A CHARACTERIZATION OF HAZARDOUS WASTE MATERIALS DISPOSED OF IN CALIFORNIA

EXECUTIVE SUMMARY

Submitted to:

State of California
Air Resources Board
Sacramento, California 95812

Contract No: A0-142-32

Submitted by:

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September 30, 1984

Science Applications, Inc. (SAI) has conducted a study for the California Air Resources Board (CARB) entitled "A Characterization of Hazardous Waste Materials in California"; this report presents the studies oriented toward its four major objectives:

- To conduct an inventory of hazardous waste sources in California and an identification of "volatile" portions of each source and the total;
- To evaluate the physical/chemical characteristics of hazardous wastes subject to on-site landfarming in California;
- To survey on-site hazardous waste incinceration processes and practices in California as a combined source of airborne pollutants; and
- To evaluate a purge and trap test method for quantifying volatile organic compounds in waste streams.

In conducting an inventory of hazardous waste generated in California, SAI reviewed all existing data bases which have assessed volume and type of waste generated. These data bases included those that have been made by Federal agencies, State agencies and private concerns. The inventory was first conducted by evaluating the individual databases in terms of their contribution to the inventory. After this initial assessment, the most applicable data bases were used to derive a total volume of hazardous waste generated in the State. The derivation relied most heavily on the U.S. Environmental Protection Agency's (EPA's) Part A Permit Application database, and on the University of California-Davis (UCD) inventory. Based on these data SAI concluded that 40.4×10^6 metric tons of hazardous waste are disposed annually in California. An additional 1.2×10^6 metric tons are disposed by small waste generators (less than 1000 kilograms per month) and in non-EPA regulated streams. No confidence limits are available for these data.

Also using the Part A database, SAI reviewed each waste stream reported by generators to determine the relative volatility of the waste components of that stream. Each RCRA code (Resource Recovery Conservation Act

- Waste Stream Code) likewise was reviewed to determine the volatile characteristics of that waste stream. Using various calculation methods, a waste stream volatility was determined by considering the dominant chemical composition of that waste stream. SAI concluded that approximately 36 percent of the waste streams generated in California are sufficiently volatile to result in the entire waste stream's being readily volatilized into the atmosphere. Table 1 lists the potentially volatile wastes disposed in California land facilities.

The classification of waste streams by common characteristics has been used as a method for regulating the many differing waste streams generated at industrial facilities. As the final component of SAI's inventory of hazardous waste streams, an evaluation of existing classification schemes was made. The California manifest system and the UCD classification system were both studied; each originally had 16 categories for which to classify wastes. The systems were recently changed to include a more comprehensive list of categories. These classification schemes have been used to inventory waste generation and disposal practices around the State. Our study indicates general trends in hazardous waste generation as well as disposal practices by various elements, including industry type, geographic location, volume, etc. Table 2 is a classification of hazardous waste disposed in California.

Landfilling, as a hazardous waste management technique, has received the greatest amount of attention from both regulators and the scientific community. Landfarming provides an excellent opportunity for volatile wastes to escape into the atmosphere. The industry most actively participating in landfarming (or land spreading) in California is the petroleum refining industry. Large quantities of sludge (Dissolved Air Flotation and American Petroleum Institute separator) are the waste streams most commonly managed by landfarming. SAI quantitatively measured the volatile constituents in land farm as wastes, hence measuring the volatility potential of waste streams from three individual refineries.

TABLE 1. POTENTIAL VOLATILE WASTES DISPOSAL AT CLASS I AND CLASS II-1 SITES IN CALIFORNIA.

