

Coal Ash Landfills – A Case Study

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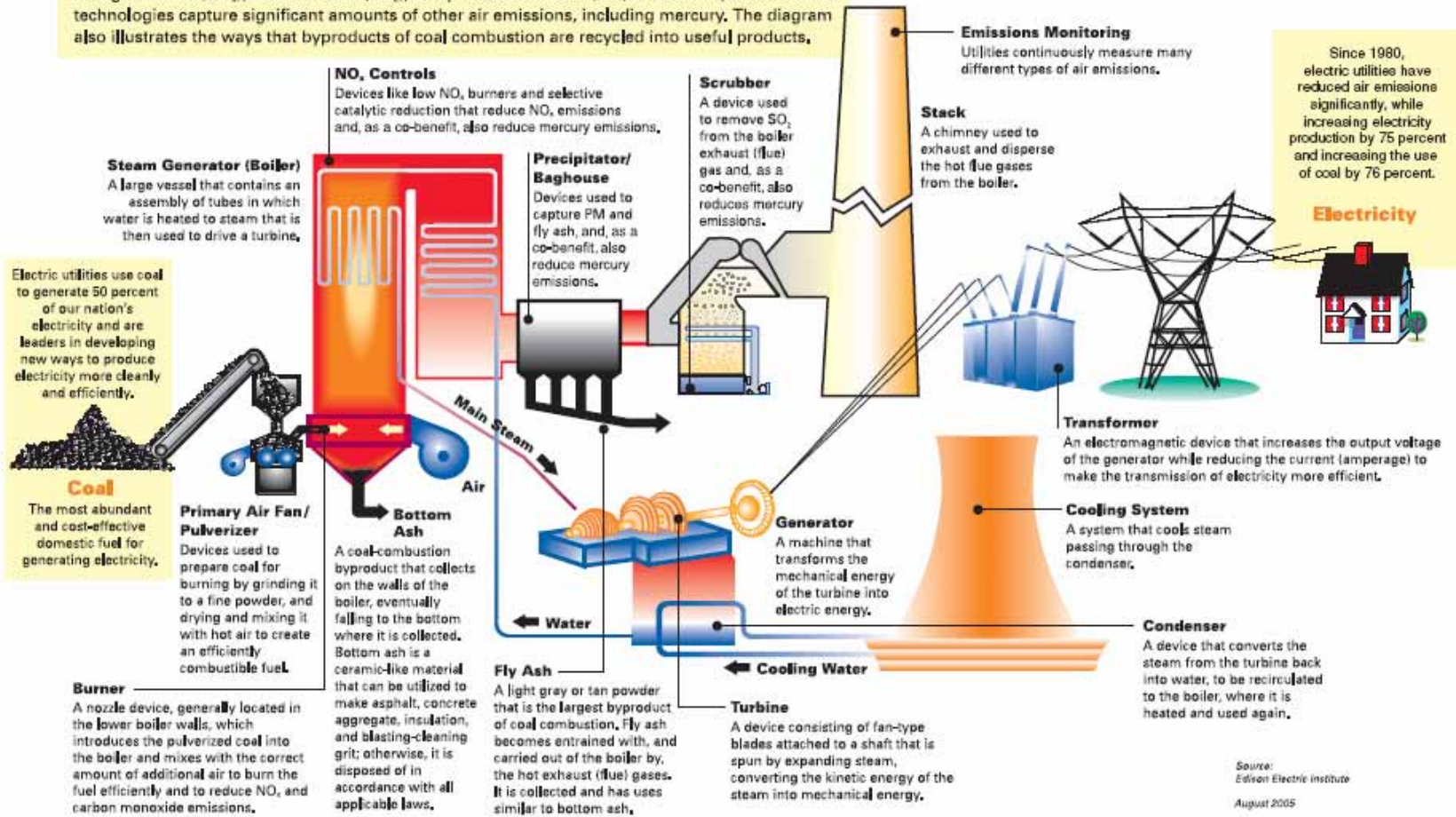
What is Coal Ash?

- Unburned portion of fuel
- Mostly comprised of minerals commonly found in soil
- Has trace elements such as arsenic, chromium, cadmium, lead & mercury

How Coal Ash Is Generated?

How Power Plants Are Reducing Air Emissions

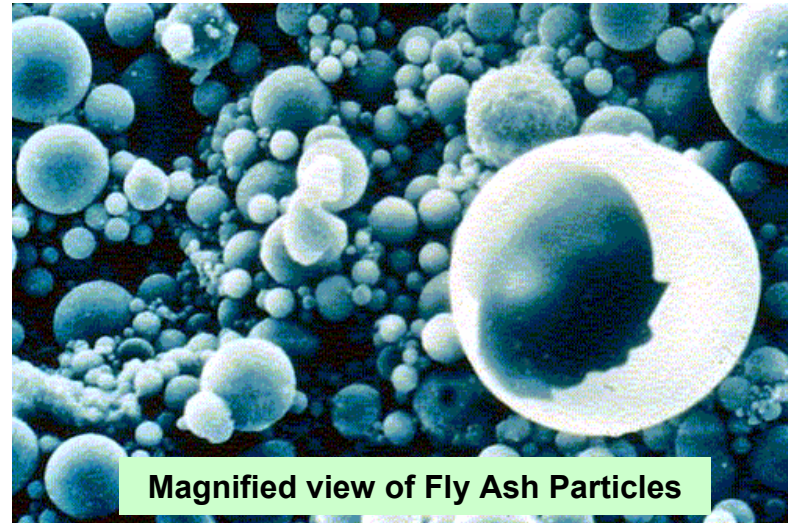
This simplified diagram is illustrative of the operations at a large coal-based electric power plant. It explains the various control technologies in place at many U.S. power plants to reduce emissions to air, land, and water. These technologies are designed to control emissions of nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter (PM). In addition, these control technologies capture significant amounts of other air emissions, including mercury. The diagram also illustrates the ways that byproducts of coal combustion are recycled into useful products.



