APPENDICES

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX A

Detailed Explanations of Methodology Used to Estimate Annual Waste Generation Rates For Individual Waste Streams

Introduction

Due to the paucity of data for several of the mineral commodity sectors and waste streams, we developed a step-wise method for mineral processing waste volume estimation. We developed an "expected value" estimate for each waste generation rate using draft industry profiles, supporting information, process flow diagrams, and professional judgment. From the "expected value" estimate, we developed upper and lower bound estimates, which reflect the degree of uncertainty in our data and understanding of a particular sector, process, and/or waste in question. For example, we obtained average or typical commodity production rates from published sources (e.g., BOM Mineral Commodity Summaries) and determined input material quantities or concentration ratios from published market specifications. In parallel with this activity, we reviewed process flow diagrams for information on flow rates, waste-to-product ratios, or material quantities. We then calculated any additional waste generation rates and subtracted out known material flows, leaving a defined material flow, which we allocated among waste streams using professional judgment. Finally, we assigned a high, medium, and low volume estimate for each waste stream.

A key element in developing waste generation rates was the fact that by definition, average facility level generation rates of solids and sludges are less that 45,000 metric tons/year, and generation rates of wastewaters are less than 1,000,000 metric tons/year. Using this fact, in the absence of any supporting information, high values for solids and sludges were set at the highest waste generation rate found in the sector in question or 45,000 metric tons/year/facility, whichever is lower.

Precise methodology for determining waste generation rates varied depending on the quantity and quality of available information. The waste streams for which we had no published annual generation rate were divided into five groups and a methodology for each group was assigned.

1. **Actual generation rates for the waste in question from one or more facilities were available.** We extrapolated from the available data to the sector on the basis of waste-to-product ratios to develop the expected value, and used a value of +/- 20% of the expected value to define the upper and lower bounds.

2. **A typical waste-to-product ratio for the waste in question was available.** We multiplied the waste-to-product ratio by sector production (actual or estimated) to yield a sector wide waste generation expected value, and used one-half and twice this value for the lower and upper bounds, respectively.

3. **No data on the waste in question were available , but generation rates for other generally comparable wastes in the sector were.** We used the maximum and minimum waste generation rates as the upper and lower bounds, respectively, and defined the expected value as the midpoint between the two ends of the range. Adjustments were made using professional judgment if unreasonable estimates resulted from this approach.

4. **No data were available for any analogous waste streams in the sector, or information for the sector generally was very limited.** We drew from information on other sectors using analogous waste types and adjusting for differences in production rates/material throughput. We used upper and lower bound estimates of one order of magnitude above and below the expected value derived using this approach. Results were modified using professional judgment if the results seemed unreasonable.

5. **All we knew (or suspected) was the name of the waste.** We used the high value threshold (45,000 metric tons/year/facility or 1,000,000 metric tons/year/facility) as the maximum value, 0 or 100 metric tons per year as the minimum, and the midpoint as the expected value.

Detailed explanations of the methodology used for each waste generation rate estimate follow.

1997 UPDATE

Several of the waste generation rate estimates detailed below have been revised since December 1995 (the date of initial publication of this appendix) due to comments received on the January 25, 1996 Supplemental Proposed Rule Applying Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes and the May 12, 1997 Second Supplemental Proposed Rule Applying Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes, as well as other new information received by the Agency. Changes to waste generation rate estimates are summarized in Exhibit A-1.

EXHIBIT A-1

CHANGES TO WASTE GENERATION RATE ESTIMATES SINCE DECEMBER 1995

Sector -- *Waste Stream*	**1995 Generation Rate Estimate (mt/yr)**	**Current Generation Rate Estimate (mt/yr)**
Antimony -- *Autoclave Filtrate*	High: 64,000 Medium: 32,000 Low: 380	High: 54,000 Medium: 27,000 Low: 320
Beryllium -- *Chip Treatment Wastewater*	High: 1,000,000 Medium: 50,000 Low: 100	High: 2,000,000 Medium: 100,000 Low: 200
Beryllium -- *Filtration Discard*	High: 45,000 Medium: 23,000 Low: 100	High: 90,000 Medium: 45,000 Low: 200
Chromium and Ferrochromium -- *GCT Sludge*	Not Included	High: 3,000 Medium: 300 Low: 30
Elemental Phosphorous -- *Furnace Scrubber Blowdown*	High: 270,000 Medium: 0 Low: 0	High: 410,000 Medium: 410,000 Low: 410,000
Lead -- *Stockpiled Miscellaneous Plant Waste*	High: 180,000 Medium: 90,200 Low: 400	High: 130,000 Medium: 67,000 Low: 300
Molybdenum, Ferromolybdenum, and Ammonium Molybdate -- *Flue Dust/Gases*	High: 540,000 Medium: 270,000 Low: 1,200	High: 500,000 Medium: 250,000 Low: 1,100
Rare Earths -- *Solvent Extraction Crud*	High: 90,000 Medium: 45,000 Low: 200	High: 4,500 Medium: 2,300 Low: 100
Tellurium -- *Slag*	High: 4,500 Medium: 1,000 Low: 100	High: 9,000 Medium: 2,000 Low: 200
Tellurium -- *Solid Waste Residues*	High: 4,500 Medium: 1,000 Low: 100	High: 9,000 Medium: 2,000 Low: 200

EXHIBIT A-1 (continued)

Sector -- *Waste Stream*	**1995 Generation Rate Estimate (mt/yr)**	**Current Generation Rate Estimate (mt/yr)**
Tellurium -- *Waste Electrolyte*	High: 10,000 Medium: 1,000 Low: 100	High: 20,000 Medium: 2,000 Low: 200
Tellurium -- *Wastewater*	High: 20,000 Medium: 10,000 Low: 100	High: 40,000 Medium: 20,000 Low: 200
Tungsten -- *Process Wastewater*	High: 7,300 Medium: 3,700 Low: 1,800	High: 9,000 Medium: 4,400 Low: 2,200

ANTIMONY

Autoclave Filtrate:	High:	64,000 mt/yr (32,000 * 2)
	Medium:	32,000 mt/yr ((64,000 + 380)/2)
	Low:	380 mt/yr (190 * 2)

A high of twice the highest waste generation rate in the sector was selected since this is a liquid waste stream. Similarly, the low was set equal to twice the lowest waste generation rate in the sector.

The waste stream may be corrosive (Table A, Text) and contains arsenic, cadmium, lead, and mercury at concentrations that may exceed TC levels.

BERYLLIUM

Chip Treatment Wastewater:	High:	1,000,000 mt/yr
	Medium:	50,000 mt/yr
	Low:	100 mt/yr

There was no information on the generation rates of this waste.

This waste may contain chromium above TC concentrations.

Filtration Discard:	High:	45,000 mt/yr
	Medium:	23,000 mt/yr
	Low:	100 mt/yr

There was no information on the generation rates of this waste.

This waste may contain lead above TC concentrations.

BISMUTH

Alloy Residues:	High:	6,000 mt/yr (3,000 * 2 * 1 facility)
	Medium:	3,000 mt/yr
	Low:	100 mt/yr

Comparing with the metal chlorides residue waste stream shown in Table (avg. waste generation rate = 3,000 mt/yr). Lower and upper bounds of 100 mt/yr and twice the medium value were used instead of an order of magnitude above and below the expected value since production rates are low (1,450 mt/yr).

Waste stream may contain lead since the process uses lead as the starting material.

Spent Caustic Soda:	High:	12,000 mt/yr (6,000 * 2 * 1 facility)
	Medium:	6,100 mt/yr ((12,000 + 100)/2)
	Low:	100 mt/yr (100* 1 facility)

No information about the waste stream was available. A high of 12,000 mt/yr was selected since low production rates (1,450 mt/yr) in the sector are expected to yield low waste generation rates. The low value was estimated as 100 mt/yr.

Common sense suggests that if large volumes of chemicals were being wasted, the process would not be economical. If large amounts of waste containing chemicals was being generated, the chemicals would probably be recovered.

Waste stream may contain lead since the process uses lead as the starting material.

Electrolytic Slimes:	High:	200 mt/yr (100 * 2 * 1 facility)
	Medium:	20 mt/yr
	Low:	0 (i.e., waste stream is reprocessed)

A low of zero was selected since the slimes are likely to be reprocessed (Text, Section C.2).

Total consumption in 1993 was only 1,450 mt. This was compared to the electrolytic waste stream (waste/product = .014) in the aluminum sector (1450 * .014 = 20 mt/yr). Upper bound of one order of magnitude above the estimate was selected to account for any differences in the waste streams.

Waste stream may contain lead since the process uses lead as the starting material.

Lead & Zinc Chlorides:	High:	6,000 mt/yr (3,000 * 2 * 1 facility)
	Medium:	3,000 mt/yr
	Low:	100 mt/yr

Comparing with the metal chlorides residue waste stream shown in Table (avg. waste generation rate = 3,000 mt/yr). Lower and upper bounds of 100 mt/yr and twice the medium value were used instead of an order of magnitude above and below the expected value since production rates are low (1,450 mt/yr).

Waste stream contains lead.

Slag:	High:	10,000 mt/yr
	Medium:	1,000 mt/yr
	Low:	100 mt/yr

Comparing with the Slag waste stream in the antimony sector (waste/product = 32,000/44,600 = 0.717), the medium value was calculated as (1,450 * 0.717 = 1,040). Upper and lower bound estimates of one order of magnitude above and below the expected value were used.

Waste stream contains lead.

Spent Electrolyte:	High:	12,000 mt/yr (3,000 mt/yr * 4)
	Medium:	6,100 mt/yr ((12,000 + 100)/2)
	Low:	100 mt/yr (100 * 1 facility)

Low production rates in the sector indicate that the waste generation rates will be low, therefore, a high value of four times the highest waste generation rate in the sector was selected.

Common sense suggests that if large volumes of chemicals were being wasted, the process would not be economical. If large amounts of waste containing chemicals was being generated, the chemicals would probably be recovered.

Waste stream may contain lead since the process uses lead as the starting material.

Spent Soda Solution:	High:	12,000 mt/yr (3,000 mt/yr * 4)
	Medium:	6,100 mt/yr ((12,000 + 100)/2)
	Low:	100 mt/yr (100 * 1 facility)

See previous comments.

Waste stream may be corrosive (engineering judgment) and may contain lead since the process uses lead as the starting material.

Waste Acid Solutions:	High:	12,000 mt/yr
	Medium:	6,100 mt/yr ((12,000 + 100)/2)
	Low:	100 mt/yr (100 * 1 facility)

See previous comments.

Waste stream may be corrosive (engineering judgment). No further information which may classify the waste stream as hazardous was found.

Waste Acids:	High:	200 mt/yr (100 * 2 * 1 facility)
	Medium:	100 mt/yr
	Low:	0

Text, Section C.2. Waste acids are neutralized and discharged with water. Therefore, a low of 0 was selected.