UCD#	WASTE CATEGORY	WASTE AMOUNTS TONS/YR	% OF STATE TOTAL
165	Spent Catalysts	16,332	1.2
211	Halogenated Solvents w/ Heavy Metals	450	0.03
212	Halogenated Solvents w/ Other Metals	72	0.01
213	Halogenated Solvents	6,924	0.51
214	Non-Halogenated Solvents w/ Heavy Metals	1,524	0.11
215	Non-Halogenated Solvents w/ Other Metals	1,236	0.09
216	Non-Halogenated Solvents	9,558	0.70
217	Unspecified Solvents	3,342	0.25
221	Organic Liquid w/ Halogens & Metals (all kinds*)	2,598	0.19
222	Organic Liquid w/ Halogens Only	2,658	0.20
223	Organic Liquid w/ Heavy Metals Only	1,362	0.10
224	Other Organic Liquids	3,480	0.26
225	Aqueous Solution w/ Organic Residues, <10%	93,666	6.88
227	Aqueous Solution w/ Organic Residues, >10%	14,976	1.10
231	Organic Solids w/ Halogens	120	0.01
232	Organic Solids w/out Halogens	576	0.04
241	Pesticides and Wastes	69,480	5.10
242	PCB and Material Containing PCB	1,374	0.10
243	Pharmaceuticals and Wastes	36	0.00
245	Off-Specification or Aged Organics	78	0.01
248	Non-Halogenated Still Bottoms	486	0.04
254	Adhesives and Glue	594	0.04
255	Other Unspecified Organic Wastes	180	0.01
281	Waste Oil and Mixed Oil	7,602	0.56

TABLE 1 (Continued)

UCD#	WASTE CATEGORY	WASTE AMOUNTS TONS/YR	% OF STATE TOTAL
282	Oily Tank Bottoms	3,984	0.29
283	Mixtures of Oil, Sediment, Water	47,487	3.48
284	Acidic Oily Sludge	3,240	0.24
285	Alkaline Oily Sludge	11,346	0.84
286	API Separator Sludge	11,526	0.85
287	Oily Sludge	24,300	1.79
288	Oily Sludge w/ Heavy Metals	4,770	0.35
289	Mixtures of Oil, Gas w/ Water	28,902	2.12
446	Degreasing Sludge	132	0.01
447	Tetraethyl Lead Sludge	18,822	1.38
454	Paint Sludge	36,810	2.71
457	Sludges w/ Organic Residues	7,608	0.56
512	Spill Clean up	366	0.03
513	Laboratory Waste Chemicals	2,676	0.20
514	Contaminated Soil and Sand	21,594	1.62
523	Tank Bottom Sediments	54,690	4.01
531	Contaminated Rags, Pallets	1,266	0.09
	TOTAL	518,223	47.7

* It is assumed that the "all kinds" of metals category does not include "heavy metals." (Otherwise there would be double counting.)

Source: Stoddard et al., 1981

TABLE 2. SUMMARY OF HAZARDOUS WASTE QUANTITIES DISPOSED OF IN CLASS I AND CLASS II-1 FACILITIES BY UCD* WASTE CATEGORY.

UCD #	WASTE CATEGORY	HAZARDOUS WASTE AMOUNTS TONS/YEAR[1]	% STATE TOTAL
111	ACIDIC SOLUTION WITH HEAVY METALS	74,298	5.46
112	ACIDIC SOLUTION WITH OTHER METALS & NON-METALS	10,530	0.78
113	OTHER ACIDIC SOLUTION	24,720	1.82
121	ALKALINE SOLUTION WITH HEAVY METALS	17,790	1.31
122	ALKALINE SOLUTION WITH OTHER METALS & NON-METALS	38,562	2.84
123	OTHER ALKALINE SOLUTION	23,184	1.71
131	SPENT ETCHING/PLATING SOLUTION, ACIDIC	5,832	0.43
132	SPENT ETCHING/PLATING SOLUTION, ALKALINE	5,268	0.39
133	SPENT PICKLE LIQUOR	2,256	0.17
141	AQUEOUS SOLUTION WITH HEAVY METALS	24,120	1.78
142	AQUEOUS SOLUTION WITH OTHER METALS	22,116	1.63
143	AQUEOUS SOLUTION WITH REACTIVE ANIONS (includes cyanides - 17%, fluorides - 42%, sulfides - 16%, bromates - 20%, hypochlorites - 5%)	59,790	4.39
144	OTHER AQUEOUS SOLUTIONS	4,596	0.34
145	BRINE	35,892	2.64
151	INORGANIC SOLIDS	1,512	0.11
153	INORGANIC (SOLID) CHEMICALS	540	0.04
161	ASBESTOS AND WASTES	33,576	2.46
162	ALUMINUM OR TIN DROSS	12	0.00
165	SPENT CATALYSTS	16,332	1.20
167	OTHER UNIDENTIFIED INORGANIC WASTES	1,542	0.11
211	HALOGENATED SOLVENT WITH HEAVY METALS	450	0.03
212	HALOGENATED SOLVENT WITH OTHER METALS	72	0.01
213	HALOGENATED SOLVENTS	6,924	0.51
214	NON-HALOGENATED SOLVENT WITH HEAVY METALS	1,524	0.11
215	NON-HALOGENATED SOLVENT WITH OTHER METALS	1,236	0.09
216	NON-HALOGENATED SOLVENTS	9,558	0.70
217	UNSPECIFIED SOLVENTS	3,342	0.25