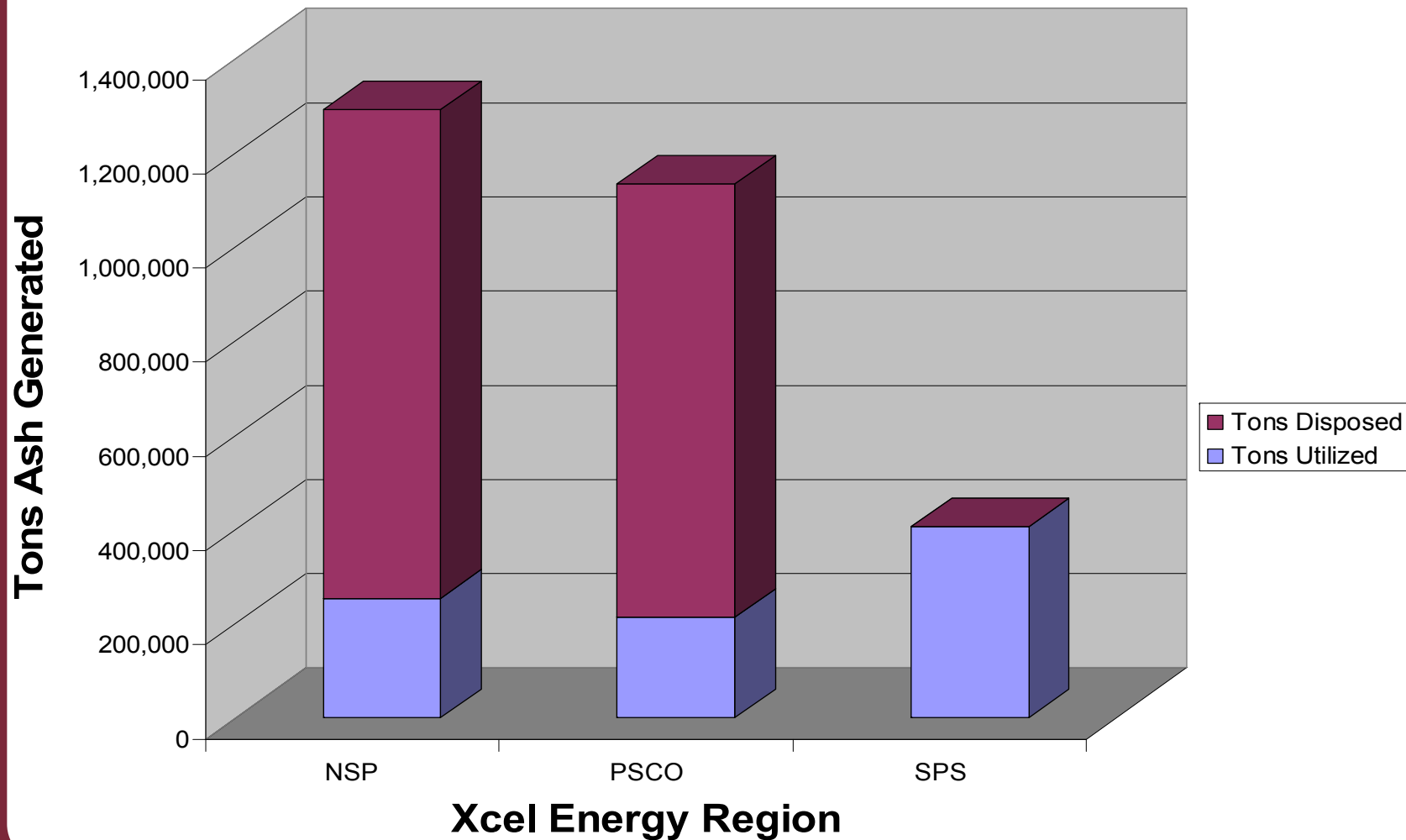
Source:
Edison Electric Institute
August 2005

Types of Ash:

- Fly Ash
- Bottom Ash
- Slag
- Scrubber Residues



2007 Coal Ash Generation:



What Factors Affecting Coal Ash Composition?

