LIGHTWEIGHT AGGREGATE

A. Commodity Summary

Lightweight aggregates are minerals, natural rock materials, rock-like products, and byproducts of manufacturing processes that are used as bulk fillers in lightweight structural concrete, concrete building blocks, precast structural units, road surfacing materials, plaster aggregates, and insulating fill. Lightweight aggregates are also used in architectural wall covers, suspended ceilings, soil conditioners, and other agricultural uses. Lightweight aggregates may be classified into four groups:

- *Natural lightweight aggregate materials* which are prepared by crushing and sizing natural rock materials, such as pumice, scoria, tuff, breccia, and volcanic cinders.
- *Manufactured structural lightweight aggregates* which are prepared by pyroprocessing shale, clay, or slate in rotary kilns or on traveling grate sintering machines.
- *Manufactured insulating ultralightweight aggregates* which are prepared by pyroprocessing ground vermiculite, perlite, and diatomite.
- *Byproduct lightweight aggregates* which are prepared by crushing and sizing foamed and granulated slag, cinders, and coke breeze.

The first three types of lightweight aggregates are produced from naturally occurring materials while the fourth is produced as a byproduct of iron and steel production. Lightweight aggregates are distinguished from other mineral aggregate materials by their lighter unit weights. Exhibit 1 presents the names and locations of facilities involved in the production of lightweight aggregates from naturally occurring raw materials. Exhibit 2 presents the names of facilities involved in the production of lightweight aggregates from iron and steel slags.

B. Generalized Process Description

Lightweight aggregate materials are produced mainly by two methods. The first method of lightweight aggregate production is from naturally occurring raw materials. The second method is byproduct production from iron and steel production. These processes are quite different and, in order to avoid ambiguity, are described separately below. Section 1 describes lightweight aggregate production from naturally occurring raw materials. Section 2 describes byproduct lightweight aggregate production.

SECTION 1: PRODUCTION FROM NATURALLY OCCURRING RAW MATERIALS

1. Discussion of Typical Production Processes

While natural lightweight aggregates are prepared through basic operations including steps such as mining, grinding, and sizing, manufactured lightweight aggregate and manufactured ultralightweight aggregate products are produced by heating certain types of clay, shale, slate, and other materials in a rotary kiln which forces the materials to expand or "bloat;" resulting in a porous product. The product will retain its physical strength despite its lighter unit weight when cooled.[1] The process is described in more detail below.

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[1] Bruce Mason, "Lightweight Aggregates," from Industrial Minerals and Rocks, 6th ed., Society for Mining, Metallurgy, and Exploration, 1994, pp. 343-350.

EXHIBIT 1

FACILITIES PRODUCING LIGHTWEIGHT AGGREGATES FROM NATURALLY OCCURRING RAW MATERIALS

Facility Name	Location
Arkansas Lightweight Aggregate	West Memphis, AR
Big River	Livingstone, AL
Big River	Erwinville, LA
Buildex	Dearborn, MO
Buildex	Ottawa, KS
Buildex	Marquette, KS
Chandler Materials Co.	Tulsa, OK
Chandler Materials Co.	Choctaw, OK
Dakota Block Co.	Rapid City, SD
Featherlite	Strawn (Ranger), TX
HP Brick Co.	Brooklyn, IN
HP Brick Co.	Independence, OH
Jackson Concrete	Jackson, MS
Kanta	Three Forks, MT
Lehigh Portland Cement Co.	Woodsboro, MD
Lorusso Corp.	Plainville, MA
Norlite	Cohoes, NY
Parkwood Lightweight Plant	Bessemer, AL
Porta Costa	Porta Costa, CA
Ridgelite	Frazier Park, CA
Solite	Cascade, VA
Solite	Arvonia, VA
Northeast Solite	Mount Marion, NY
Carolina Solite	Norwood, NC
Kentucky Solite	Brooks, KY
Florida Solite	Green Cove, FL
Strawn	Strawn, TX
Texas Industries	Streetman, TX
Utelite	Coalville, UT
Weblite	Blue Ridge, VA

Source: Determination of Waste Volume for Twenty Conditionally Retained Bevill Mineral Processing Wastes, 1990, pp. 5-9, A10.