Waste stream may be corrosive (engineering judgment). No further information which may classify the waste stream as hazardous was found.

BORON

Waste Liquor:	High:	300,000 (100,000 * 3 Facilities)
	Medium:	150,000 mt/yr ((300,000 + 300)/2)
	Low:	300 mt/yr (100 * 3 Facilities)

Since some waste liquor may be recycled (text), the high waste generation rate was set at 100,000 mt/yr.

This waste is expected to exhibit the characteristic of toxicity for arsenic.

CADMIUM

Methodology for estimating waste generation rates for the waste streams listed below is provided at the end of the sector.

Caustic Washwater:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium and/or be corrosive.

Copper and Lead Sulfate Filter Cakes:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium and/or lead.

Copper Removal Filter Cake:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium.

Iron Containing Impurities:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium.

Spent Leach Solutions:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for arsenic, cadmium, and/or lead and/or may be corrosive.

Lead Sulfate Waste:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium and/or lead.

Post-Leach Filter Cake:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium.

Spent Purification Solution:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium and/or be corrosive.

Scrubber Wastewater:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium and/or be corrosive.

Spent Electrolyte:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium and/or be corrosive.

Zinc Precipitates:	High:	19,000 mt/yr
	Medium:	1,900 mt/yr
	Low:	190 mt/yr

This waste may be toxic for cadmium.

According to RTC II (Report to Congress on Solid Wastes from Selected Metallic Ore Processing Operations; Technical Memorandum for the Zinc Sector, 1988), saleable metallic residues from both electrolytic and pyrometallurgical production of zinc amounts to .127 ton/ton product. This document also cites a production capacity for the sector of 400,000 metric tons, 83% of which is utilized. This amounts to a production rate of 332,000 metric tons per year of zinc. Using the above waste-to-product ratio, 42,164 metric tons of saleable metallic residues are generated per year. These metallic residues are used for cadmium recovery as well as the recovery of other heavy metals. Therefore, given an input of 42,164 metric tons and assuming a process efficiency of 50%, 21,082 metric tons of cadmium waste are generated annually. Assuming each of the 11 wastes from cadmium production is generated equally, a medium annual waste generation rate for each cadmium waste is 1,900 metric tons. The high estimate is one order of magnitude above the medium estimate and the low estimate is one order of magnitude below the medium estimate.

COAL GASIFICATION

MEE Concentrate:	High:	65,000 mt/yr
	Medium:	0 mt/yr
	Low:	0 mt/yr

This waste is most likely entirely recycled. Therefore, both the minimum and medium value of MEE Concentrate were estimated to be 0. The maximum generation rate was set at 64,600 mt/yr, based on a ratio of Cooling tower blowdown/MEE Concentrate of 500 gpm/50 gpm, and a cooling tower blowdown generation rate of 646,000 mt/yr.

This waste may contain arsenic and selenium above TC concentrations.

COPPER

Scrubber Blowdown:	High:	4,900,000 mt/yr
	Medium:	490,000 mt/yr
	Low:	49,000 mt/yr

This waste is similar to acid plant blowdown, but will be generated at a lower volume. Therefore, we assumed the medium value to be 10 percent of the acid plant blowdown. The minimum and maximum values are one order of magnitude below and above this rate, respectively.

This waste may contain arsenic, cadmium, mercury, and selenium above TC concentrations.

APC Dust/Sludge:	High:	450,000 mt/yr
	Medium:	220,000 mt/yr
	Low:	1,000 mt/yr

There was no information available for this waste stream so the minimum, medium, and maximum values were set at 100; 22,000; and 45,000 mt/y, respectively. These rates apply to 10 facilities so the sector wide generation rates were calculated to be the above values.

ELEMENTAL PHOSPHORUS

Furnace Scrubber Blowdown:	High:	270,000 mt/yr
	Medium:	0 mt/yr
	Low:	0 mt/yr

The Newly Identified Waste Characterization Data Set Reports that 680,000 mt/yr of Furnace Scrubber Blowdown was generated in 1989. This generation rate corresponds to 5 facilities. Today, there are only 2 facilities producing elemental phosphorous furnace scrubber blowdown. The 680,000 mt/yr value was readjusted as follows:

(680,000)/5 = 136,000

136,000 * 2 = 270,000 mt/yr

This waste stream may be treated prior to discharge, therefore, a generation rate of 0 mt/yr was selected for the low and medium estimates.

This waste may is corrosive and toxic for cadmium.

Slag Quenchwater:	High:	1,000,000 mt/yr
	Medium:	0 mt/yr
	Low:	0 mt/yr

Default rate is 1,000,000 mt/yr per facility. Since the generation rate is not expected to be nearly this high, half the default value was selected. Since there are two facilities, a maximum of 1,000,000 mt/yr was selected. Low and medium estimates were set at 0 mt/yr, since this waste may be treated prior to discharge.

This waste stream is toxic for cadmium and lead.

FLUORSPAR AND HYDROFLUORIC ACID

Off-Spec Fluosilicic Acid:	High:	44,000 mt/yr
	Medium:	15,000 mt/yr
	Low:	0 mt/yr

To estimate the maximum quantity of this waste, we assumed the entire three percent of impurity in acid grade fluorspar was silicon, and that this was the only source of silicon. Therefore, at Allied Signal three percent of 209,839 short tons fluorspar would be 6,295 short tons. If all of this silicon reacted to form fluosilicic acid (H_2SiF_6), approximately 32,297 short tons (29,299 metric tons) could be formed at one plant. However, the waste is off-spec fluosilicic acid, so we assumed that 50 percent could be sold, and there are three facilities in the sector. So the maximum value for industry is 43,950 mt/yr. We assumed the medium value to be one-third of the maximum, representing only one percent silicon in the acid grade fluorspar. Finally, since it is possible to sell this waste as a product, the minimum generation rate was assumed to be 0 mt/yr.

This waste may exhibit the hazardous characteristic of corrosivity.

GERMANIUM

Waste Acid Wash & Rinse Water:	High:	4,000 mt/yr (1,000 * 4 facilities)
	Medium:	2,200 mt/yr ((4,000 + 400)/2)
	Low:	400 mt/yr (100 * 4 facilities)

A high rate of 1,000 was selected which is three orders of magnitude below the average facility generation rate (1,000,000 mt/yr) since the annual consumption rate is only 25 metric tons/yr. The low estimate was set at 100 mt/yr.

Since Hydrofluoric Acid is very expensive and the water is being used for rinsing only, the volume of waste produced is expected to be low. Also, the total consumption rate in 1993 was 25,000 kg (25 mt) (text). Assuming that all of this was produced domestically, low waste generation rates are expected.

We used engineering judgment to determine that this waste stream may be corrosive and toxic (arsenic, cadmium, chromium, lead, selenium, and silver).

Chlorinator Wet APC Sludge:	High:	400 mt/yr (100 * 4 facilities)
	Medium:	210 mt/yr ((400 + 10)/2)
	Low:	10 mt/yr

A high rate of 100 was selected based on the low consumption rates (25 mt/yr). The low was set equal to the highest known production rate in the sector.

Since the wet APC system is primarily being used to control fumes, and concentrated germanium is being used in the process (as compared to germanium with lot of impurities), the sludge generated is expected to be low to medium in volume.

We used engineering judgment to determine that this waste stream may be toxic (arsenic, cadmium, chromium, lead, selenium, and silver).

Hydrolysis Filtrate:	High:	400 mt/yr (100 * 4 facilities)
	Medium:	210 mt/yr ((400 + 10)/2)
	Low:	10 mt/yr

A high rate of 100 was selected based on the low consumption rates (25 mt/yr). The low was set equal to the highest known production rate (10 mt/yr) in the sector.

We used engineering judgment to determine that this waste stream may be toxic (arsenic, cadmium, chromium, lead, selenium, and lead).

Spent Acid/Leachate:	High:	4,000 mt/yr (1,000 * 4 facilities)
	Medium:	2,200 mt/yr ((4,000 + 400)/2)
	Low:	400 mt/yr (100 * 4 facilities)

A high rate of 1,000 was selected which is three orders of magnitude below the average facility generation rate (1,000,000 mt/yr) since the annual consumption rate is only 25 tons/yr. The low estimate was set at 100 mt/yr.

Waste stream may be corrosive and toxic (arsenic and lead).

Waste Still Liquor:	High:	400 mt/yr (100 * 4 facilities)
	Medium:	210 mt/yr ((400 + 10)/2)
	Low:	10 mt/yr

A high rate of 100 was selected based on the low consumption rates (25 mt/yr). The low was set equal to the highest known production rate in the sector.

Waste stream may be ignitable (engineering judgment) and toxic (arsenic, cadmium, chromium, lead, selenium, and silver).

GOLD AND SILVER

Spent Furnace Dusts, Refining Wastes, Slag, and Wastewater Treatment Sludge:	High:	720,000 mt/yr
	Medium:	360,000 mt/yr
	Low:	100 mt/yr

By definition, average facility-level generation rates of solids and sludges are less than 45,000 metric tons. Therefore, due to lack of more precise information, this was used as a high-end in order to estimate waste generation rates for spent furnace dusts, refining wastes, slag, and wastewater treatment sludge from gold and silver production. There are 16 known gold and silver smelters and refineries. Therefore a high-end estimate of 720,000 metric tons, a low-end estimate of 100 metric tons, and a medium estimate of 360,000 metric tons (the midpoint between the high and low estimates) were set for the wastes.

Each of these wastes may be toxic for silver.

Wastewater:	High:	1,700,000 mt/yr
	Medium:	870,000 mt/yr
	Low:	440,000 mt/yr

According to the Effluent Guidelines, 1989, wastewater generated from the production of gold and silver is made up of wastewater from electrolyte preparation wet air pollution control, smelter wet air pollution control, silver chloride reduction spent solution, and electrolytic cells wet air pollution control. These are generated at the following waste-to-product ratios:

- Electrolyte preparation wet APC: .05 L/troy ounce silver in electrolyte
- Smelter wet APC: 6.73 L/troy ounce gold and silver smelted
- Silver chloride reduction spent solution: .4 L/troy ounce silver reduced
- Electrolytic cells wet APC: 19 L/troy ounce gold refined electrolytically

Gold and silver production rates of 2.10 million troy ounces and 59.3 million troy ounces, respectively, were used. These yield wastewater generation rates of 3,517; 791,912; 28,136; and 47,328 metric tons. Therefore, the medium estimate of total waste generation for wastewater is the sum of these four, 870,893 metric tons. One-half and twice the medium value were assigned as lower and upper bounds, respectively.

This waste may be toxic for arsenic, cadmium, chromium, lead, and/or silver.