- **Fuel Source**
- **Combustion Process**
 - Circulating Fluidized Bed
 - Pulverized Coal (example SHERCO)
 - Cyclone (example A.S. King)
- **Emission Control Devices**
 - Sulfur Control
 - NOx Control
 - Particulate Control
 - Mercury Control

Coal and Additives: Trace Metal Analysis

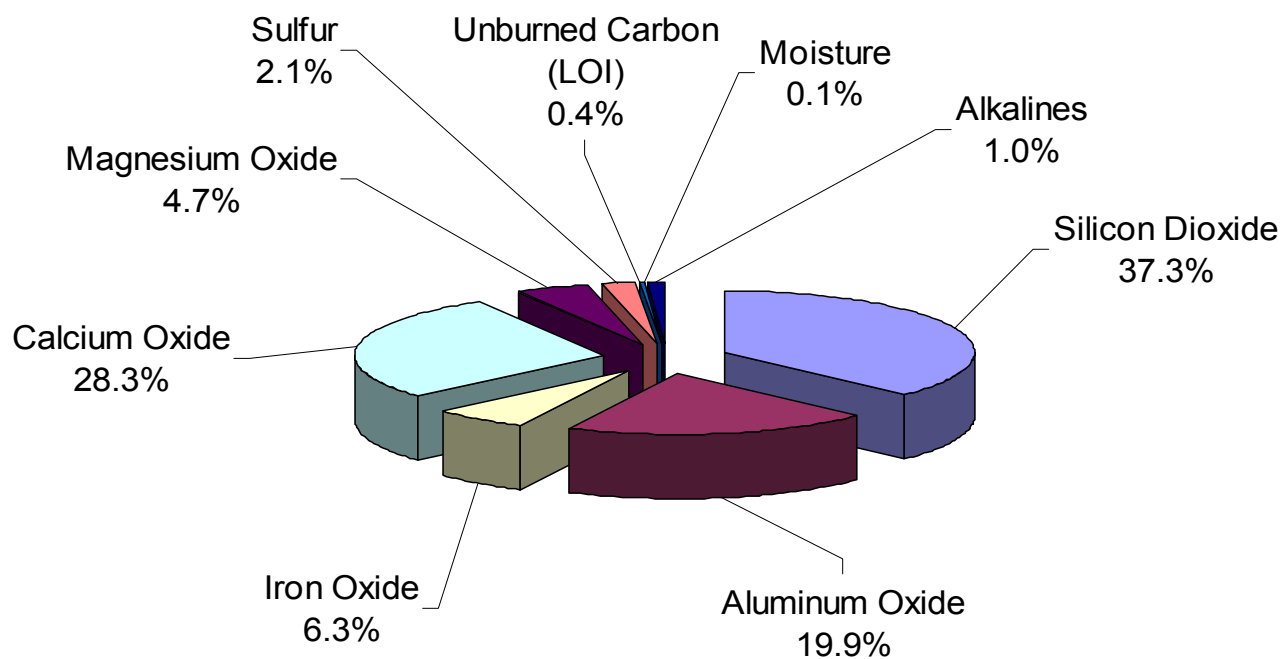
		Current Blend		
		Rochelle	Westmoreland	Petcoke
Antimony	mg/kg	-1	1.029	4
Arsenic	mg/kg	-1	1.263	-8
Barium	mg/kg	183	194.2	2.1
Beryllium	mg/kg	-0.2	0.371	-0.2
Boron	mg/kg	24	77.3	
Bromine	mg/kg	-20		
Cadmium	mg/kg	-0.2	0.274	-0.4
Chlorine	mg/kg	-50		
Chromium	mg/kg	4	4.034	-0.8
Cobalt	mg/kg	2	2.579	-2
Copper	mg/kg	9	7.000	-2
Fluorine	mg/kg	68		-10
Lead	mg/kg	2	6.13	-2
Lithium	mg/kg	3	16.24	
Manganese	mg/kg	9	78.89	1.1
Mercury	mg/kg	0.05	0.095	0.05
Molybdenum	mg/kg	-2	3.395	8
Nickel	mg/kg	3	3.211	199
Selenium	mg/kg	-1	1.158	-8
Silver	mg/kg	-0.2	0.476	-0.4
Strontium	mg/kg	148	448.6	1
Thallium	mg/kg	-1		-20
Tin	mg/kg	-1	1.432	-8
Vanadium	mg/kg	9	10.053	1041
Zinc	mg/kg	6	5.211	2
Zirconium	mg/kg	8	15.778	-0.4

Coal Trace Element Summary:

<u>PPM – Dry Basis</u>	<u>Cordero Rojo</u>	<u>Soil</u>
Arsenic (As)	1.4	1 to 50
Barium (Ba)	373	100 to 3000
Boron (B)	44	2 to 100
Cadmium (Cd)	0.2	0.1 to 0.7
Chromium (Cr)	6.1	1 to 100
Copper (Cu)	14.5	2 to 100
Lead (Pb)	3.1	2 to 200
Mercury (Hg)	0.1	0.01 to 0.3
Molybdenum (Mo)	2.1	0.2 to 5
Nickel (Ni)	2.5	5 to 500
Selenium (Se)	1.1	0.1 to 2
Strontium (Sr)	254	50 to 1000
Vanadium (Va)	21.7	20 to 500
Zinc (Zn)	10.2	10 to 300

