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STUDY OF THE CHARACTERIZATION OF WASTES AND DISCHARGES FROM SELECTED ORGANIC CHEMICAL PLANTS

By

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1. SUMMARY

The basic objective of the study was to generate analytical data on the types and quantities of organic chemicals present in the discharges from the subject plants with special emphasis on general solvents and on Priority and Candidate Chemicals identified by the Environmental Contaminants Act.

This report examines the organic and inorganic characteristics of liquid and solid wastes generated by five organic chemical plants selected by EPS. The subject plants can be described as follows:

Plant A manufactures alkyd and latex paints, stains, varnishes, lacquers, metal primers, metal enamels and a wood preservative.

Plant B manufactures resins which include phenol-formaldehyde, urea-formaldehyde, alkyds, polyester, polyvinyl acetate and butyl acrylate.

Plant C manufactures ABS and PVC pipe by extrusion.

Plant D manufactures latex, alkyd and clear coatings.

Plant E manufactures polyester resin.

Plants A, C and D utilize resins and emulsions manufactured off site to produce their final products. Plants B and E manufacture some of the resins required by the other plants, but in turn utilize raw materials and monomers manufactured by others.

Plant descriptions, sample descriptions and discussions on the priority chemicals and major waste components are provided with a separate section allotted for each plant, Sections 3 - 7. The tabulated analytical results for both the conventional and organic analyses are provided at the end of each section. Volumetric loadings of all liquid and solid wastes were estimated in conjunction with information provided by each plant representative and are included in each plant section. Recommendations for reducing the environmental impact of the individual waste streams are provided where appropriate.

The mass loadings should be utilized for comparative purposes only since they are based on single samples collected during the site visit.

The analytical methodology is described in Appendix A. Organic analyses in general involved extraction for individual compound groups followed by gas chromatography for identification of Priority Chemicals. Selected extracts were also analyzed by gas chromatography/mass spectrometry in order to identify major components. A quality assurance program was conducted to provide a check on procedures and is also outlined in Appendix A.

All solid wastes were subjected to a leaching test following the BC Ministry of the Environment Special Waste Extraction Procedure(1). The analytical results from leachate samples are included in each plant section. All samples were evaluated and classified according to the regulations pursuant to the Transportation of Dangerous Goods Act. Classifications are provided in Section 8.

Priority and candidate chemicals detected in at least some of the samples examined during the study included phthalic acid esters, organotins, anilines and a trialkyl phosphate. Priority and candidate chemicals not detected in any samples included chloroparaffins, chloromethanes and triaryl phosphates.

Effluent from Plants A and E was very toxic to fish and mitigation to reduce toxicity is recommended. Final effluents from Plants B, C and D were non-toxic. The practice of final effluent disposal at Plant E using an exfiltration basin should be evaluated to determine ultimate impact on groundwater quality.

The practice of storing spent solvent sludge at Plant A and off-spec resins at Plant B represents an environmental hazard. Methods are required for either recycle or disposal to reduce these hazards.

The handling methods for baghouse and cyclone dust at Plant C result in spills that are ultimately washed to the storm sewer. Equipment modifications are required to reduce these losses.

The study was conducted as a joint project of Sigma Resource Consultants Ltd (Sigma) and Analytical Service Laboratories Ltd (ASL). All conventional analyses were conducted by the Environmental Protection Service/Fisheries and Oceans Laboratory of West Vancouver, B.C. ASL was responsible for all organic analyses and in turn utilized Enviro-Test Laboratories Ltd of Edmonton, Alberta for the GC/MS work.

2. APPROACH

2.1 GENERAL

The general approach to the study involved process review, site visits, sample site selection, sample collection, conventional analyses, organic parameter analytical schedule preparation, organic analyses and finally analytical results review and report preparation. The objective of the study was to generate data on types and quantities of organic chemicals present in the discharges from the selected plants with special emphasis on Priority and Candidate Chemicals identified by the Environmental Contaminants Act.