LEAD

Baghouse Incinerator Ash:	High:	30,000 mt/yr
	Medium:	3,000 mt/yr
	Low:	300 mt/yr

A low generation rate of 100 mt/yr was selected. A high generation rate of 10,000 mt/yr was selected since the waste generation rates are not expected to be as high as 45,000 mt/yr. A medium value one order of magnitude above the low generation rate was estimated.

The waste may be TC toxic for cadmium and lead.

Stockpiled Miscellaneous Plant Waste:	High:	180,000 mt/yr
	Medium:	90,200 mt/yr
	Low:	400 mt/yr

High and low generation rates of 45,000 and 100 mt/yr,respectively were selected since no other information about the waste stream was available. The medium rate was calculated as the average of the high and low generation rates.

The waste may be TC toxic for cadmium and lead.

MAGNESIUM AND MAGNESIA FROM BRINES

Casthouse Dust:	High:	7,600 mt/yr
	Medium:	760 mt/yr
	Low:	76 mt/yr

Casthouse dust is analogous to aluminum production casthouse dust. Aluminum production casthouse dust is generated at a medium rate of 19,000 metric tons per year. Therefore, since the annual production rate for magnesium is about 25 times less than that of aluminum, a medium waste generation rate of 760 metric tons was assigned to casthouse dust. Upper and lower bound estimates of one order of magnitude above and below the medium value were assigned.

This waste may be toxic for barium.

MOLYBDENUM, FERROMOLYBDENUM, AND AMMONIUM MOLYBDATE

Flue Dust/Gases:	High:	540,000 mt/yr
	Medium:	270,000 mt/yr
	Low:	1,200 mt/yr

There was no information on the generation rates of this waste, but 12 facilities produce it. Therefore, we multiplied default values by 12 to estimate the minimum, medium and maximum generation rates.

This waste may contain lead above TC concentrations.

PLATINUM GROUP METALS

Slag:	High:	460 mt/yr
	Medium:	46 mt/yr
	Low:	4.6 mt/yr

Comparing with the slag waste stream in the antimony sector (waste/product = 32,000/44,600 = 0.717), the medium value was calculated as (65 * 0.717) 46 mt/yr. Upper and lower bound estimates of one order of magnitude above and below the expected value were used.

The waste stream may contain selenium and lead since these two TC metals are being produced in the process.

Spent Acids:	High:	3,000 mt/yr (1,000 * 3 facilities)
	Medium:	1,700 mt/yr ((3,000 + 300)/2)
	Low:	300 mt/yr (100 * 3 facilities)

A high rate of 1,000 mt/yr was selected which is three orders of magnitude below the highest possible average facility generation rate (1,000,000 mt/yr) since the production is only 65 mt/yr. The low estimate was set at 100 mt/yr.

The waste stream may be corrosive (engineering judgment). The waste stream may contain silver and lead, since these two TC metals are being produced in the process.

Spent Solvents:	High:	3,000 mt/yr (1,000 * 3 facilities)
	Medium:	1,700 mt/yr (3,000 + 300/2)
	Low:	300 mt/yr (100 * 3 facilities)

See the previous comment.

The waste stream may be ignitable. The waste stream may contain silver and lead, since these two TC metals are being produced in the process.

PYROBITUMENS, MINERAL WAXES, AND NATURAL ASPHALT

Methodology for estimating waste generation rates for the waste streams listed below is provided at the end of the sector.

Still Bottoms:	High:	90,000 mt/yr (45,000 mt/yr * 2 facilities)
	Medium:	45,000 mt/yr
	Low:	2 mt/yr

This waste may be ignitable.

Waste Catalysts:	High:	20,000 mt/yr (10,000 mt/yr * 2 facilities)
	Medium:	10,000 mt/yr
	Low:	2 mt/yr

This waste may be toxic for cadmium and/or selenium.

No information was available on waste generation rates from the production of pyrobitumens, mineral waxes, and natural asphalts. There are only two facilities that produce bituminous materials. Therefore, since the production must be less than 45,000 metric tons per facility, the waste generation rate for still bottoms was set as follows:

high, 90,000; medium, 45,000; and low, 2 metric tons. Waste catalysts are assumed to be generated in lower volumes because they are usually recycled. Therefore, a high value was set at 10,000 metric tons per facility. This yields waste catalyst generation rates of high, 20,000; medium, 10,000; and low, 2 metric tons.

RARE EARTHS

The methodology for estimating waste generation rates for the waste streams listed below is provided after the estimates.

Electrolytic Cell Caustic Wet APC:	High:	7,0 00 mt/yr
	Medium:	700 mt/yr
	Low:	70 mt/yr

This waste may be corrosive.

The Development Document for Effluent Limitations Guidelines, 1989, gives waste-to-product ratios for spent electrolytic cell quench water and scrubber water and spent sodium hypochlorite filter backwash from mischmetal production. Spent electrolytic cell quench water and scrubber water is produced at a rate of 9,390 to 12,683 L/kkg mischmetal produced. Spent sodium hypochlorite filter backwash is produced at a rate of 362 L/kkg mischmetal produced.

Since mischmetal is produced by only one company, Reactive Metals and Alloys Corporation in West Pittsburgh, Pennsylvania, information on production of mischmetal is CBI. For this reason an approximation must be made. The following facts guided the estimation:

- ♦ Mischmetal is produced from rare earth chlorides which are produced from bastnasite ore.
- ♦ Annual production of mischmetal will not exceed annual production of rare earth chlorides since mischmetal is a specialty product.
- ♦ Production of rare earth chlorides will not exceed production of bastnasite ore since rare earth chlorides come from bastnasite ore.
- ♦ Substituting production of bastnasite ore for production of mischmetal will yield conservative estimates of waste generation rates.

The 1994 Minerals Yearbook gives a production rate for bastnasite concentrates of 20,787 metric tons of rare earth oxide (REO) content. Mischmetal is made from rare earth chlorides which are made from bastnasite ore. According to the 1992 Minerals Yearbook, three grades of bastnasite ore are produced in the United States: (1) unleached concentrate, 60% REO, (2) acid-leached concentrate, 70% REO, and (3) calcined concentrate, 85% REO. These grades specifications were used to establish the total volume of bastnasite ore. The following relationship was used in the calculation.

$$\frac{\text{Ore production in metric tons of REO}}{\text{Total Ore Production}} = \frac{\text{\%REO in ore}}{100}$$

This calculation yields the following bastnasite ore production rates:

- ♦ Calcined: 24,000 metric tons bastnasite ore
- ♦ Acid-leached: 30,000 metric tons bastnasite ore
- ♦ Unleached: 35,000 metric tons bastnasite ore

Assuming all three grades are produced equally, dividing the above values by three gives the annual production of each of the three grades of bastnasite ore (calcined, 8,152 metric tons; acid-leached, 9,899 metric tons; and 11,548 metric tons). Totalling these three values provides the total production of bastnasite ore, 29,599 metric tons. Substituting this value for mischmetal in the waste-to-product ratios yields a high-end generation rate. The medium and low-end estimates are one and two orders of magnitude below this value, respectively.

The methodology for estimating waste generation rates for the waste streams listed below is provided at the end of the sector.

Solvent Extraction Crud:	High:	90,000 mt/yr
	Medium:	45,000 mt/yr
	Low:	200 mt/yr

The default value of 45,000 mt/yr was reduced by a factor of 10 since the generation rate is not expected to be that high.
This waste may be ignitable.

Spent Lead Filter Cake:	High:	5,000 mt/yr
	Medium:	4,200 mt/yr
	Low:	3,300 mt/yr

This waste may be toxic for lead.

Spent Scrubber Liquor:	High:	1,000,000 mt/yr (1,000,000*1 facility)
	Medium:	500,000 mt/yr
	Low:	100 mt/yr (100*1 facility)

This waste may be corrosive.

Waste Solvent:	High:	2,000,000 mt/yr
	Medium:	1,000,000 mt/yr
	Low:	200 mt/yr (100*14 facilities)

This waste may be ignitable

The default value of 1,000,000 mt/yr was reduced by a factor of 10 since waste solvents are presumed to be generated in smaller quantities than other wastes.

Wastewater from Caustic Wet APC:	High:	1,000,000 mt/yr (1,000,000*1 facility)
	Medium:	500,000 mt/yr
	Low:	100 mt/yr (100*1 facility)

This waste may be corrosive and/or toxic for chromium and/or lead.

Waste Zinc Contaminated with Mercury:	High:	90,000 mt/yr (45,000*14 facilities)
	Medium:	45,000 mt/yr
	Low:	200 mt/yr (100*14 facilities)

The default value of 45,000 was reduced by a factor of 10 since the rate is not expected to be that high.

RHENIUM

Spent Barren Scrubber Liquor:	High:	200 mt/yr (100 * 2 facilities)
	Medium:	100 mt/yr ((200 + 0)/2)
	Low:	0

Text indicates that plants achieve zero discharge through reuse and treatment. Therefore, a low of zero and a high of 100 mt/yr were selected.

The waste stream contains selenium.

SCANDIUM

Spent Acids:	High:	7,000 mt/yr (1,000 * 7 facilities)
	Medium:	3,900 mt/yr ((7,000 + 700)/2)
	Low:	700 mt/yr (100 * 7 facilities)

A high rate of 1,000 was selected which is three orders of magnitude lower than 1,000,000 mt/yr. Based on the very low production rates (0.5 tons/yr), the waste generation rate is not expected to be as high as 1,000,000 mt/yr. A low of 100 mt/yr was selected.

The waste stream may be corrosive (engineering judgment).

Spent Solvents from Solvent Extraction:	High:	7,000 mt/yr (1,000 * 7 facilities)
	Medium:	3,900 mt/yr ((7,000 + 700)/2)
	Low:	700 mt/yr (100 * 7 facilities)

A high rate of 1,000 was selected which is three orders of magnitude lower than 1,000,000 mt/yr. Based on the very low production rates (0.5 tons/yr), the waste generation rate is not expected to be as high as 1,000,000 mt/yr. A low of 100 mt/yr was selected.

The waste stream may be ignitable (engineering judgment).

SELENIUM

The methodology for estimating waste generation rates for the waste streams listed below is provided at the end of the sector.

Spent Filter Cake:	High:	5,000 mt/yr
	Medium:	500 mt/yr
	Low:	50 mt/yr

This waste may be toxic for selenium.

Waste Solids:	High:	5,000 mt/yr
	Medium:	500 mt/yr
	Low:	50 mt/yr

This waste may be toxic for selenium.

Slag:	High:	5,000 mt/yr
	Medium:	500 mt/yr
	Low:	50 mt/yr

This waste may be toxic for selenium.

Tellurium Slime Waste:	High:	5,000 mt/yr
	Medium:	500 mt/yr
	Low:	50 mt/yr

This waste may be toxic for selenium.