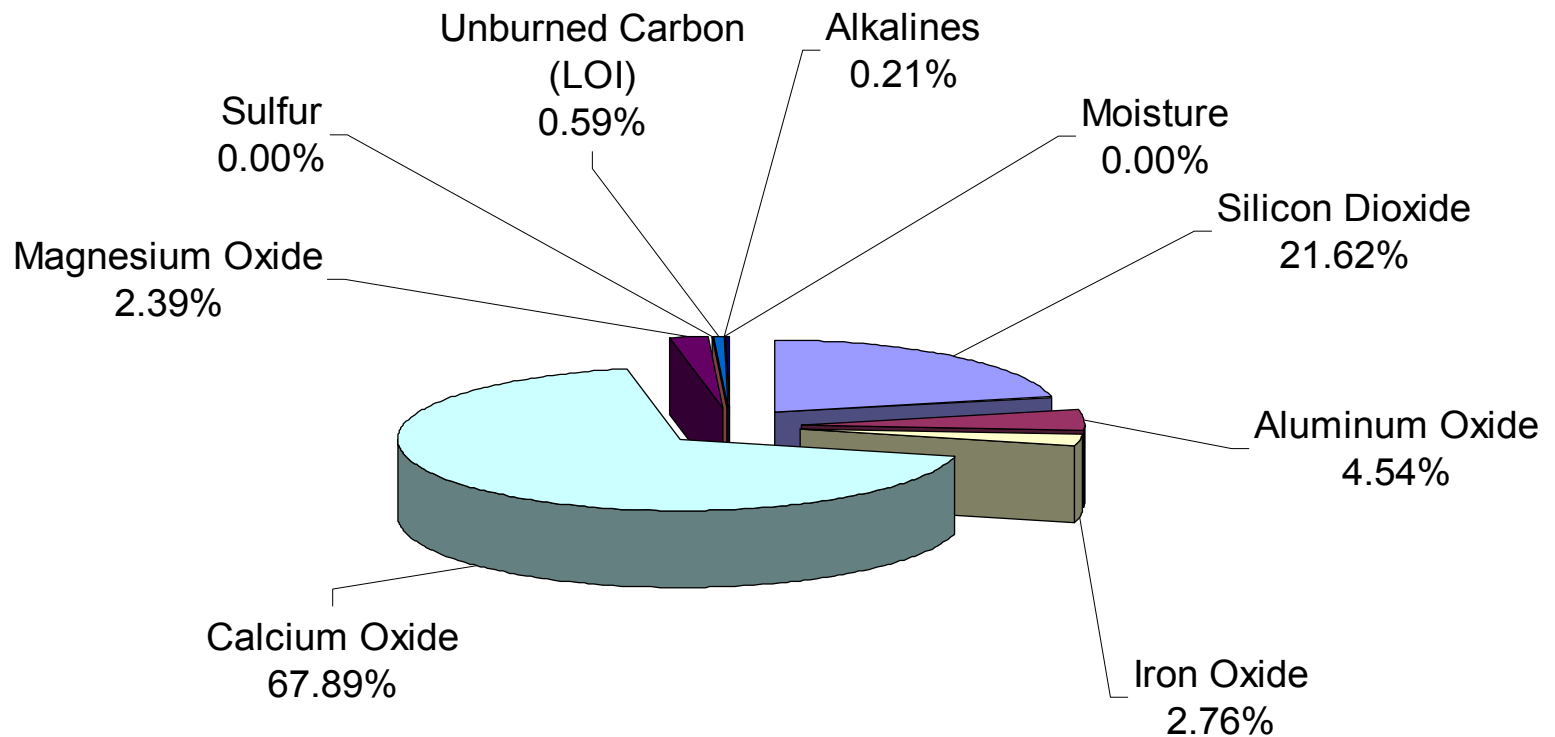
Major Constituents: Fly Ash

Typical Chemical Composition of Fly Ash



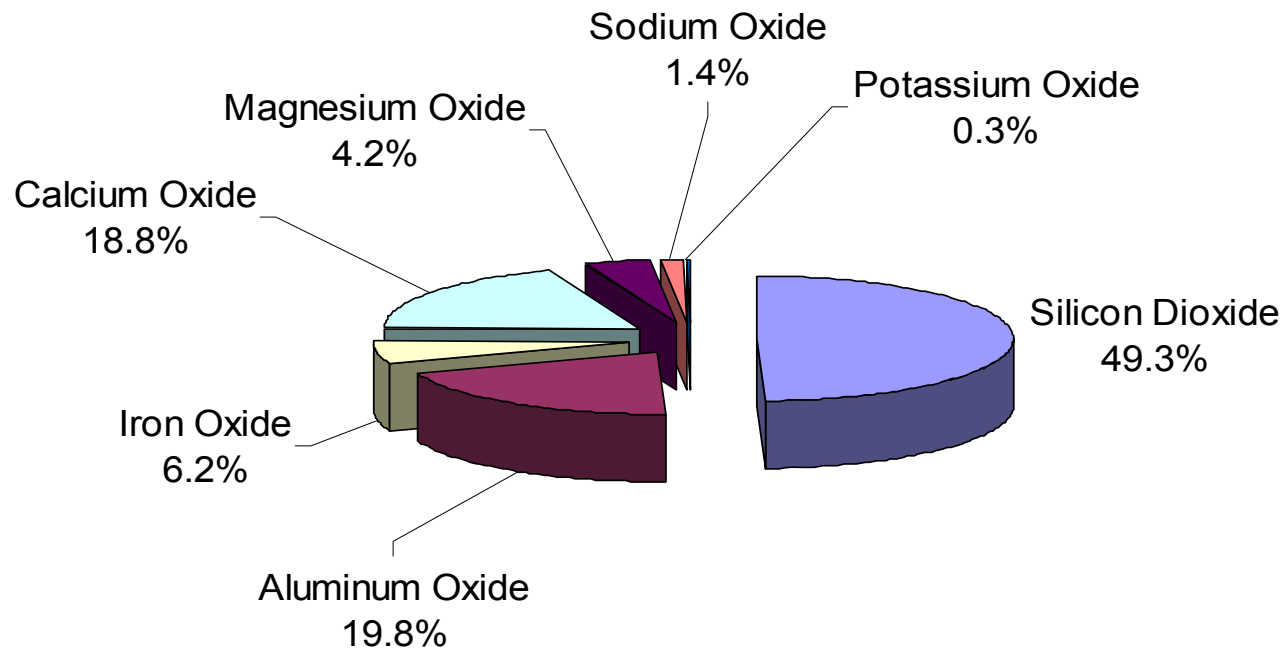
Major Constituents: Cement