2.2 SAMPLE COLLECTION APPROACH

Wastewater and sludge samples were collected at each plant with the intent of characterizing and quantifying all major waste components and priority chemicals. Prior to the site visits, internal EPS plant dossiers (6) were reviewed to provide background information on the manufacturing processes involved, plus related wastewater and sludge production at each subject plant. Plant visits then involved review of manufacturing processes and waste generation with company representatives so as to determine waste sample collection sites, flowrates and discharge frequency of all wastewater and solid discharges. The major emphasis of sample collection was in obtaining samples which were as representative as possible. A log of all samples collected during the study are presented in Table 1. All samples except final effluent at Plant D were grab. The final liquid effluent at Plants A & E were collected in holding tanks, mixed and then discharged on a batch basis. These effluent grab samples were therefore representative of a significant number of days of plant operation. Raw liquid effluent from Plant B discharges to a mixed 14 day equalization pond prior to treatment in an activated sludge unit. Therefore the intermediate sample (Table B-1, B-2) would be representative of a reasonable number of days of operation at Plant B and obviously the discharge from the activated sludge unit would be fairly representative of treated effluent. The final effluent at Plant C is excess cooling water bled from a cooling water circuit. A forced air cooling tower is utilized to reduce water temperature

TABLE 1

WASTE CHARACTERIZATION STUDY

SAMPLE LOG

ASL #	SAMPLE TYPE	PLANT	DESCRIPTION	SAMPLING DATE	SIGMA DESIGNATION
1630-1	Water	A	Effluent	Feb 19	AE-1
1630-2	Sludge	A	Latex Sludge	Feb 19	AS-2
1630-3	Water	A	Effluent	Feb 25	AE-3
1630-4	Water	A	Trans Blank	Feb 25	TB-4
1630-5	Sludge	A	Spent Solvent Sludge	Feb 25	AS-5
1630-6	Sludge	A	Paint Skins	Feb 25	AS-6
1630-7	Water	B	Raw Effluent	Feb 26	BE-7
1630-8	Water	B	Equalized Intermediate Effluent	Feb 26	BE-8
1630-9	Water	B	Final Effluent	Feb 26	BE-9
1630-10	Sludge	B	Collection Tank Sludge	Feb 26	BS-10
1630-11	Solid	B	Filter Paper from Alkyd Resin Filter Press	Feb 26	BS-11
1630-12	Water	C	Cooling Water Effluent	Feb 27	CE-12
1630-13	Solids	C	Pipe Trimmings	Feb 27	CS-13
1530-14	Sludge	C	Sump Sludge	Feb 27	CS-14
1630-15	Solids	C	Baghouse Dust	Feb 27	CS-15
1630-16	Solids	C	Cyclone Dust	Feb 27	CS-16
1630-17	Water	D	Combined Effluent	Mar 01	DE-17
1630-18	Water	D	Tank Washing	Mar 01	DE-18
1630-19	Solids	D	Baghouse Dust	Mar 01	DS-19
1630-20	Water	E	Final Effluent	Mar 11	EE-20
1630-21	Sludge	E	Sludge from Collection Trough	Mar 11	ES-21
1630-22	Solids	E	Baghouse Dust	Mar 11	ES-22

prior to recycle. Excess cooling water would represent only a small percentage of the recycle flowrate, therefore the effluent sample would be representative of several weeks of operation. Plant D is a relatively small paint manufacturer. Waste discharges at this plant are highly dependent on the type of paint being manufactured at any given time. Recycle of solvent and water washes can virtually eliminate a discharge. Therefore a composite sample was collected during a period when some discharge was expected. This sample therefore did not represent "typical" or average conditions. All sludge and solids samples collected during the study were grabs due to the extreme difficulty involved in obtaining representative sludge samples. However, sludge samples AS-2 and CS-14 would be relatively representative since they were mixed and accumulated over a reasonable time period.

2.3 ANALYTICAL APPROACH

The twenty samples obtained from the plants consisted of two major types: liquid effluents and solid wastes. The solid wastes could be further subdivided into sludges (process and treatment wastes) and dry solids (baghouse and cyclone collection dusts). The samples collected were very diverse, due to the different chemical processes, raw materials and final products involved.

A number of factors were taken into consideration in choosing an approach to the analyses of the samples for organic parameters. Firstly, information obtained from the plant dossiers supplied by the Scientific Authority and information from the manufacturers, was used to determine the raw materials and type of process utilized. This, in conjunction with technical literature on production techniques allowed for some insight into the possible presence of some chemical compounds.