Facilities that burn hazardous waste fuels are shaded.

EXHIBIT 2

BYPRODUCT LIGHTWEIGHT AGGREGATE PRODUCERS

Facilities	Location
Waylite Corporation	Bethlehem, PA
Standard LaFarge Corporation	Cleveland, OH
Edward C. Levy Company	Detroit, MI
Koch Minerals	Gary, IN

2. Generalized Process Flow Diagram

Naturally occurring lightweight aggregate raw materials, such as pumice and volcanic cinders, are normally mined by open pit or quarry methods, depending on the degree of consolidation of the raw materials. Shale, clay, and slate mined by open pit and quarry methods are dried in large sheds or open stockpiles to control water content in the raw feed prior to high temperature pyroprocessing in either rotary kilns or sintering machines. The resulting clinker may then be crushed before screening to yield proper gradation mixes for final use. Most lightweight aggregate plants use coal as a primary source of fuel. Waste-derived fuels and solvents from various industrial processes are also used as alternate fuel sources at a few locations (e.g., those operated by Solite and Norlite). Exhibit 3 presents a typical process flow diagram for lightweight aggregate production for facilities using a wet scrubber air pollution control technology or a dry collection method. All facilities currently use dry collection systems.

3. Identification of Novel (or otherwise distinct) Processes

None identified.

4. Beneficiation/Processing Boundaries

EPA established the criteria for determining which wastes arising from the various mineral production sectors come from mineral processing operations and which are from beneficiation activities in the September 1989 final rule (see 54 Fed. Reg. 36592, 36616 codified at 261.4(b)(7)). In essence, beneficiation operations typically serve to separate and concentrate the mineral values from waste material, remove impurities, or prepare the ore for further refinement. Beneficiation activities generally do not change the mineral values themselves other than by reducing (e.g., crushing or grinding), or enlarging (e.g., pelletizing or briquetting) particle size to facilitate processing. A chemical change in the mineral value does not typically occur in beneficiation.

Mineral processing operations, in contrast, generally follow beneficiation and serve to change the concentrated mineral value into a more useful chemical form. This is often done by using heat (e.g., smelting) or chemical reactions (e.g., acid digestion, chlorination) to change the chemical composition of the mineral. In contrast to beneficiation operations, processing activities often destroy the physical and chemical structure of the incoming ore or mineral feedstock such that the materials leaving the operation do not closely resemble those that entered the operation. Typically, beneficiation wastes are earthen in character, whereas mineral processing wastes are derived from melting or chemical changes.

EPA approached the problem of determining which operations are beneficiation and which (if any) are processing in a step-wise fashion, beginning with relatively straightforward questions and proceeding into more detailed examination of unit operations, as necessary. To locate the beneficiation/processing "line" at a given facility within this mineral commodity sector, EPA reviewed the detailed process flow diagram(s), as well as information on ore type(s), the functional importance of each step in the production sequence, and waste generation points and quantities presented above in Section B.

EPA determined that for the production of lightweight aggregates from naturally ocurring raw materials, the beneficiation/processing line occurs after drying at the kiln/sinter machine because the elevated temperatures destroy the physical structure of the raw material. Therefore, because EPA has determined that all operations following the initial "processing" step in the production sequence are also considered processing operations, irrespective of whether they involve only techniques otherwise defined as beneficiation, all solid wastes arising from any such operation(s) after the initial mineral processing operation are considered mineral processing wastes, rather than beneficiation wastes. EPA presents below the mineral processing waste streams generated after the beneficiation/processing line, along with associated information on waste generation rates, characteristics, and management practices for each of these waste streams.

