effects on NO_x emissions, this emission factor is considered to represent uncontrolled NO_x emissions; it is assigned a rating of D.

For CO_2 emissions from industrial sand dryers, there are two data sets: one B-rated data set from Reference 10 for an oil-fired fluidized bed dryer/cooler (15 kg/Mg [29 lb/ton]) with a fabric filter and one A-rated data set from Reference 13 for an oil-fired rotary dryer (13 kg/Mg [25 lb/ton]) with a wet scrubber. These emission factors were combined to yield a candidate emission factor of (14 kg/Mg [27 lb/ton]) for CO_2 emissions from industrial sand dryers. This emission factor also is considered to represent uncontrolled CO_2 emissions and is assigned a rating of D.

For emissions of organic pollutants from industrial sand dryers, data were available from Reference 8 for four pollutants (formaldehyde, fluoranthene, naphthalene, and phenanthrene) emitted from a diesel-fired dryer of unspecified type. The data are rated B, and the corresponding emission factors are rated D. In all likelihood, the emissions of these pollutants are a function of the fuel used rather than the material dried. Therefore, unlike the other emission factors for industrial sand dryers, these emission factors are considered to be fuel specific.

4.3.2.2 Other Sources. The remaining data sets for industrial sand emissions are from Reference 9 for filterable PM emissions from dried sand handling, transfer, and storage operations controlled with a wet scrubber and from Reference 14 for a screening operation controlled with a venturi scrubber. Both data sets are rated B, and both were used to develop D-rated emission factors.

4.4 SUMMARY OF CHANGES TO AP-42 SECTION

4.4.1 Section Narrative

The process descriptions for both construction sand and gravel and industrial sand and gravel were expanded to provide more details on process operations, equipment used, and emission sources associated with the process. Process flow diagrams for construction sand and gravel and for industrial sand and gravel also were added to the section.

The discussion of emissions and controls for the industry also was modified. The previous AP-42 section included a detailed discussion of using predictive emission factor equations for estimating fugitive dust emissions. Because use of the equations is described in detail in AP-42 Section 13.2, the discussion in this AP-42 section was eliminated; the reader is referred to Section 13.2 for more information on estimating fugitive dust emissions. Finally, the discussion of controls was expanded to include add-on control devices commonly used at industrial sand and gravel processing facilities.

4.4.2 Emission Factors

The previous AP-42 section included emission factors for PM only. All of those emission factors were eliminated from the section. The majority of the factors were omitted because they were based on tests conducted on crushed stone processing sources. However, the reports for those tests were reviewed and incorporated in part in the revised AP-42 Section 11.19.2 on crushed stone processing. In addition, the factors for storage pile emissions were eliminated because the factors actually represented a combination of storage pile wind erosion, material handling, and vehicle traffic, and, thus, their applicability to other storage piles is questionable.

The revised section includes new emission factors developed from emission test reports not previously used for AP-42. All of the new factors are based on emission data for industrial sand processing. In addition to filterable PM, factors are presented for NO_x, CO_2, and four speciated organic pollutants.

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