Secondly, the Priority and Candidate Chemicals of the Environmental Contaminants Act were taken into consideration. Based on raw material usage, finished product and by-product production, the potential presence of the regulated compounds were examined.

Finally, general physical observation and conventional chemical analyses, as well as a "crude" organic extraction and analyses, yielded information on the chemical complexity of the various samples.

Taking into account all of the above, the analytical requirements with respect to the priority and candidate chemicals were defined. Many of the groups of chemicals defined in the Act were eliminated by their absence from use in production and the impossibility involved with generation as by-products. These include compounds or compound groups such as polychlorinated biphenyls (PCBS), chlorofluorocarbons, chlorobenzenes, ethylenethiourea and halogenated toluenes and diphenyl ethers. Priority and candidate chemicals not investigated during the study are listed in Table 2.

A number of groups were targeted for specific analyses, including phthalate acid esters, chlorinated phenols, tri-aryl phosphates, and solvents. The analyses for these groups were optimized and a select list of parameters within each group were specifically sought.

Due to the nature of some of the raw materials consumed and the types of products produced, it was identified that many of the organic compounds present would not be amenable to analyses by the techniques selected. Long chain cellulose compounds used as thickeners and fillers as well as polymers would be prime examples. Many of these compounds are considered innocuous relative to the compounds of interest, therefore the need for identifications or quantitation of these compounds was a low priority.

The extraction of the samples for organic parameters generally followed the protocol of the U S E.P.A. priority pollutant analysis. Extractions of the liquid samples were carried out on a total extractable basis. This was achieved using liquid - liquid extractions under both acidic and basic pH conditions. The solid waste samples were extracted in two ways: firstly on a total basis and secondly on a leachable or extractable basis using a modification of the BC Ministry of Environment Special Waste Extraction Procedure (SWEP). This leacheate procedure is used to simulate the effect of landfill conditions on solid waste.

TABLE 2

PRIORITY AND CANDIDATE CHEMICALS NOT INVESTIGATED

Chlorobenzenes

Chloroethanes

Chloroethylenes

Chlorofluorocarbons

Ethylenethiourea

Halogenated Diphenyl Ethers

Halogenated Toluenes

Nitrophenols

Organophosphorous Compounds (excluding phosphates and derivatives)

Polychlorinated Biphenyls

Extractions were carried out on the dewatered portion of wet sludges, but directly on dry solids. A modification was made in the procedure to allow for certain important conventional parameters to be analyzed on the leacheate solution. The solutions generated from the SWEP test were then extracted on a total basis for the organic analyses. Details of the analytical methodology covering the extraction of liquid and solid wastes and the SWEP test are included as in Appendix A.

Based on the results of the conventional analyses, the "crude" extraction and analyses, and the gas chromatographic analysis of the acid and base-neutral fractions of the sample extracts, ten samples were selected for further analyses by gas chromatography/mass spectrometry (GC/MS). All samples analyzed by GC/MS are listed in Table 3. The criteria used was the complexity of the sample extracts and the number of "unknown" components present. Each set of sample extracts was subjected to a target search for certain classes of U S E.P.A. organic priority pollutants. The PCB and pesticide fraction was omitted as discussed previously. This allowed for analysis for many compounds in the sample extracts which could not be economically achieved using conventional gas chromatography techniques. The extracts were also analyzed by searching the GC/MS spectral data generated through a library of spectra in order to facilitate identification of many of the major components. A threshold was set for each sample extract to enable this phase of the study to remain cost effective. Despite the extensiveness of the library of spectra it was expected that some of the components would remain unidentified.

Solvents were considered to be a major component of the liquid effluents and sludges and the leachate extractions. The analysis for solvents was carried out using a direct injection technique. This was found to have a distinct advantage over head space or extractable analyses as a number of factors, including temperature, partition coefficients and extraction solvent selection were eliminated.

A quality assurance program was implemented for this study and included the analyses of blanks, duplicates and spikes. The major focus was on the analysis of blanks. Details of the program are included in Appendix A.