Selenium is produced from copper anode slimes or "tankhouse slimes." According to the Newly Identified Waste Characterization Data Set, 1992, 4,000 metric tons of these slimes are produced annually. Assuming a process efficiency of 50%, 2,000 metric tons of wastes from selenium production is generated annually. Assuming each of the wastes from selenium production is produced equally, a medium estimate of 500 metric tons of each of the above wastes is produced annually. (Plant process wastewater was not used in this calculation of medium waste generation rates.) The high and low estimates are one order of magnitude above and below the medium estimate.

TELLURIUM

Slag:	High:	4,500 mt/yr (4,500 * 1 facility)
	Medium:	1,000 mt/yr
	Low:	100 mt/yr

No information about production rates or waste stream is available, therefore, high and low estimates of 4,500 and 100 mt/yr were selected. A medium estimate of 1,000 mt/yr was selected because the number of refineries in the U.S. (1) and uses of the metal indicate that production rates and, therefore, waste generation rates would be low.

The waste stream may contain selenium.

Solid Waste Residues:	High:	4,500 mt/yr (4,500 * 1 facility)
	Medium:	1,000 mt/yr
	Low:	100 mt/yr

See previous comment.

The waste may contain selenium since selenium is produced in the process.

Waste Electrolyte:	High:	10,000 mt/yr (10,000 * 1 facility)
	Medium:	1,000 mt/yr
	Low:	100 mt/yr

No information about production rates was available. However, the number of refineries in the U.S. (1) and the uses of the metal indicate that production rates and, therefore, waste generation rates will be low. A medium value of 1,000 mt/yr was used for reasons discussed above. High and low values of 10,000 and 100 mt/yr, respectively, were selected for the same reasons.

The waste stream may contain selenium since selenium is produced in the process. Lead, as an impurity, may also be present in the waste stream.

Wastewater: High: 20,000 mt/yr (20,000 * 1 facility)
Medium: 10,000 mt/yr
Low: 100 mt/yr

See previous comment.

The waste stream may be corrosive. The waste may contain selenium since selenium is also produced in the process.

TITANIUM

Sulfate Process

Waste Acids: High: 77,000 mt/yr (Newly Identified Document)
Medium: 39,000 mt/yr
Low: 200 mt/yr (100 * 2 facilities)

Chloride and Chloride-Ilmenite Processes

Waste Ferric Chloride: High: 75,000 mt/yr
Medium: 29,000 mt/yr
Low: 22,000 mt/yr

Ferric chloride is generated in the chloride-ilmenite process when gaseous titanium tetrachloride is separated from other chlorides. Ferric chloride is removed as an acidic, liquid waste stream through fractional condensation and treated with lime and either landfilled or sold as a by-product. Volume estimated as 10% of Waste Solids volume.

This waste may exhibit the corrosivity characteristic.

Surface Impoundment Liquids: High: 6,700 mt/yr
Medium: 3,400 mt/yr
Low: 630 mt/yr

Surface impoundment liquids consist of various waste streams, such as chloride process waste acids and solids in slurry form and wastewater treatment plant effluent. Waste acids managed in surface impoundments are generally routed to a solids/liquids separation process and then disposed by deep-well injection. Treated effluent is discharged through NPDES outfalls after solids have settled.

This waste may be hazardous for chromium and lead.

Kroll Process for Ti Sponge (Metal) Production

Leach Liquor and Sponge Wash Water: High: 580,000 mt/yr
Medium: 480,000 mt/yr
Low: 380,000 mt/yr

Use discharge rates from Vol. IX of Eff. Guidelines Develop. Doc. for Acid Leachate and Rinse Water (Table V-9, p. 4869) for 4 plants (unidentified). Because these two streams are given as a combined stream in the Dev. Doc., we should combine them in our analysis. Need to get an average value per plant for sponge (Ti metal) production. Use sponge production value for 1991 from Gambogi (1993, p. 12) (1992 data withheld due to CBI). This is for two plants. Calculate average water rate for the four reporting plants and multiply by 2 plants and the sponge production number to get liters of wastewater.

Convert to mtons using density of water at 20°C. This gives a medium estimate; use the ±20% rule to estimate upper and lower bounds.

Based on EPA sampling and responses to the RTI survey, leach liquor is believed to exhibit the hazardous characteristic of corrosivity (pH 0 and 1 recorded at Timet); according to the Eff. Guidelines Dev. Doc., it also contains treatable concentrations of copper, lead, nickel, thallium, and suspended solids.

Smut from Mg Recovery:	High:	45,000 mt/yr (high vol. threshhold)
	Medium:	22,000 mt./yr
	Low:	100 mt/yr

This waste may be reactive in water.

Ingot Production

Pickle Liquor & Wash Water:	High:	3,200 mt/yr
	Medium:	2,700 mt/yr
	Low:	2,200 mt/yr

Use discharge rates from Vol. IX of Eff. Guidelines Develop. Doc. for Acid Pickle & Wash Water (Table V-11, p. 4870) for 2 plants (unidentified). A third plant did not report, so assume its value is average of other two. Use scrap consumption value from Gambogi (1993, p. 12) to estimate volume of pickling liquor. Convert to mtons using density of water at 20°C. This gives a medium estimate; use the ±20% rule to estimate upper and lower bounds.

According to Eff. Guidelines Develop. Doc., this waste contains treatable concentrations of antimony, cadmium, chromium, copper, lead, nickel, and zinc; no concentrations were given. In absence of concentrations, assume potentially hazardous for cadmium, chromium, and lead.. Because HF acid is used as pickling acid, may also contain high concentration of fluoride and may exhibit corrosivity characteristic due to low pH.

Scrap Detergent Wash Water:	High:	540,000 mt/yr
	Medium:	450,000 mt/yr
	Low:	360,000 mt/yr

Use discharge rates from Vol. IX of Eff. Guidelines Develop. Doc. for Scrap Detergent Wash water (Table V-13, p. 4871) for 2 plants (unidentified). Use scrap consumption value from Gambogi (1993, p. 12) to estimate volume of scrap detergent wash water. Convert to mtons using density of water at 20°C. This gives a medium estimate; use the ±20% rule to estimate upper and lower bounds.

According to Eff. Guidelines Develop. Doc., this waste contains treatable concentrations of oil and grease, TSS, and toxic metals. No concentrations were given due to confidentiality. In absence of concentrations, assume potentially hazardous for cadmium, chromium, and lead. This waste may also exhibit the corrosivity characteristic because it is caustic.

Scrap Milling Scrubber Water:	High:	6,000 mt/yr
	Medium:	5,000 mt/yr
	Low:	4,000 mt/yr

Use discharge rates from Vol. IX of Eff. Guidelines Develop. Doc. for Scrap Milling Wet Air Pollution Control (Table V-12, p. 4870) for 1 plant (unidentified). Use scrap consumption value from Gambogi (1993, p. 12) to estimate volume of scrap milling scrubber water. Convert to mtons using density of water at 20°C. This gives a medium estimate; use the ±20% rule to estimate upper and lower bounds.

According to Eff. Guidelines Develop. Doc., this waste contains treatable concentrations of TSS, titanium, and low concentrations of toxic metals. No concentrations were given due to confidentiality. In absence of concentrations, assume potentially hazardous for cadmium, chromium, and lead.

TUNGSTEN

Spent Acid and Rinse Water:	High:	2,100 mt/yr
	Medium:	0 mt/yr
	Low:	0 mt/yr

The Technical Background Document reports a production rate of 7,324 kkg for tungsten metal powder. The Development Document for Effluent Limitations Guidelines provides discharge rates for 2 plants for rinsewater and spent acid from tungsten powder production. An average of these 2 rates was used to calculate a waste generation rate. An average waste-to-product ratio of 2,400 L/kkg of tungsten was calculated. Using the annual production of tungsten metal above, this waste-to-product ratio corresponds to a high value of 21,000 metric tons of scrubber water annually. Medium and low values were set at 0 mt/yr since the waste is treated prior to discharge.

This waste may be corrosive.

Process Wastewater:	High:	7,300 mt/yr
	Medium:	3,700 mt/yr
	Low:	1,800 mt/yr

The generation rate for a comparable waste stream is assumed to be an acceptable medium estimate for wastes for which no generation rate information is available. Using this assumption, the waste generation rates for tungsten carbide process wastewater were set at those of water of formation.

This waste may be corrosive.

URANIUM

Note: Since the number of mineral processing facilities is currently unknown, we used the number of mining facilities (17) to calculate the quantity of wastes generated.

Tailing Pond Seepage:	High:	7,650,000 mt/yr (450,000 * 17 facilities)
	Medium:	3,833,500 mt/yr ((7,650,000 + 17,000)/2)
	Low:	17,000 mt/yr (1,000 * 17 facilities)

Seepage from one facility is estimated at 1,855 m^3/day (Werthman, P., Purdue Industrial Waste Conference). Using this value, a high annual waste generation rate of 450,000 mt/yr was calculated as shown below. Since this seepage is treated, the low value was estimated to be 1,000 mt/yr.
High Waste Generation Rate = 1,855 m^3/day * 250 days/yr * 1.01 mt/m^3
(using density for water) = Approximately 450,000 mt/yr per facility

Sampling data from a facility (Werthman, P., Proceedings of the Purdue Industrial Waste Conference) shows that this waste stream has a pH of 1.7 and may exhibit the characteristic of toxicity for lead, chromium, arsenic, and selenium.

Barren Lixiviant:	High:	17,000 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	1,700 mt/yr (100 mt/yr * 17 facilities)
	Low:	0 mt/yr

Barren lixiviant (raffinate) is recycled back to the leaching circuit. Therefore, a low of 0 mt/yr was selected. High and medium waste generation rates were estimated as 1,000 mt/yr and 100 mt/yr, respectively.

Engineering judgment suggests that this waste may exhibit the characteristics of toxicity (arsenic, chromium, lead, and selenium) and corrosivity.

Waste Solvents:	High:	1,700 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	0 mt/yr (100 mt/yr * 17 facilities)
	Low:	0 mt/yr

Low and medium waste generation rates were set equal to 0 mt/yr since organic solvents used in solvent extraction are recycled. However, due to incomplete phase separation, a small amount may be lost (0.5 gallon per 1,000 gallons of solution passing through the solvent extraction circuit). Therefore, a high waste generation rate of 100 mt/yr was selected.

Waste stream may be ignitable (engineering judgment).

Waste Acids from Solvent Extraction:	High:	17,000 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	9,350 mt/yr ((17,000 + 1,700)/2)
	Low:	1,700 mt/yr

High and low waste generation rates of 1,000 mt/yr and 100 mt/yr, respectively, were selected based on the low production rates (1,361 mt/yr).

This waste stream may exhibit the characteristics of toxicity (arsenic, chromium, lead, and selenium) and corrosivity.

Slimes from Solvent Extraction:	High:	17,000 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	9,350 mt/yr ((17,000 + 1,700)/2)
	Low:	1,700 mt/yr

High and low waste generation rates of 1,000 mt/yr and 100 mt/yr, respectively, were selected based on the low production rates (1,361 mt/yr).