[1]Estimated by extrapolating UCD data for 2 months and adding estimates for Big Blue Hills.

*UCD = the University California, Davis

Source: California Office of Appropriate Technology, 1981

TABLE 2. SUMMARY OF HAZARDOUS WASTE QUANTITIES DISPOSED OF IN CLASS I AND CLASS II-1 FACILITIES BY UCD WASTE CATEGORY. (Continued)

UCD #	WASTE CATEGORY	HAZARDOUS WASTE AMOUNTS TONS/YEAR	% STATE TOTAL
221	ORGANIC LIQUID WITH HALOGENS & METALS (ALL KINDS)	2,598	0.19
222	ORGANIC LIQUID WITH HALOGENS ONLY	2,658	0.20
223	ORGANIC LIQUID WITH HEAVY METALS ONLY	1,362	0.10
224	OTHER ORGANIC LIQUIDS	3,480	0.26
225	AQUEOUS SOLUTION WITH ORGANIC RESIDUES, LESS THAN 10%	93,666	6.88
227	AQUEOUS SOLUTION WITH ORGANIC RESIDUES, GREATER THAN 10%	14,976	1.10
231	ORGANIC SOLID WITH HALOGENS	120	0.01
232	ORGANIC SOLID WITHOUT HALOGENS	576	0.04
241	PESTICIDES AND WASTES	69,480	5.10
242	PCB & MATERIAL CONTAINING PCB	1,374	0.10
243	PHARMACEUTICALS & WASTES	36	0.00
244	PHOTOCHEMICALS & WASTES	1,470	0.11
245	OFF-SPECIFICATION OR AGED ORGANICS	78	0.01
248	NON-HALOGENATED STILL BOTTOMS	486	0.04
251	TANNERY WASTES	11,100	0.82
253	DETERGENTS & SOAP	2,130	0.16
254	ADHESIVES AND GLUE	594	0.04
255	OTHER UNSPECIFIED ORGANIC WASTES	180	0.01
261	POLYMERIC RESIN WASTES	4,038	0.30
262	LATEX & WASTES	1,938	0.14
263	OTHER POLYMERIC WATER WASTES	9,618	0.71
271	SEWAGE SLUDGE	984	0.07
272	OTHER BIOLOGICAL WASTES	1,494	0.11
281	WASTE OIL & MIXED OIL	7,602	0.56
282	OILY TANK BOTTOMS	3,984	0.29
283	MIXTURES OF OIL, SEDIMENTS & WATER	47,487	3.48
284	ACIDIC OILY SLUDGE	3,240	0.24
285	ALKALINE OILY SLUDGE	11,346	0.84
286	API SEPARATOR SLUDGE	11,526	0.85
287	OILY SLUDGE	24,300	1.79
288	OILY SLUDGE WITH HEAVY METALS	4,770	0.35
289	MIXTURES OF OIL, GAS, WITH WATER	28,902	2.12
412	FILTER PRESS CAKE/SLUDGE	864	0.06
413	SCRUBBER SLUDGE	780	0.06
416	INK SLUDGE	1,152	0.08
417	ALUM & GYPSUM SLUDGE	156	0.01
431	HEAVY-METAL SLUDGE	64,512	4.74

TABLE 2. SUMMARY OF HAZARDOUS WASTE QUANTITIES DISPOSED OF IN CLASS I AND CLASS II-1 FACILITIES BY UCD. WASTE CATEGORY. (Continued)