Typical Chemical Composition of Cement

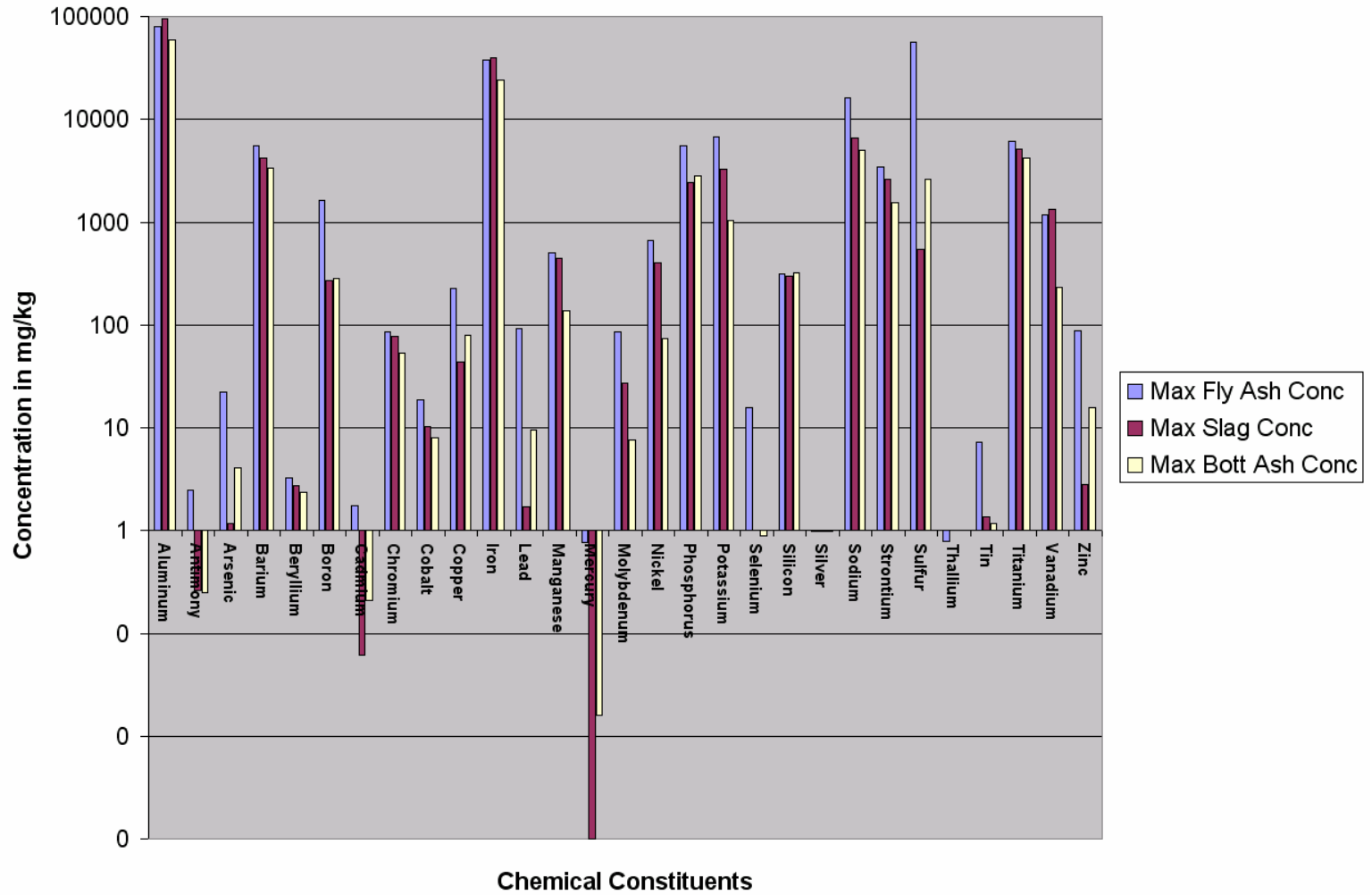


Major Constituents: Bottom Ash

Typical Chemical Composition of Bottom Ash



Relative Chemical Content:



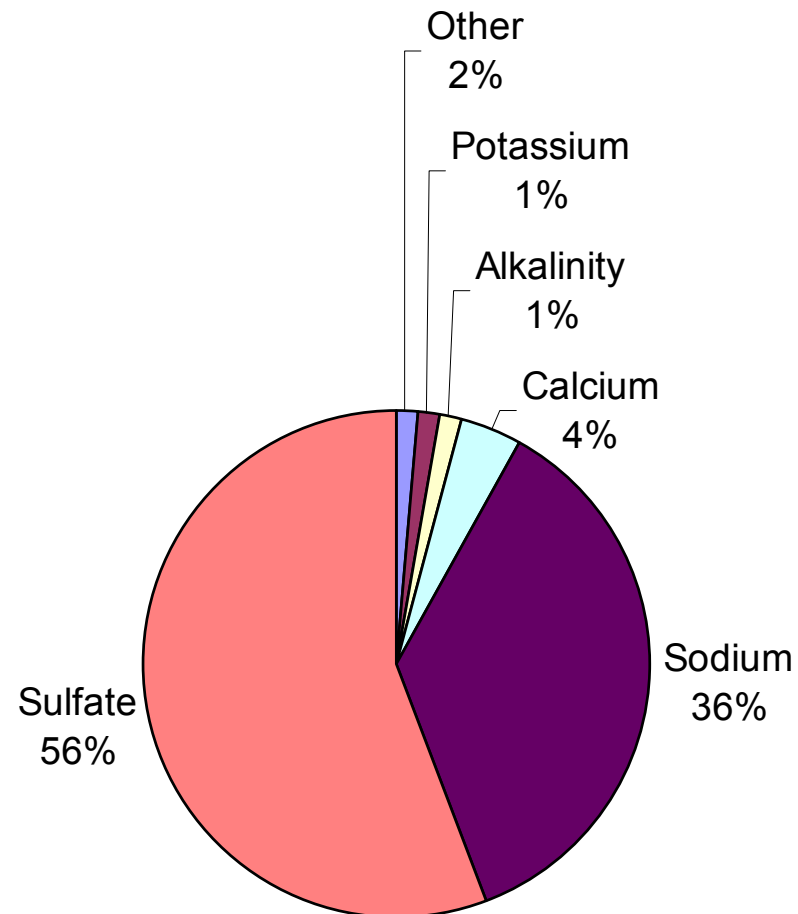
Fly Ash Total Composition: (ppm, dry)

	<u>Black Dog 3&4</u>	<u>MN Chronic Industrial SRVs</u>
Arsenic (As)	13	25
Barium (Ba)	5,260	12,500
Boron (B)	582	23,000
Cadmium (Cd)	2.7	250
Chromium (Cr)	66	425 (<i>as VI</i>)
Copper (Cu)	148	9,000
Lead (Pb)	33	700
Mercury (Hg)	0.10	2
Molybdenum (Mo)	9.0	--
Nickel (Ni)	30.2	3,000
Selenium (Se)	10.4	1,250
Sodium (Na)	10,483	--
Sulfur (S)	30,136	--
Zinc (Zn)	77	7,000

What is Leachate?