This waste stream may exhibit the characteristic of toxicity (arsenic, chromium, lead, and selenium).

Waste Nitric Acids from the Production of UO_2:	High:	3,400 mt/yr
	Medium:	2,550 mt/yr ((3,400 + 1,700)/2)
	Low:	1,700 mt/yr

High and low waste generation rates of 200 mt/yr and 100 mt/yr, respectively, were selected based on the low production rates.

This waste stream may be corrosive (engineering judgment).

Vaporizer Condensate:	High:	17,000 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	9,350 mt/yr
	Low:	1,700 mt/yr

High and low waste generation rate of 1,000 mt/yr and 100 mt/yr, respectively, were estimated based on the low production rates for uranium (1,361 mt/yr).

This waste may be corrosive since the process uses hydrofluoric acid.

Superheater Condensate:	High:	17,000 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	9,350 mt/yr
	Low:	1,700 mt/yr

High and Low waste generation rate of 1,000 mt/yr and 100 mt/yr, respectively, were estimated based on the low production rates for uranium (1,361 mt/yr).

This waste stream may be corrosive (engineering judgment) since the process uses hydrofluoric acid.

Slag:	High:	17,000 mt/yr (1,000 mt/yr * 17 facilities)
	Medium:	8,500 mt/yr
	Low:	0 mt/yr

High waste generation rate of 1,000 mt/yr was estimated based on the low production rates for uranium (1,361 mt/yr). The low generation rate was set equal to 0 mt/yr since the slag is recycled.

This waste stream may be ignitable since it may contain uranium metal (engineering judgment, DOT Emergency Response Guidebook).

Uranium Chips from Ingot Production:	High:	3,400 mt/yr
	Medium:	2,550 mt/yr ((3,400 + 1,700)/2)
	Low:	1,700 mt/yr

High and low waste generation rates of 100 mt/yr and 200 mt/yr, respectively, were selected based on the low production rates.

This waste stream may be ignitable (engineering judgment) since it contains uranium metal (DOT Emergency Response Guidebook).

ZIRCONIUM AND HAFNIUM

Spent Acid Leachate Zirconium and Hafnium Alloy Production:	High:	850,000 mt/yr
	Medium:	0 mt/yr
	Low:	0 mt/yr

For spent acid leachate from zirconium alloy production, waste-to-product ratios were given in the Effluent Guidelines, 1989. The waste-to-product ratios for acid leachate were 12,617 to 18,925 L/kkg zirconium in alloys. A production rate for zirconium in alloys was not available so the production rate for zirconium was used instead. (It is assumed that the production of zirconium alloys does not exceed the production of zirconium.) The above mentioned waste-to-product ratios were used to calculate an average generation rate. This generation rate was used as the high rate. Low and medium rates were set equal to zero since the waste may be treated prior to discharge.

This waste may be corrosive.

Spent Acid Leachate Zirconium and Hafnium Metal Production:	High:	1,600,000 mt/yr
	Medium:	0 mt/yr
	Low:	0 mt/yr

For spent acid leachate from zirconium metal production, waste-to-product ratios were given in the Effluent Guidelines, 1989. The waste-to-product ratio for acid leachate was 29,465 L/kkg zirconium produced. The production rate for zirconium used was 45,350 metric tons. Using the production of zirconium and the waste-to-product ratio, a high sector wide estimate of 1,600,000 mt/yr was calculated. Low and medium rates were set equal to zero since the waste may be treated prior to discharge.

This waste may be corrosive.

Leaching Rinsewater from Zirconium Alloy Production:	High:	51,000 mt/yr
	Medium:	42,000 mt/yr
	Low:	34,000 mt/yr

For leaching rinsewater, waste-to-product ratios (632 to 946 L/kkg zirconium in alloys) were given in the 1989 Effluent guidelines. A production rate for zirconium was not available so the production rate for zirconium was used instead. (It is assumed that the production of zirconium alloys does not exceed the production of zirconium). The above mentioned waste-to-product ratios correspond to low and high estimates.

This waste may be corrosive

Leaching Rinsewater from Zirconium Metal Production:	High:	2,000,000 mt/yr (1,000,000 * 2 facilities)
	Medium:	1,000,000 mt/yr
	Low:	200 mt/yr

This waste may be corrosive.

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX B

Work Sheet for Waste Stream Assessment of Recycling, Recovery, and Reuse Potential

WORK SHEET FOR WASTE STREAM ASSESSMENT FOR RECYCLING, RECOVERY, AND REUSE POTENTIAL

Industrial Sector and Process: ____
Waste Stream: ____
Waste Generation Rate: ____
Waste Form: Liquid(Aq./Non-Aq.)/Slurry/Solids(Wet/Dry)
Hazard Characteristics (all): I C R T
Hazardous Constituents (major):____

1. Process Flow Diagram & Waste Characterization: By looking at both documents, try to answer the following questions for each major source of the same waste generated in the process. *Complete a separate form for each major source.*

   A. Source: ____
   B. Waste generation is closest to: Raw Material/Major Intermediates/Final Product
   C. Waste appears to have: recoverable products/removable contaminants/neither
   D. Comment: ____

2. Reasons for Waste Generation: Based on the description of the process, and waste generation and its management practices given for a sector, make the following assessment.

   A. Is the same waste generated at every facility using the process?: Yes/No/Can't Tell
   Comment: ____
   ____

   B. What was the basic purpose for generating this waste (e.g., plant maintenance, chemical reaction, physical separation, water rinsing, other purification steps)?
   Comment: ____
   ____

   C. Why did this waste become hazardous (e.g., physical contact during production, mixing with other waste streams, results from impurity removal)?
   Comment: ____
   ____

3. Waste Management Alternatives: Review the potential for reducing the quantities of waste generated at any of its sources by considering the following waste management alternatives.

   A. Waste Segregation: Yes/No/Can't Tell
   Comment: ____

   B. Water Use Reduction: Yes/No/Can't Tell
   Comment: ____

   C. On-site Waste Recycling/Recovery/Reuse: Yes/No/Can't Tell
   Comment: ____

   D. Off-site Waste Recycling/Recovery/Reuse: Yes/No/Can't Tell
   Comment: ____

Conclusion: ___ Recyclable ___ Non-Recyclable ___ Partially Recyclable

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX C

Definitions Formerly Used to Classify Mineral Processing Waste Streams

DEFINITIONS FOR CLASSIFYING MINERAL PROCESSING WASTESTREAMS

Sludge - any solid, semi-solid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility exclusive of the treated effluent from a wastewater treatment plant. Examples include:

- baghouse dusts
- cast house dusts
- wastewater treatment plant sludges and solids
- chlorinator wet air pollution control sludges
- scrubber wastewater
- APC dust/sludges

Spent Material - any material that has been used and as a result of contamination can no longer serve the purpose for which it was produced without processing (e.g., treatment or regeneration). Examples include:

- process wastewaters
- spent barren filtrate
- spent raffinate
- spent caustic soda
- spent electrolyte
- waste acid solutions
- waste liquors
- caustic washwaters
- spent bleed electrolyte
- contact cooling water
- slag quench water
- spent furnace brick

By-Product - a material that is not one of the primary products of a production process and is not solely or separately produced by the production process. Examples are process residues such as slags or distillation column bottoms. The term does not include a co-product that is produced for the general public's use and is ordinarily used in the form it is produced by the process. Other examples include:

- anode or tankhouse slimes
- beryl thickener slurry
- post-leach filter cake
- furnace residues
- synthetic gypsum

Note: If a surface impoundment is used for pollution control, then both the liquid and solid components are considered to be "sludge." If a surface impoundment is not used for pollution control, then the liquid is probably a "spent material" and the solid is probably a "by-product."

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX D

Recycling Work Sheets for Individual Mineral Processing Waste Streams

1997 UPDATE

Several of the recycling status conclusions and former RCRA waste type classifications detailed on the following worksheets have been revised since December 1995 (the date of initial publication of this appendix) due to comments received on the January 25, 1996 Supplemental Proposed Rule Applying Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes and the May 12, 1997 Second Supplemental Proposed Rule Applying Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes, as well as other new information received by the Agency. Changes in recycling status are summarized in Exhibit D-1, and changes in former RCRA waste type classification are summarized in Exhibit D-2. Note that in Exhibit D-1, the symbols Y and Y? are equivalent to the term "Recyclable," the symbol N is equivalent to "Not Recyclable," and the symbols YS and YS? are equivalent to "Partially Recyclable" on the following worksheets.

EXHIBIT D-1
Changes in Recycling Status Since December 1995

Sector -- *Waste Stream*	1995 Recycling Status	Current Recycling Status
Beryllium -- *Spent Barren Filtrate*	YS?	YS
Elemental Phosphorous -- *Furnace Scrubber Blowdown*	N	Y
Magnesium and Magnesia from Brines -- *Smut*	Y?	N
Mercury -- *Dust*	YS?	N
Rare Earths -- *Solvent Extraction Crud*	YS?	N
Selenium -- *Tellurium Slime Wastes*	YS?	Y?
Zinc -- *WWTP Solids*	N	YS

EXHIBIT D-2
Changes in Former RCRA Waste Type Classification Since December 1995

Sector -- *Waste Stream*	1995 Former RCRA Waste Type Classification	Current Former RCRA Waste Type Classification
Cadmium -- *Scrubber Wastewater*	Spent Material	Sludge
Copper -- *Acid Plant Blowdown*	By-Product	Sludge
Elemental Phosphorous -- *Furnace Scrubber Blowdown*	N/A	Sludge
Lead -- *WWTP Liquid Effluent*	Sludge	Spent Material
Rare Earths -- *Spent Scrubber Liquor*	Spent Material	Sludge
Rare Earths -- *Wastewater from Caustic Wet APC*	Spent Material	Sludge
Rhenium -- *Spent Barren Scrubber Liquor*	Spent Material	Sludge

EXHIBIT D-2 (continued)

Sector -- *Waste Stream*	**1995 Former RCRA Waste Type Classification**	**Current Former RCRA Waste Type Classification**
Titanium and Titanium Dioxide -- *Scrap Milling Scrubber Water*	Spent Material	Sludge
Zinc -- *Acid Plant Blowdown*	Spent Material	Sludge
Zinc -- *WWTP Solids*	N/A	Sludge

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX E

Listing of Waste Streams Generated by Mineral Production Activities by Commodity

Note: The failure to list a mineral processing waste on this table in no way assumes that the Agency has determined that the waste is not a mineral processing waste. A company has an obligation to determine whether it is generating a mineral processing wastestream subject to the 1989 rulemaking.