UCD #	WASTE CATEGORY	HAZARDOUS WASTE AMOUNTS TONS/YEAR	% STATE TOTAL
433	OTHER METALS SLUDGE	19,194	1.41
441	LIME SLUDGE	21,738	1.60
442	PHOSPHATE SLUDGE	114	0.01
443	SULPHUR SLUDGE	32,706	2.41
445	PLATING/METAL FINISHING SLUDGE	6,276	0.46
446	DECREASING SLUDGE	132	0.01
447	TETRAETHYL LEAD SLUDGE	18,822	1.38
453	PAPER PULP/SLUDGE	4,020	0.30
454	PAINT SLUDGE	36,810	2.71
455	DYE SLUDGE	54	0.00
456	OTHER WASTE TREATMENT SLUDGE	2,784	0.21
457	SLUDGES WITH ORGANIC RESIDUES	7,608	0.56
509	GAS CYLINDERS OR CONTAINERS	18	0.00
510	FLUE-GAS SCRUBBER LIQUID	78,474	5.77
511	RINSE WATER & WASTEWATER	24,012	1.77
512	SPILL CLEAN UP	366	0.03
513	LABORATORY WASTE CHEMICALS	2,676	0.20
514	CONTAMINATED SOIL & SAND	21,594	1.62
515	DRILLING MUD	130,782	9.61
518	DUST COLLECTOR WASTE	174	9.61
519	FLY ASH, RETORT ASH	2,634	0.19
521	SPENT CARTRIDGE FILTERS	60	0.00
523	TANK BOTTOM SEDIMENTS	54,690	4.01
524	CHEMICAL TOILET WASTE	960	0.07
525	METAL DUST & MACHINING WASTE	936	0.07
526	CANNERY WASTE	732	0.05
527	MUD/SEDIMENT & WATER	19,890	1.46
531	CONTAMINATED RAGS, PALLETS	1,266	0.09
532	CONTAMINATED EQUIPMENT CONTAINERS	6,736	0.50
535	TOTALLY UNSPECIFIED WASTES	2,994	0.22
	TOTAL	1,359,883	100.00%

Samples of the sludges were collected at each refinery just prior to the time the material was to be spread. The sludges while analysed for priority pollutants (volatile organics, base-neutral extractables, pesticides, metals) and examined for physical properties. The analyses showed that the sludges (DAF and IAF) contained more than trace amounts of cadmium, copper, lead, selenium, and zinc and that the algae skimmings were high in cadmium, copper, lead nickel and selenium. The concern is the potential accumulation of heavy metals in the soil, particularly of cadmium, chromium, copper, lead, mercury, selenium and zinc.

In analyzing the sludge for organic materials, particular emphasis was placed on the more highly volatile organic compounds which have the greatest potential for release to the atmosphere. Overall the sludges showed a relatively low concentration of highly volatile constituents. This condition is most likely explained by the fact that the treatment of the sludges prior to landfarming has resulted in the volatiles being stripped from the waste material. The analysis of the sludges for their semi-volatile, or solvent extractable organic compounds showed that the waste contained much higher concentration of these pollutants than of the volatile organics. The heavier molecular weight fraction of the waste stream contained a range of polyaromatic compounds from naphthalene through fluoranthene. No appreciable concentrations of pesticides or polychlorinated biphenyls were found in the land farmed materials. The analysis showed that the land farmed sludges contain significant amounts of both inorganic and organic constituents which could contribute to volatile emissions.

As a third objective in this study, an inventory was conducted of California industrial facilities which incinerate hazardous waste as a disposal option. At the time SAI undertook this effort an inventory of incinerators had not been conducted in several years (1981) and there was reason to believe that the status of hazardous waste incinerators had changed significantly in that time. SAI's inventory was conducted by formally surveying all

facilities which had indicated that they conducted incineration when they filed their Part A RCRA permit. The results of the SAI survey showed that of the eleven active incinerators, three do not incinerate hazardous waste (Table 3). The average capacity of the incinerators is 11.3 million BTU/hr, although there is a very wide range in capacities. Approximately 50,000 tons of hazardous waste are being incinerated annually in California. Of greatest significance in comparing the survey results from the 1981 and 1983 surveys is that, the number of incinerators have dropped (19 to 11) while the volume of waste incinerated annually has risen dramatically (28,800 to 50,000 tons).