SECTION 2: BYPRODUCT PRODUCTION

1. Discussion of Typical Production Processes

Both expanded slag and air-cooled slag are lightweight aggregate products produced as byproducts from iron and steel production. The process is described below.

2. Generalized Process Flow Diagram

Expanded slag and air-cooled slag are byproducts of iron and steel production. Expanded slag is manufactured by spraying a stream of water through molten blast furnace slag as it is drawn from the furnace. The resulting foamed slag is crushed and screened for use in concrete block or structural concrete. Air-cooled slag is manufactured by pouring molten blast furnace slag into pits where it is cooled by water. It is then excavated, crushed, and screened.[2] Iron and steel slags may be considered special wastes, and were addressed in the 1990 Report to Congress on Special Wastes from Mineral Processing. Exhibits 4 and 5 present flow diagrams for expanded slag and air-cooled slag, respectively.

3. Identification of Novel (or otherwise distinct) Processes

None identified.

4. Extraction/Beneficiation Boundaries

Since lightweight aggregates are recovered as by-products of other metals, all of the wastes generated during lightweight aggregate recovery are mineral processing wastes. For a description of where the beneficiation/processing boundary occurs for this mineral commodity, see the report for iron and steel presented elsewhere in this document.

C. Process Waste Streams

1. Extraction/Beneficiation Wastes

The preparation of natural lightweight aggregate materials only generates extraction/beneficiation wastes since no thermal processes are involved. However, production of manufactured lightweight aggregates generates both extraction/beneficiation and mineral processing wastes. **Overburden** and **screenings** are generated from the mining and extraction of lightweight aggregate minerals. These materials are likely left in place at the original mining site.

2. Mineral Processing Wastes

The hazardous wastes generated from lightweight aggregate production are not "newly identified mineral processing wastes" and are therefore outside the scope of this report. However, a description of these wastes is included.

Production From Naturally Occurring Raw Materials

Hazardous waste fuels may be used in the production of lightweight aggregates. Therefore, some of the waste streams discussed below would be considered hazardous through application of the derived-from rule. Likely waste-derived fuels are high in Btu and oily substances. Waste generated from this process may contain metals, semivolatiles, and dioxins/furans. Six facilities burn listed hazardous waste as fuel in their kilns. These facilities are Carolina Solite, Florida Solite, Kentucky Solite, Norlite, and the two Solite facilities in Virginia.[3] However, the Solite facility in Cascade, VA generates no waste because all the APC dust that is generated is returned to the operation.

Air pollution control scrubber water and solids. This waste is no longer generated since all facilities now use dry collection systems. Kilns equipped with wet scrubbers generated scrubber wastewater which contained particles from the kiln. In 1989, 18 of the active facilities used wet scrubbers for air pollution control. Lightweight aggregate production for these 18 facilities ranged from 23,123 to 907,185 mt/y, and the volume of scrubber solids generated ranged from 104 to 61,235 mt/y. Generally, the scrubber solids were managed in settling ponds, surface impoundments,

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[2] Bruce Mason, 1994, Op. Cit., pp. 343-350.

[3] U.S. Environmental Protection Agency, Addendum to the Technical Background Document, Development of the Cost and Economic Impacts of Implementing the Bevill Mineral Processing Wastes Criteria, Office of Solid Waste, 1990.

or landfills where dewatering occurred and the particulate matter settled out in the form of sludge.[4] In 1989, this waste was generated at a rate of 2,420,000 mt/y.[5] Attachment 1 presents waste characterization data for this waste stream. Although this waste stream is no longer generated, Exhibit 6 presents facility specific management information as well as generation rates and waste characteristics for the facilities that do not burn hazardous waste fuels in their kilns.

Because of the derived-from rule, scrubberwater and solids would have been considered a hazardous waste at the five facilities that used wet scrubbers and burn hazardous waste fuels in their kilns. Although this waste is no longer generated, Exhibit 7 presents waste generation rates for these five facilities.