EXHIBIT E-1

SUMMARY OF MINERAL PROCESSING WASTE STREAMS BY COMMODITY

Commodity	Waste Stream	Nature of Operation
Alumina and Aluminum	Anode prep waste	Mineral Processing
	APC dust/sludge	Mineral Processing
	Baghouse bags and spent plant filters	Mineral Processing
	Bauxite residue	Mineral Processing
	Cast house dust	Mineral Processing
	Cryolite recovery residue	Mineral Processing
	Wastewater	Mineral Processing
	Discarded Dross	Mineral Processing
	Flue Dust	Mineral Processing
	Electrolysis waste	Mineral Processing
	Evaporator salt wastes	Mineral Processing
	Miscellaneous wastewater	Mineral Processing
	Pisolites	Mineral Processing
	Scrap furnace brick	Mineral Processing
	Skims	Mineral Processing
	Sludge	Mineral Processing
	Spent cleaning residue	Mineral Processing
	Spent potliners	Mineral Processing
	Sweepings	Mineral Processing
	Treatment Plant Effluent	Mineral Processing
	Waste alumina	Mineral Processing
Antimony	Gangue	Mineral Processing
	Wastewater	Mineral Processing
	APC Dust/Sludge	Mineral Processing
	Autoclave Filtrate	Mineral Processing
	Spent Barren Solution	Mineral Processing
	Gangue (Filter Cake)	Mineral Processing
	Leach Residue	Mineral Processing
	Refining Dross	Mineral Processing
	Slag and Furnace Residue	Mineral Processing
	Sludge from Treating Process Waste Water	Mineral Processing
	Stripped Anolyte Solids	Mineral Processing
	Waste Solids	Mineral Processing
Beryllium	Spent Barren filtrate streams	Mineral Processing
	Beryllium hydroxide supernatant	Mineral Processing
	Chip Treatment Wastewater	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Beryllium (continued)	Dross discard	Mineral Processing
	Filtration discard	Mineral Processing
	Leaching discard	Mineral Processing
	Neutralization discard	Mineral Processing
	Pebble Plant Area Vent Scrubber Water	Mineral Processing
	Precipitation discard	Mineral Processing
	Process wastewater	Mineral Processing
	Melting Emissions	Mineral Processing
	Scrubber Liquor	Mineral Processing
	Separation slurry	Mineral Processing
	Waste Solids	Mineral Processing
Bismuth	Alloy residues	Mineral Processing
	Spent Caustic Soda	Mineral Processing
	Electrolytic Slimes	Mineral Processing
	Excess chlorine	Mineral Processing
	Lead and Zinc chlorides	Mineral Processing
	Metal Chloride Residues	Mineral Processing
	Slag	Mineral Processing
	Spent Electrolyte	Mineral Processing
	Spent Material	Mineral Processing
	Spent soda solution	Mineral Processing
	Waste acid solutions	Mineral Processing
	Waste Acids	Mineral Processing
	Wastewater	Mineral Processing
Cadmium	Caustic washwater	Mineral Processing
	Copper and Lead Sulfate Filter Cakes	Mineral Processing
	Copper Removal Filter Cake	Mineral Processing
	Iron containing impurities	Mineral Processing
	Spent Leach solution	Mineral Processing
	Lead Sulfate waste	Mineral Processing
	Post-leach Filter Cakes	Mineral Processing
	Spent Purification solution	Mineral Processing
	Scrubber wastewater	Mineral Processing
	Spent electrolyte	Mineral Processing
	Zinc Precipitates	Mineral Processing
Calcium Metal	Calcium Aluminate wastes	Mineral Processing
	Dust with Quicklime	Mineral Processing
Cesium/Rubidium	Chemical Residues	Mineral Processing
	Digester waste	Mineral Processing
	Electrolytic Slimes	Mineral Processing
	Pyrolytic Residue	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Cerium/Rubidium (continued)	Slag	Mineral Processing
Chromium, Ferrochrome, and Ferrochromium-Silicon	Gangue and tailings	Extraction/Beneficiation
	Dust or Sludge from ferrochromium production	Mineral Processing
	Dust or Sludge from ferrochromium-silicon production	Mineral Processing
	Treated Roast/Leach Residues	Mineral Processing
	Slag and Residues	Mineral Processing
Coal Gas	API Oil/Water Separator Sludge	Mineral Processing
	API Water	Mineral Processing
	Cooling Tower Blowdown	Mineral Processing
	Dissolved Air Flotation (DAF) Sludge	Mineral Processing
	Flue Dust Residues	Mineral Processing
	Liquid Waste Incinerator Blowdown	Mineral Processing
	Liquid Waste Incinerator Pond Sludge	Mineral Processing
	Multiple Effects Evaporator Concentrate	Mineral Processing
	Multiple Effects Evaporator Pond Sludge	Mineral Processing
	Sludge and Filter Cake	Mineral Processing
	Spent Methanol Catalyst	Mineral Processing
	Stretford Solution Purge Stream	Mineral Processing
	Surface Impoundment Solids	Mineral Processing
	Vacuum Filter Sludge	Mineral Processing
	Zeolite Softening PWW	Mineral Processing
Copper	Acid plant blowdown	Mineral Processing
	Acid plant thickener sludge	Mineral Processing
	APC dusts/sludges	Mineral Processing
	Spent bleed electrolyte	Mineral Processing
	Chamber solids/scrubber sludge	Mineral Processing
	Waste contact cooling water	Mineral Processing
	Discarded furnace brick	Mineral Processing
	Process wastewaters	Mineral Processing
	Scrubber blowdown	Mineral Processing
	Spent black sulfuric acid sludge	Mineral Processing
	Surface impoundment waste liquids	Mineral Processing
	Tankhouse slimes	Mineral Processing
	WWTP liquid effluent	Mineral Processing
	WWTP sludge	Mineral Processing
Elemental Phosphorous	Condenser phossy water discard	Mineral Processing
	Cooling water	Mineral Processing
	Furnace building washdown	Mineral Processing
	Dust	Mineral Processing
	Waste ferrophosphorus	Mineral Processing
	Furnace offgas solids	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Elemental Phosphorous (continued)	Furnace scrubber blowdown	Mineral Processing
	Precipitator slurry scrubber water	Mineral Processing
	Precipitator slurry	Mineral Processing
	NOSAP slurry	Mineral Processing
	Sludge	Mineral Processing
	Spent furnace brick	Mineral Processing
	Surface impoundment waste liquids	Mineral Processing
	Surface impoundment waste solids	Mineral Processing
	Waste Andersen Filter Media	Mineral Processing
	WWTP liquid effluent	Mineral Processing
	WWTP Sludge/Solids	Mineral Processing
Fluorspar and Hydrofluoric Acid	APC Dusts	Mineral Processing
	Off-spec fluosilicic acid	Mineral Processing
	Sludges	Mineral Processing
Germanium	Waste Acid Wash and Rinse Water	Mineral Processing
	Chlorinator Wet Air Pollution Control Sludge	Mineral Processing
	Germanium oxides fumes	Mineral Processing
	Hydrolysis Filtrate	Mineral Processing
	Leach Residues	Mineral Processing
	Roaster off-gases	Mineral Processing
	Spent Acid/Leachate	Mineral Processing
	Waste Still Liquor	Mineral Processing
	Wastewater	Mineral Processing
Gold and Silver	Spent Furnace Dust	Mineral Processing
	Refining wastes	Mineral Processing
	Retort cooling water	Mineral Processing
	Slag	Mineral Processing
	Wastewater treatment sludge	Mineral Processing
	Wastewater	Mineral Processing
Iron and Steel	Wastewater	Mineral Processing
Lead	Acid Plant Blowdown	Mineral Processing
	Acid Plant Sludge	Mineral Processing
	Baghouse Dust	Mineral Processing
	Baghouse Incinerator Ash	Mineral Processing
	Cooling Tower Blowdown	Mineral Processing
	Waste Nickel Matte	Mineral Processing
	Process Wastewater	Mineral Processing
	Slurried APC Dust	Mineral Processing
	Solid Residues	Mineral Processing
	Solids in Plant Washdown	Mineral Processing
	Spent Furnace Brick	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Lead (continued)	Stockpiled Miscellaneous Plant Waste	Mineral Processing
	Surface Impoundment Waste Liquids	Mineral Processing
	Surface Impoundment Waste Solids	Mineral Processing
	SVG Backwash	Mineral Processing
	WWTP Liquid Effluent	Mineral Processing
	WWTP Sludges/Solids	Mineral Processing
Lightweight Aggregate	APC control scrubber water and solids	Mineral Processing
	APC Dust/Sludge	Mineral Processing
	Surface impoundment waste liquids	Mineral Processing
	WWTP liquid effluent	Mineral Processing
Magnesium and Magnesia from Brines	APC Dust/Sludge	Mineral Processing
	Calciner offgases	Mineral Processing
	Calcium sludge	Mineral Processing
	Casthouse Dust	Mineral Processing
	Casting plant slag	Mineral Processing
	Cathode Scrubber Liquor	Mineral Processing
	Slag	Mineral Processing
	Smut	Mineral Processing
	Spent Brines	Mineral Processing
Manganese, Manganese Dioxide, Ferromanganese and Silicomanganese	APC Dust/Sludge	Mineral Processing
	APC Water	Mineral Processing
	Iron Sulfide Sludge	Mineral Processing
	Ore Residues	Mineral Processing
Manganese, Manganese Dioxide, Ferromanganese and Silicomanganese (continued)	Slag	Mineral Processing
	Spent Graphite Anode	Mineral Processing
	Spent Process Liquor	Mineral Processing
	Waste Electrolyte	Mineral Processing
	Wastewater (CMD)	Mineral Processing
	Wastewater (EMD)	Mineral Processing
	Wastewater Treatment Solids	Mineral Processing
Mercury	Dust	Mineral Processing
	Mercury Quench Water	Mineral Processing
	Furnace Residues	Mineral Processing
Molybdenum, Ferromolybdenum, and Ammonium Molybdate	APC Dust/Sludge	Mineral Processing
	Flue Dust/Gases	Mineral Processing
	Liquid Residues	Mineral Processing
	H2 Reduction Furnace Scrubber Water	Mineral Processing
	Molybdic Oxide Refining Wastes	Mineral Processing
	Refining Wastes	Mineral Processing
	Roaster Gas Blowdown Solids	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Molybdenum, Ferromolybdenum, and Ammonium Molybdaten (continued)	Slag	Mineral Processing
	Solid Residues	Mineral Processing
	Treatment Solids	Mineral Processing
Phosphoric Acid	Waste Scale	Mineral Processing
Platinum Group Metals	Slag	Mineral Processing
	Scrubber offgases	Mineral Processing
	SO2 waste	Mineral Processing
	Spent Acids	Mineral Processing
	Spent Solvents	Mineral Processing
Pyrobitumens, Mineral Waxes, and Natural Asphalts	Still bottoms	Mineral Processing
	Waste catalysts	Mineral Processing
Rare Earths	Spent ammonium nitrate processing solution	Mineral Processing
	Electrolytic cell caustic wet APC waste	Mineral Processing
	Spent Electrolytic cell quench water and scrubber water	Mineral Processing
	Spent iron hydroxide cake	Mineral Processing
	Spent lead filter cake	Mineral Processing
	Lead backwash sludge	Mineral Processing
	Monazite solids	Mineral Processing
	Process wastewater	Mineral Processing
	Spent scrubber liquor	Mineral Processing
	Off-gases from dehydration	Mineral Processing
	Spent off-gases from electrolytic reduction	Mineral Processing
	Spent sodium hypochlorite filter backwash	Mineral Processing
	Solvent extraction crud	Mineral Processing
	Spent surface impoundment solids	Mineral Processing
	Spent surface impoundment liquids	Mineral Processing
	Waste filtrate	Mineral Processing
	Waste solvent	Mineral Processing
	Wastewater from caustic wet APC	Mineral Processing
	Waste zinc contaminated with mercury	Mineral Processing
Rhenium	APC Dust/Sludge	Mineral Processing
	Spent Barren Scrubber Liquor	Mineral Processing
	Spent Rhenium Raffinate	Mineral Processing
	Roaster Dust	Mineral Processing
	Spent Ion Exchange/SX Solutions	Mineral Processing
	Spent Salt Solutions	Mineral Processing
	Slag	Mineral Processing
Scandium	Crud from the bottom of the solvent extraction unit	Mineral Processing
	Dusts and spent filters from decomposition	Mineral Processing
	Spent acids	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Scandium (continued)	Spent ion exchange resins and backwash	Mineral Processing
	Spent solvents from solvent extraction	Mineral Processing
	Spent wash water	Mineral Processing
	Waste chlorine solution	Mineral Processing
	Waste solutions/solids from leaching and precipitation	Mineral Processing
Selenium	Spent filter cake	Mineral Processing
	Plant process wastewater	Mineral Processing
	Slag	Mineral Processing
	Tellurium slime wastes	Mineral Processing
	Waste Solids	Mineral Processing
Silicon and Ferrosilicon	APC Dust Sludge	Mineral Processing
	Dross discard	Mineral Processing
	Slag	Mineral Processing
Sulfur	Airborne emissions from sulfuric acid production	Mineral Processing
	Spent catalysts (Claus process)	Mineral Processing
	Spent vanadium pentoxide catalysts from sulfuric acid production	Mineral Processing
	Tail gases	Mineral Processing
	Wastewater from wet-scrubbing, spilled product and condensates	Mineral Processing
Synthetic Rutile	APC Dust/Sludges	Mineral Processing
	Spent Iron Oxide Slurry	Mineral Processing
	Spent Acid Solution	Mineral Processing
Tantalum, Columbium and Ferrocolumbium	APC Dust Sludge	Mineral Processing
	Digester Sludge	Mineral Processing
	Spent Potassium Titanium Chloride	Mineral Processing
	Process Wastewater	Mineral Processing
	Spent Raffinate Solids	Mineral Processing
	Scrubber Overflow	Mineral Processing
	Slag	Mineral Processing
	WWTP Liquid Effluent	Mineral Processing
	WWTP Sludge	Mineral Processing
Tellurium	Slag	Mineral Processing
	Fumes of telluride dioxide	Mineral Processing
	Solid waste residues	Mineral Processing
	Waste Electrolyte	Mineral Processing
	Wastewater	Mineral Processing
Tin	Brick Lining and Fabric Filters	Mineral Processing
	Dross	Mineral Processing
	Process Wastewater and Treatment Sludge	Mineral Processing
	Slag	Mineral Processing
	Slimes	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Tin (continued)	Waste Acid and Alkaline baths	Mineral Processing
Titanium and Titanium Dioxide	Spent Brine Treatment Filter Cake	Mineral Processing
	FeCl Treatment Sludge	Mineral Processing
	Waste Ferric Chloride	Mineral Processing
	Finishing Scrap	Mineral Processing
	Leach Liquor and Sponge Wash Water	Mineral Processing
	Waste Non-Contact Cooling Water	Mineral Processing
	Pickling Liquor and Wash Water	Mineral Processing
	Scrap Detergent Wash Water	Mineral Processing
	Scrap Milling Scrubber Water	Mineral Processing
	Reduction Area Scrubber Water	Mineral Processing
	Chlorination Off gas Scrubber Water	Mineral Processing
	Chlorination Area - Vent Scrubber Water	Mineral Processing
	Melt Cell Scrubber Water	Mineral Processing
	Chlorine Liquefaction Scrubber Water	Mineral Processing
	Chip Crushing Scrubber Water	Mineral Processing
	Casting Crucible Contact Cooling Water	Mineral Processing
	Smut from Mg Recovery	Mineral Processing
	Spent Surface Impoundment Liquids	Mineral Processing
	Spent Surface Impoundment Solids	Mineral Processing
	TiCl4 Purification Effluent	Mineral Processing
	Spent Vanadium Oxychloride	Mineral Processing
	Sodium Reduction Container Reconditioning Wash Water	Mineral Processing
	Casting Crucible Wash Water	Mineral Processing
	Waste Acids (Chloride process)	Mineral Processing
	Waste Solids (Chloride process)	Mineral Processing
	Waste Acids (Sulfate process)	Mineral Processing
	Waste Solids (Sulfate process)	Mineral Processing
	WWTP Liquid Effluent	Mineral Processing
	WWTP Sludge/Solids	Mineral Processing
Tungsten	Spent Acid and Rinse water	Mineral Processing
	Scrubber wastewater	Mineral Processing
	Process wastewater treatment plant effluent	Mineral Processing
	Water of formation	Mineral Processing
Uranium	Waste Nitric Acid from Production of UO_2	Mineral Processing
	Vaporizer Condensate	Mineral Processing
	Superheater Condensate	Mineral Processing
	Slag	Mineral Processing
	Uranium Chips from Ingot Production	Mineral Processing
	Waste Calcium Fluoride	Mineral Processing