The final objective of this program was an assessment of a proposed analytical protocol for measuring volatile organic matter in land farmed materials. The California ARB has developed a Suggested Control Measure (SCM) test protocol for assaying volatile organic compounds (VOC). This regulatory measure recommends that any waste containing greater than 1 percent VOC not be permitted for land disposal. To ensure compliance with this measure, CARB proposes an analytical technique for determining VOC which could be conducted rapidly, inexpensively and accurately and be adaptable to field applications. SAI was requested to review this protocol and assess the proposed method. SAI's review is included as an Appendix to this overall report.

The VOC measuring protocol is a gravimetric purge and trap technique which strips the VOC from the sample onto a solid sorbent where it is weighed gravimetrically. To assess the reliability and accuracy of the protocol, SAI compared this technique with sophisticated monitoring methods (gas chromatography). In addition, evaluations of each step of the VOC procedure were made to determine where, or if, bias could be introduced to the analytical technique. The results of SAI's evaluation showed that the VOC protocol was in need of further development before it could be used as a regulatory control option. Specifically, problems were identified with its ability to remove moisture from the samples, the ability to perform accurately in the presence of low molecular weight hydrocarbons, and the overall safety of the apparatus design.

TABLE 3. CALIFORNIA INCINERATOR FACILITIES SUMMARY - 1983 SURVEY
(Plant numbers indicated below are same as in 1981 survey)

Plants	No. of Waste Streams	Annual Amount of Waste Processed	Reason for Incinerator Installation	Purpose of Incinerator	Purpose of Permit from Air Pollution Central Districts
*Plant 1	1	600 tons	Air Pollution control	To control rising odor from Polyester production	Regulation
*Plant 2	1	250 tons	APCD Requirement odor & organic emission control	Condensed organic vapors reclaimed as energy source	Odor and emission control APCD Requirement
Plant 3	8	6,500,000 gals./ 11 months	Incinerate waste from manufacturing process	To incinerate waste	Regulates air pollutants
Plant 5	1	24,800 lbs.	Security & economy	To incinerate waste	Control visible emissions and particulate matter emissions
Plant 8	2	260 tons	Production fume control	Fume control a waste heat boiler & an aqueous waste system were added	Restrict emission of NO_x, SO_x particulate
Plant 9	2	50 tons 1,800 lbs.	Incinerate pathological material and woodshavings.	Incinerate waste	Revenue and quality assurance
Plant 10	1	457,998 gals.	Disposal of fumes	Steam is also generated for plant processing	Air pollution control system
*Plant 11	2	600 tons	Odor control and distruction of acidic aqueous waste stream	To incinerate odorous air emissions	Regulations require permits to determine compliance and monitor emissions
Plant 12	1	7,400 tons	Improvement of solid wastes disposal operation, energy conservation, method and destruction of sensitive material generated by govt. contracts	To utilize the available energy in solid waste to reduce electrical power required for environmental heating & cooling 2 plant buildings	Restrict emission of NO_x, SO_x particulate
Plant 13	2	119 tons	To dispose of waste from proprietary chemical Mftr. decrease disposal cost and receiving of useful energy	To incinerate waste for steam generation	Regulations require a permit to operate any equipment which may cause, reduce or control air contamination
Plant 14	2	51,900 tons	To regenerate spent sulfuric acid from local refineries & soap Mftr.	Regenerate spent H_2SO_4 to manuf. virgin soap	SO_2 abatement

*These incinerators are not considered to be hazardous waste incinerators by DOHS.

Overall this study resulted in a comprehensive evaluation of the generation of hazardous waste in the State of California. As a focus on volatile waste materials, it identified waste streams most likely to create emmission problems, and then focused on the analysis of waste which are landfarmed. The inventory of incinerators in California and the types and quantities of waste material being treated by this technique were updated. Finally, SAI evaluated a regulatory control measure which could mitigate the amount of volatile waste being land disposed.