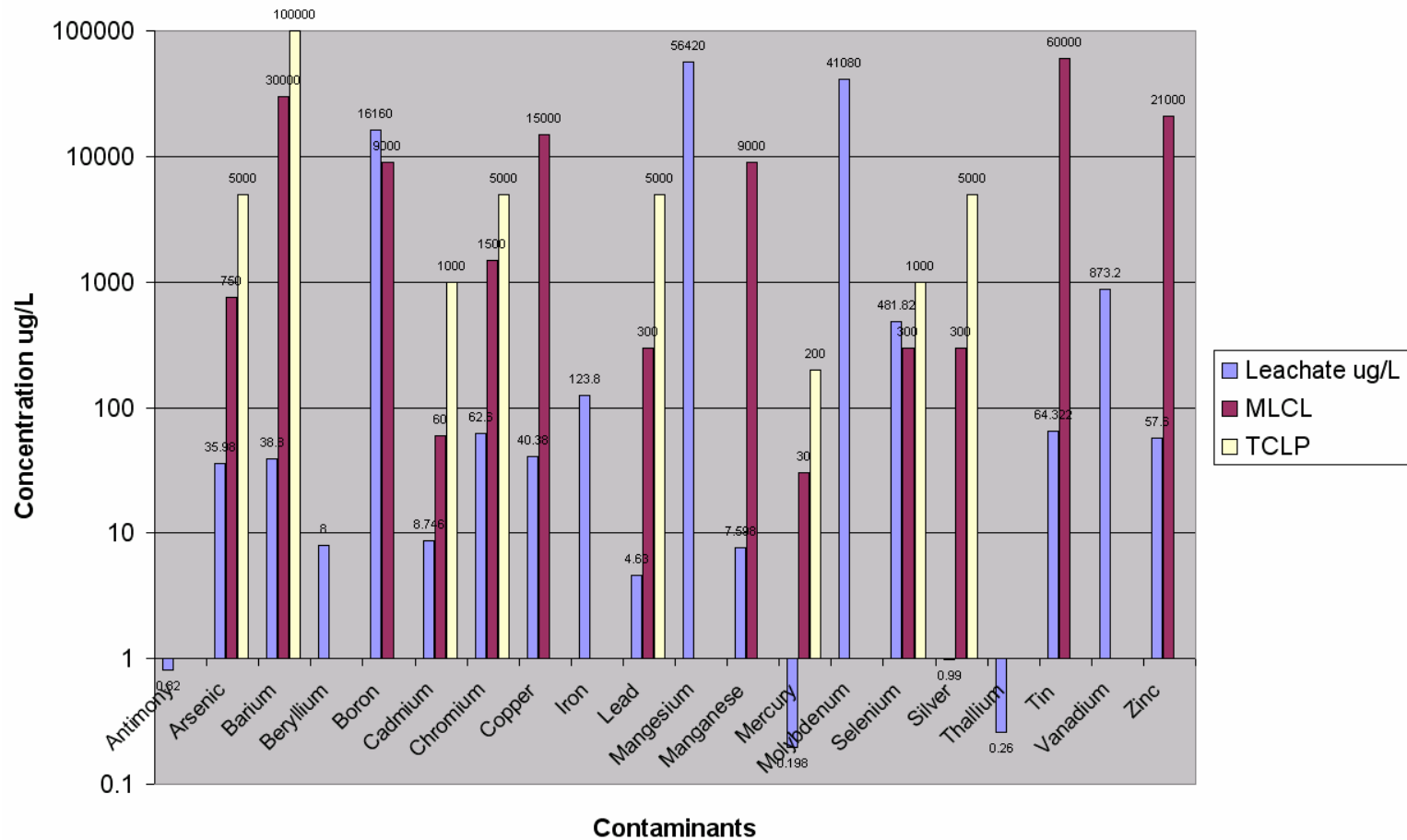
- **Leachate is defined as “liquid that has percolated through solid waste and has extracted, dissolved, or suspended materials from it”**
- **Leachate generation controlled by:**
 - Type of material and its porosity
 - Precipitation levels
 - Facility design
 - Operational controls such as size of working face
- **Leachate chemistry controlled by:**
 - Characteristics of the waste material
 - Volume of contact water
 - Chemistry of the contact water