EXHIBIT E-1 (Continued)

Commodity	Waste Stream	Nature of Operation
Vanadium	Filtrate and Process Wastewaters	Mineral Processing
	Solid Waste	Mineral Processing
	Spent Precipitate	Mineral Processing
	Slag	Mineral Processing
	Wet scrubber wastewater	Mineral Processing
Zinc	Acid Plant Blowdown	Mineral Processing
	Spent Cloths, Bags, and Filters	Mineral Processing
	Waste Ferrosilicon	Mineral Processing
	Spent Goethite and Leach Cake Residues	Mineral Processing
	Saleable residues	Mineral Processing
	Process Wastewater	Mineral Processing
	Discarded Refractory Brick	Mineral Processing
	Spent Surface Impoundment Liquid	Mineral Processing
	Spent Surface Impoundment Solids	Mineral Processing
	Spent Synthetic Gypsum	Mineral Processing
	TCA Tower Blowdown (ZCA Bartlesville, OK - Electrolytic Plant)	Mineral Processing
	Wastewater Treatment Plant Liquid Effluent	Mineral Processing
	Wastewater Treatment Plant Sludge	Mineral Processing
	Zinc-lean Slag	Mineral Processing
Zirconium and Hafnium	Spent Acid leachate from zirconium alloy production	Mineral Processing
	Spent Acid leachate from zirconium metal production	Mineral Processing
	Ammonium Thiocyanate Bleed Stream	Mineral Processing
	Reduction area-vent wet APC wastewater	Mineral Processing
	Caustic wet APC wastewater	Mineral Processing
	Feed makeup wet APC wastewater	Mineral Processing
	Filter cake/sludge	Mineral Processing
	Furnace residue	Mineral Processing
	Hafnium filtrate wastewater	Mineral Processing
	Iron extraction stream stripper bottoms	Mineral Processing
	Leaching rinse water from zirconium alloy production	Mineral Processing
	Leaching rinse water from zirconium metal production	Mineral Processing
	Magnesium recovery area vent wet APC wastewater	Mineral Processing
	Magnesium recovery off-gas wet APC wastewater	Mineral Processing
	Sand Chlorination Off-Gas Wet APC wastewater	Mineral Processing
	Sand Chlorination Area Vent Wet APC wastewater	Mineral Processing
	Silicon Tetrachloride Purification Wet APC wastewater	Mineral Processing
	Wet APC wastewater	Mineral Processing
	Zirconium chip crushing wet APC wastewater	Mineral Processing
	Zirconium filtrate wastewater	Mineral Processing

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX F

Mineral Processing Sectors Generating Hazardous Wastes

This list is not exclusive. Other sectors may generate mineral processing wastes that are hazardous. A generator has the obligation to test each wastestream to determine if a waste has hazardous characteristics.

EXHIBIT F-1

LIST OF SECTORS GENERATING HAZARDOUS MINERAL PROCESSING WASTE STREAMS*

Alumina and Aluminum
Antimony
Beryllium
Bismuth
Cadmium
Calcium
Chromium and Ferrochromium
Coal Gasification
Copper
Elemental Phosphorous
Fluorspar and Hydrofluoric Acid
Germanium
Gold and Silver
Lead
Magnesium and Magnesia from Brines
Mercury
Molybdenum, Ferromolybdenum, and Ammonium Molybdate
Platinum Group Metals
Rare Earths
Rhenium
Scandium
Selenium
Synthetic Rutile
Tantalum, Columbium, and Ferrocolumbium
Tellerium
Titanium and Titanium Dioxide
Tungsten
Uranium
Zinc
Zirconium and Hafnium

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX G

Mineral Processing Sectors Not Generating Hazardous Wastes

EXHIBIT G-1

LIST OF SECTORS NOT GENERATING HAZARDOUS MINERAL PROCESSING WASTE STREAMS

Arsenic Acid
Boron
Bromine
Cesium and Rubidium
Gemstones
Iodine
Iron and Steel
Lightweight Aggregates
Lithium and Lithium Carbonate
Manganese, MnO_2, Ferromanganese, and Silicomanganese
Phosporic Acid
Pyrobitumens, Mineral Waxes, and Natural Asphalts
Scandium
Silicon and Ferrosilcon
Soda Ash
Sodium Sulfate
Strontium
Tungsten
Vanadium

Note: This list is not exclusive. Generators of these waste streams should not assume that their wastes are non-hazardous simply because they are found on this list. Each generator should test its wastes to determine if they are hazardous.