Air pollution control dust/sludge. Lightweight aggregate facilities that use baghouses and other dry collection systems generate APC dust that is collected in dry form. Some facilities using dry collection systems recycle the dust to the process or use it in products (e.g., block mix). At Arkansas Lightweight Aggregate Corporation, particulate matter that is too fine to continue on in the kilning process is exhausted in the mechanical dust collector. After filtering, the waste dust drops into conical piles beneath the collector. Three piles collect beneath the collector, one consisting of heavier particles and two consisting of lighter particles. This waste is collected by a shovel loader and placed in a waste water

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[4] U.S. Environmental Protection Agency, 1990, Op. Cit., pp. 5-9, A10.

[5] U.S. Environmental Protection Agency, Newly Identified Mineral Processing Waste Characterization Data Set, Office of Solid Waste, 1992, Vol. I, pp. I-2 - I-8.

EXHIBIT 3

LIGHTWEIGHT AGGREGATE PROCESS FLOW DIAGRAM

Graphic Not Available.

EXHIBIT 4

EXPANDED SLAG PROCESS FLOW DIAGRAM

Graphic Not Available.

EXHIBIT 5

AIR-COOLED SLAG PROCESS FLOW DIAGRAM

Graphic Not Available.

EXHIBIT 6

APC SCRUBBERWATER AND SOLIDS AT FACILITIES NOT USING WASTE-DERIVED FUELS

Facility	RTI ID#	1988 Generation	pH	Management Practices
Buildex, Dearborn, MO	100685	Wastewater: 8,784,000 gallons	5.8	Sent to bedrock lined surface impoundment for settling
Chandler Materials, Tulsa, OK	101725	Wastewater: 17,900,000 gallons Solids: 177 cubic yards	5.5	Sent to bedrock lined surface impoundment for solids precipitation
Chandler, Choctaw, OK	101766	Wastewater: 14,100,000 gallons	5.6	Sent to in-situ clay lined surface impoundment for solids precipitation
Featherlite, Strawn, TX	101659	Wastewater: 4,535 mtons	NA	Sent to in-situ clay lined surface impoundment for solids precipitation
HP Brick, Brooklyn, IN	100263	Wastewater: 9,071 mtons	5.5	Sent to in-situ shale lined surface impoundment for dewatering
Texas Industries, Streetman, TX	101808	Wastewater: 250,000,000 gallons	9.94	Sent to in-situ clay lined surface impoundment for solids precipitation
Porta Costa, Porta Costa, CA	100792	Wastewater: 600 gallons	7.2	Sent to in-situ clay lined surface impoundment for water evaporation and solids recycling
Parkwood, Bessemer, AL	100180	Wastewater: 8,981 mtons	NA	Sent to bedrock lined surface impoundment for solids precipitation and pH adjustment with caustic soda
Jackson Ready Mix Concrete, Jackson, MS	100438	Wastewater: 104 mtons	NA	Sent to recompacted local clay lined surface impoundment for solids precipitation
Big River, Livingston, AL	NA	NA	NA	NA
Big River, Erwinville, LA	NA	NA	NA	NA
Arkansas Lightweight Aggregate, West Memphis, AR	NA	NA	NA	NA
NE Solite, Mt. Marion, NY	NA	NA	NA	NA

SOURCE: 1988 RTI Surveys.

EXHIBIT 7

APC SCRUBBERWATER AND SOLIDS AT FACILITIES USING WASTE-DERIVED FUELS

Facility	Location	APC Scrubberwater and Solids (mt/y)	Percent Solids	APC Dust/Sludge (mt/y)

Carolina Solite	Norwood, NC	923,902	40	369,561
Florida Solite	Green Cove, FL	478,751	40	191,500
Kentucky Solite	Brooks, KY	224,541	40	89,816
Norlite	Cohoes, NY	NA	NA	NA
Solite	Arvonia, VA	NA	NA	NA

SOURCE: Determination of Waste Volumes for Twenty Conditionally Retained Bevill Mineral Processing Wastes, EPA, Office of Solid Waste, January, 1990.

pond/lagoon area onsite. The wet scrubber at the Arkansas facility operates for particulate removal only; no chemical treatment of water occurs.[6]

This waste would be considered a hazardous waste at facilities that burn hazardous waste fuels because of the derived-from rule. These facilities are identified in Exhibit 1. The Solite facility in Cascade, VA does not generate this waste since all APC dust is returned to the process. Exhibit 7 presents waste generation rates for these five facilities.