Leachate: Primary Constituents

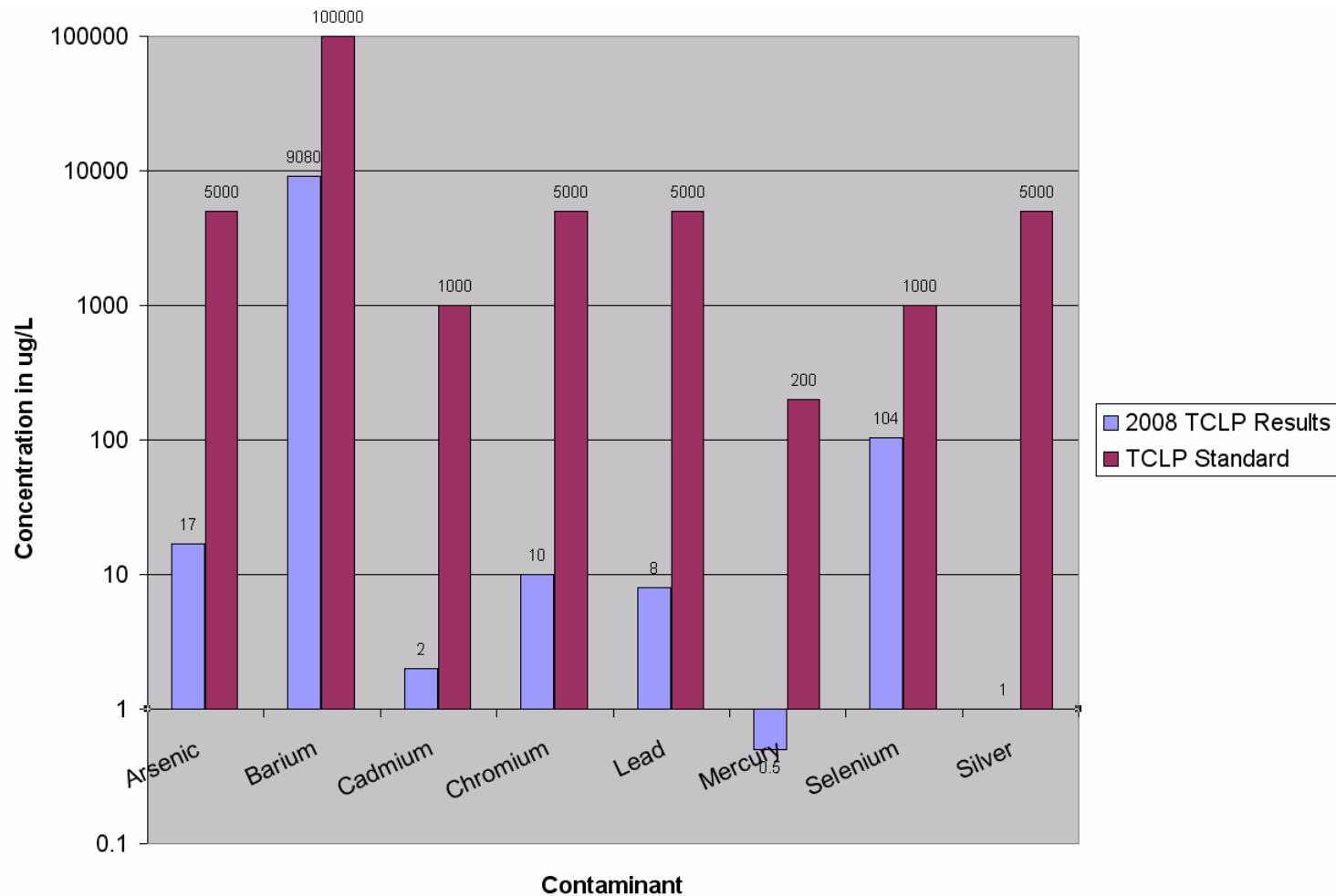


Leachate: Minor Constituents

Minor Constituents of Leachate



TCLP Test Results: 2008



NSP Disposal Facility Design

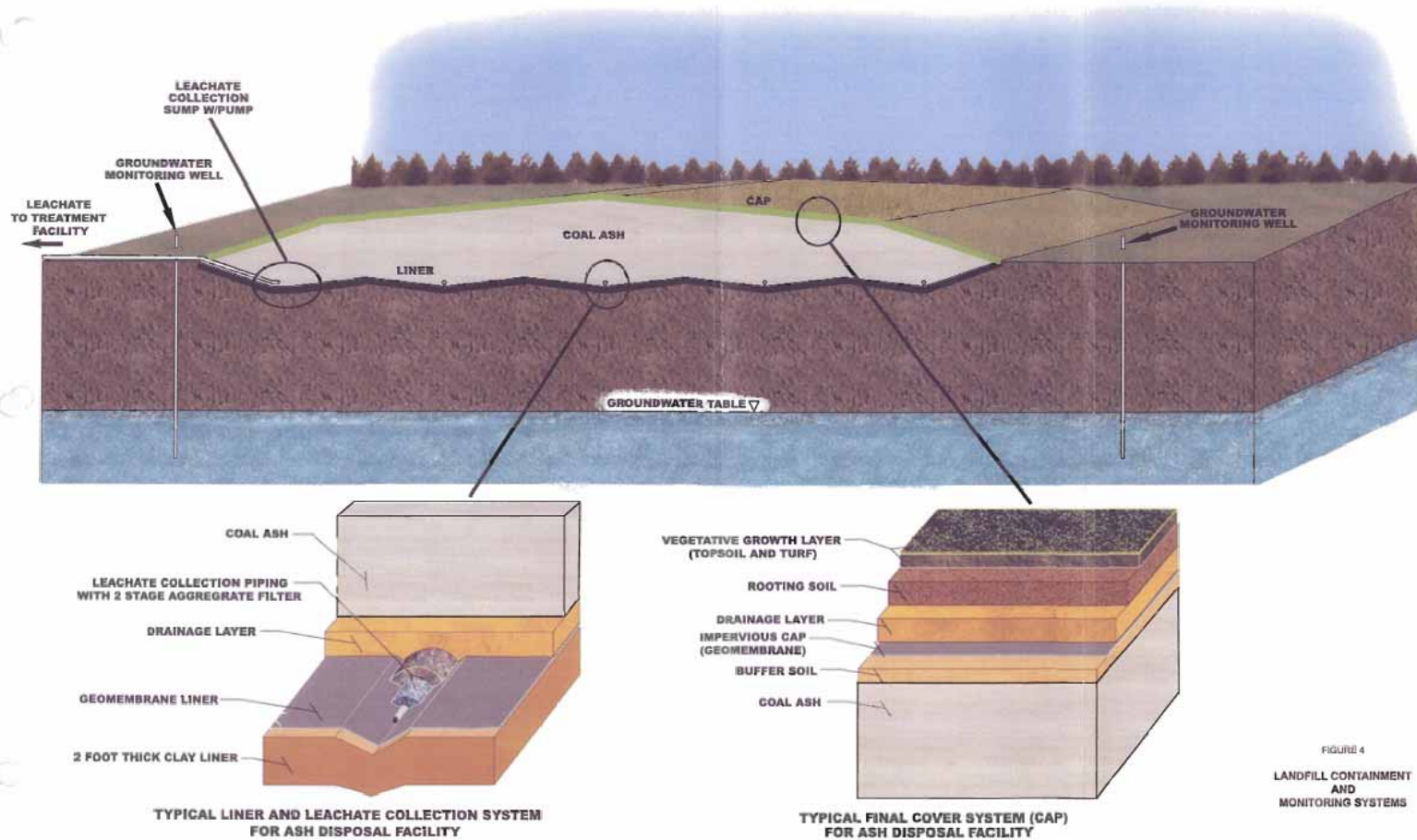


FIGURE 4
LANDFILL CONTAINMENT
AND
MONITORING SYSTEMS