IDENTIFICATION AND DESCRIPTION OF MINERAL PROCESSING SECTORS AND WASTE STREAMS

APPENDIX H

List of Commenters

January 25, 1996 Supplemental Proposed Rule

May 12, 1997 Second Supplemental Proposed Rule

Commenter List, January 1996 Proposed Rule

Number	Name(s)
COMM1	National Mining Association
COMM2	PTI Environmental Services
COMM3	The Ferroalloys Association
COMM4	Heritage Environmental Services, Inc.
COMM5	Marine Shale Processors, Inc.
COMM6	U.S. Department of Energy
COMM7	American Electric Power
COMM8	Arizona Public Service Company
COMM9	Institute for Interconnecting and Packaging Electric Circuits
COMM10	Lead Industries Association, Inc.
COMM11	New York State Department of Environmental Conservation
COMM12	Anson County ACTUS, Chapter of the Blue Ridge Environmental Defense League
COMM13	Avocet Tungsten, Inc.
COMM14	Chemgold, Inc.
COMM15	General Motors Corporation
COMM16	Public Service Electric and Gas Company
COMM17	Chemical Waste Management, Inc.
COMM18	DuPont White Pigment and Mineral Products
COMM19	Westinghouse Electric Corporation
COMM20	U.S. Borax, Inc.
COMM21	Association of Container Reconditioners
COMM22	SCM Chemicals, Inc.
COMM23	Montana Department of Environmental Quality
COMM24	Homestake Mining Company
COMM25	KRONOS, Inc.
COMM26	Jersey Central Power & Light Company
COMM27	Union Carbide Corporation
COMM28	South Carolina Electric and Gas company
COMM29	Sonora Mining Corporation
COMM30	Chemical Waste Management
COMM31	Laidlaw Environmental Services, Inc.
COMM32	Kodak

Commenter List, January 1996 (continued)

Number	Name(s)
COMM33	International Precious Metals Institute
COMM34	Institute of Scrap Recycling Industries, Inc.
COMM35	Metal Industries Recycling Coalition
COMM36	ASARCO
COMM37	Sierra Club's Midwest Office and the Mining Impact Coalition of Wisconsin, Inc.
COMM38	Phelps Dodge Corporation
COMM39	Solite Corporation
COMM40	Kennecott Corporation
COMM41	Environmental Defense Fund
COMM42	Phosphorus Producers Environmental Council
COMM43	Precious Metals Producers Battle Mountain Gold Company Barrick Gold Corporation Echo Bay Mines Independence Mining Company Santa Fe Pacific Gold Corporation
COMM44	Battery Council International
COMM45	The Fertilizer Institute
COMM46	Cyprus Amax Minerals Company
COMM47	Safety-Kleen Corp.
COMM48	SKW Metals & Alloys, Inc.
COMM49	Kemira Pigments, Inc.
COMM50	New Jersey Natural Gas Company
COMM51	South Jersey Gas Company
COMM52	Robert Lucht, Mining Engineer and Geologist
COMM53	INCO LTD INCO United States, Inc. International Metals Reclamation Company, Inc.
COMM54	RSR Corporation
COMM55	Copper & Brass Fabricators Council, Inc.
COMM56	Utility Solid Waste Activities Group Edison Electric Institute American Public Power Association National Rural Electric Cooperative Association
COMM57	Newmont Gold Company
COMM58	National Mining Association

Commenter List, January 1996 (continued)

Number	Name(s)
COMM59	Brush Wellman, Inc.
COMM60	Brush Wellman, Inc.
COMM61	Brush Wellman, Inc.
COMM62	Brush Wellman
COMM63	Brush Wellman, Inc.
COMM64	Utah Mining Association
COMM65	Aluminum Company of America
COMM66	Rio Algom Mining Corp.
COMM67	BHP Copper
COMM68	Molycorp, Inc.
COMM69	Molycorp, Inc.
COMM70	FMC
COMM71	U.S. Department of Defense
COMM72	Uranium Resources, Inc.
COMM73	Copper Range Company
COMM74	U.S. Department of Interior
COMM75	Recyclers of Copper Alloy Products, Inc.
COMM76	Kerr-McGee Corporation
COMM77	The Aluminum Association
COMM78	Rhone-Poulenc
COMM79	The Colorado Mining Association
COMM80	Molten Metal Technology
COMM81	OxyChem
COMM82	Horsehead Resource Development Company, Inc.
COMM83	Electronics Industries Association
COMM84	Chemical Manufacturers Association
COMM85	Nevada Mining Association
COMM86	U.S. Borax
COMM87	Kennecott
COMM88	California Mining Association
COMM89	Arizona Department of Environmental Quality
LCOMM1	American Gas Association

Commenter List, January 1996 (continued)

Number	Name(s)
LCOMM2	Environmental Technology Council
LCOMM3	U.S. Department of Agriculture
LCOMM4	The Ferroalloys Association
LCOMM5	Association of Battery Recyclers, Inc.
LCOMM6	Northern Plains Resource Council
LCOMM7	MISSING
LCOMM8	State of Wyoming Department of Environmental Quality

Commenter List for May 12, 1997 Second Supplemental Proposed Rule

Commenter #	Commenter Name
COMM1001	ASARCO Incorporated
COMM1002	American Wood Preservers Institute
COMM1003	Chemical Products Corporation
COMM1004	Occidental Chemical Corporation (OxyChem)
COMM1005	American Chrome & Chemicals, L.P.
COMM1006	Marine Shale Processors, Inc. (MSP)
COMM1007	Frontier Technologies Inc. (FTI)
COMM1008	Florida Phosphate Council
COMM1009	World Resources Company
COMM1010	International Metals Reclamation Company, Inc. (INMETCO) and INCO United States, Inc.
COMM1011	CITGO Petroleum Corporation
COMM1012	The Ferroalloys Association (TFA)
COMM1013	GF Industries
COMM1014	Westinghouse Electric Corporation
COMM1015	Ms. Linda W. Pierce
COMM1016	Chemical Manufacturers Association
COMM1017	Battery Council International (BCI) and Association of Battery Recyclers (ABR)
COMM1018	Collier, Shannon, Rill & Scott, PLLC for Specialty Steel Industry of North America (SSINA)
COMM1019	The Doe Run Company (DRC)
COMM1020	American Portland Cement Alliance (APCA)
COMM1021	American Petroleum Institute
COMM1022	Eastman Kodak Company
COMM1023	U.S. Department of Energy (DOE)
COMM1024	Lead Industries Association, Inc. (LIA)
COMM1025	RSR Corporation
COMM1026	Homestake Mining Company
COMM1027	Solite Corporation
COMM1028	Laidlaw Environmental Services
COMM1029	Newmont Gold Company
COMM1030	Chemical Products Corporation (CPC)
COMM1031	Florida Institute of Phosphate Research (FIPR)
COMM1032	Savage Zinc, Incorporated
COMM1033	General Motors Corporation (GM)

Commenter List, May 12, 1997 (Continued)

Commenter #	Commenter Name
COMM1034	ASARCO Incorporated
COMM1035	Utility Solid Waste Activities Group (USWAG)
COMM1036	Okanogan Highlands Alliance (OHA)
COMM1037	CF Industries, Inc.
COMM1038	The Fertilizer Institute
COMM1039	American Iron and Steel Institute (AISI)
COMM1040	Molycorp, Inc.
COMM1041	Cyprus Amax Minerals Company
COMM1042	Law Office of David J. Lennett (for Environmental Defense Fund, Mineral Policy Center, Southwest Research and Information Center, North Santiam Watershed Council, Pamlico-Tar River Foundation, Siskiyou Regional Education Project, Okanogan Highlands Alliance, and the Louisiana Environmental Action Network
COMM1043	BHP Copper
COMM1044	National Lime Association
COMM1045	The Silver Council
COMM1046	Mineral Policy Center
COMM1047	American Gas Association (AGA)
COMM1048	National Mining Association
COMM1048-D	National Mining Association
COMM1048-E	National Mining Association
COMM1049	Lake Superior Alliance (LSA)
COMM1050	Reynolds Metals Company
COMM1051	Brush Wellman Inc.
COMM1052	Brush Wellman Inc.
COMM1053	Brush Wellman, Inc.
COMM1054	Kennecott
COMM1055	Mr. William R. Schneider, P.E. (Consultant to Macalloy Corp.)
COMM1056	Nexsen, Pruet, Jacobs & Pollard, LLP (Counsel to Macalloy Corporation)
COMM1057	Photo Marketing Association International
COMM1058	Menominee Indian Tribe of Wisconsin
COMM1059	Lake Michigan Federation
COMM1060	Mr. David Isbister
COMM1061	Ms. Marianne Isbister
COMM1062	Rolling Stone Lake Protection & Rehabilitation District
COMM1063	Ms. Laura Furtman
COMM1064	Mr. Gregory Furtman

Commenter List, May 12, 1997 (Continued)

Commenter #	Commenter Name
COMM1065	Ms. Jennifer Pierce
COMM1066	Cement Kiln Recycling Coalition
COMM1067	Institute for Interconnecting and Packaging Electronic Circuits
COMM1068	Horsehead Resource Development Company, Inc.
COMM1069	Macalloy Corporation
COMM1070	Ms. Dori Gilels
COMM1071	Kenneth and Linda Pierce
COMM1072	Ms. Ellen Wertheimer
COMM1073	Mr. Earl Meyer
COMM1074	New York State Department of Environmental Conservation
COMM1075	United States Department of Defense (DoD)
COMM1076	Clean Water Action Council of Northeast Wisconsin, Inc.
COMM1077	Air Products and Chemicals, Inc.
COMM1078	EnviroSource Treatment and Disposal Services, Inc. (TDS)
COMM1079	Independence Mining Company Inc. (IMCI)
COMM1080	Uniroyal Chemical Company, Inc.
COMM1081	Eastman Chemical Company
COMM1082	Nevada Mining Association (NvMA)
COMM1083	Kerr-McGee Corporation
COMM1084	Elf Atochem North America Inc.
COMM1085	New Mexico Mining Association
COMM1086	DuPont
COMM1087	Waste Management
COMM1088	FMC Corporation
COMM1089	Phelps Dodge Corporation
COMM1090	Arizona Mining Association
COMM1091	Beazer East, Inc.
COMM1092	AlliedSignal Inc.
COMM1093	Placer Dome U.S., Inc.
COMM1094	Phosphorus Producers Environmental Council
COMM1095	U.S. Borax, Inc.
COMM1096	Appalachian Producers
COMM1097	Aluminum Company of America; Kaiser Aluminum & Chemical Corporation; Ormet Corporation; and Reynolds Metals Company.
COMM1098	AMAX Metal Recovery, Inc.
COMM1099	Barrick Resources, Inc.

Commenter List, May 12, 1997 (Continued)

Commenter #	Commenter Name
COMM1100	Koppers Industries, Inc.
COMM1101	IMC-Agrico Company
COMM1102	Echo Bay Mines
COMM1103	Mining Impact Coalition of Wisconsin Inc.
COMM1104	Precious Metals Producers (PMP)
COMM1105	California Mining Association
COMM1106	Freeport-McMoRan
COMM1107	Shoshone-Bannock Tribe Land Use Department
COMM1108	Texaco
COMM1109	Occidental Chemical Corporation (OxyChem)
COMML1001	Photographic & Imaging Manufacturers Association, Inc.
COMML1002	Phosphorus Producers Environmental Council
COMML1003	Environmental Technology Council