Wastewater treatment plant (WWTP) liquid effluent. Attachment 1 presents waste characterization data for this waste stream. In 1991, the waste generation rate for this waste stream was 1,094,000 metric tons per year.[7] At the Carolina Solite facility in Norwood, NC., WWTP liquid effluent is discharged under an NPDES.[8] This waste is not expected to be hazardous.

Surface impoundment waste liquids. Attachment 1 presents characterization data for this waste stream. The generation rate for this waste stream is 2,571,00 metric tons per year[9] (adjusted from a reported value to reflect recent changes in the sector). This waste is discharged under an NPDES at the Carolina Solite in Norwood, NC and the Norlite Corporation in Cohoes, NY.[10] This waste is not expected to be hazardous.

Byproduct Production

Waste streams from byproduct production of lightweight aggregate products from iron and steel production include **cooling water** and **slag**. These wastes are not expected to be hazardous.

D. Ancillary Hazardous Wastes

Ancillary hazardous wastes may be generated at on-site laboratories, and may include used chemicals and liquid samples. Other hazardous wastes may include spent solvents (e.g., petroleum naptha), acidic tank cleaning wastes, and polychlorinated biphenyls from electrical transformers and capacitors. Non-hazardous wastes may include tires from trucks and large machinery, sanitary sewage, waste oil (which may or may not be hazardous) and other lubricants.

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[6] U.S. Environmental Protection Agency, 1990, Op. Cit., pp. 5-9, A10.

[7] U.S. Environmental Protection Agency, 1990, Op. Cit., pp. 5-9, A10.

[8] U.S. Environmental Protection Agency, Newly Identified Mineral Processing Waste Characterization Data Set, Office of Solid Waste, 1992, Vol. II, pp. 22-1 - 22-19.

[9] U.S. Environmental Protection Agency, 1990, Op. Cit., pp. 5-9, A10.

[10] U.S. Environmental Protection Agency, 1992, Op. Cit., Vol. II, pp. 22-1 - 22-19.

BIBLIOGRAPHY

Mason, Bruce H., "Lightweight Aggregates." From Industrial Minerals and Rocks. 6th ed. Society for Mining, Metallurgy, and Exploration. 1994. pp. 343-350.

U.S. Environmental Protection Agency. Newly Identified Mineral Processing Waste Characterization Data Set. Office of Solid Waste. Volume I. August 1992. pp. I-2 - I-8.

U.S. Environmental Protection Agency. Newly Identified Mineral Processing Waste Characterization Data Set. Vol. II. Office of Solid Waste. August 1992. pp. 22-1 - 22-19.

U.S. Environmental Protection Agency. Addendum to the Technical Background Document, Development of the Cost and Economic Impacts of Implementing the Bevill Mineral Processing Wastes Criteria, Office of Solid Waste. 1990.

U.S. Environmental Protection Agency, Mining Industry Profile, Lightweight Aggregate, Office of Solid Waste, November 9, 1990, pp. 31-33.

U.S. Environmental Protection Agency. Determination of Waste Volume for Twenty Conditionally Retained Bevill Mineral Processing Wastes. Office of Solid Waste. 1990. pp. 5-9, A10.

U.S. Environmental Protection Agency. Mineral Processing Wastes Sampling Survey Trip Reports. Arkansas Lightweight Aggregate Corporation, West Memphis, AR. August 1989.