TABLE 3

Samples Analyzed by GC/MS

Plant A	Latex Sludge Leachate	ASL-2
	Latex Effluent	AE-3
	Spent Solvent Sludge	AS-5
Plant B	Equalization Pond Effluent	BE-8
	Primary Sludge (Collection Tank)	BS-10
Plant C	Sump Sludge	CS-14
Plant D	Baghouse Dust Leachate	DSL-19
Plant E	Final Effluent	EE-20
	Collection Trough Sludge Leachate	ESL-21
	Baghouse Dust Leachate	ESL-22

2.4 PRESENTATION OF RESULTS

Detailed analytical results are presented in Tables A-1 through E-6. The tables are grouped according to Plant (A, B, C, D, E), Type of Analyses (Conventional and Organic) and Sample Type (Effluents, Sludges and Leachates). Tables for each plant are prefixed with their letter designation and are assembled at the back of each plant section. The conventional analyses for effluents, sludges and leachates are presented in Tables desiginated -1, -3 and -5 respectively, while the similar organic analyses are presented in Tables designated -2, -4, and -6. The organic analytical parameters in each table are grouped into three sections from the top down. The phthalates and chlorophenols are listed at the top of each organic analyses table. The next section below contains all parameters which were present in the sample above their detection limits; while the bottom section lists all parameters which were analyzed for but were below their detection limits. Only those organic parameters for which analyses were performed appear in the tables, the exceptions being items listed in Tables 5 and 6.

Table 4 lists the Priority and Candidate Chemicals as defined by the Environmental Contaminants Act that were investigated and detected in at least some of the samples analyzed in this study.

Table 5 lists the Priority and Candidate Chemicals as definied by the Environmental Contaminants Act that were investigated but which were below detection limits in all samples selected for the specific analyses.

Table 6 lists the US EPA Priority Pollutants that were investigated by GC/MS but were below detection limits.

TABLE 4

PRIORITY AND CANDIDATE CHEMICALS DETECTED

Category	Compounds
Phthalic Acid Esters	Dimethyl Phthalate Diethyl Phthalate Di-n-butyl Phthalate Bis (2-ethyl hexyl) Phthalate
Organotins	Dibutyl tin Dilaurate
Aromatic Amines - aniline derivatives	Diethyl Aniline
Organophosphorous Compounds - trialkylphosphate	Tributyl Phosphate

TABLE 5

PRIORITY AND CANDIDATE CHEMICALS BELOW DETECTION LIMIT

Parameter	Samples Analyzed
Chloroparaffins	Plant C Cooling Water Effluent CE-12 Sump Sludge CS-14 Baghouse Dust CS-15
Chloromethanes	All samples analyzed for solvents
Triaryl Phosphate - Triphenyl phosphate - Tricresyl phosphate	All samples

TABLE 6

U.S. EPA PRIORITY POLLUTANTS BELOW DETECTION LIMITS IN EXTRACTS EXAMINED BY GC/MS

Base/Neutral

Benzidine
Bis (2-chloroethyoxy) methane
Bis(2-chloroethyl) ether
Bis (2-chloroisopropyl) ether
Bis (2-ethylhexyl) phthalate
2-Chloronaphthalene
4-Chlorophenl phenyl ether
1, 2-Dichlorobenzene
1, 3-Dichlorobenzidine
2, 4-Dinitrotoluene
2, 6-Dinitrotoluene
Hexachlorobenzene
Hexahlorobutadiene
Hexachlorocyclopentadiene
Isophorone
Nitrobenzene
N-Nitrosodiphenylamine
N-Nitrosodimethylamine
N-Nitrosodi-n-propylamine
1, 2, 4-Trichlorobenzene

Phenols

2-Chlorophenol
2, 4-Dichlorophenol
2, 4-Dimethylphenol
4, 6-Dinitro-o-cresol
2, 4-Dinitro-phenol
4-Nitrophenol
P-Chloro-m-cresol
2, 4, 6-Trichlorophenol

Polycyclic Aromatics

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene or Chrysene
Benzo(k)fluoranthene or Benzo (b) fluoranthene
Benzo(a)pyrene
Fluoranthene
Fluorene
Naphthalene
Phenanthrene
Pyrene

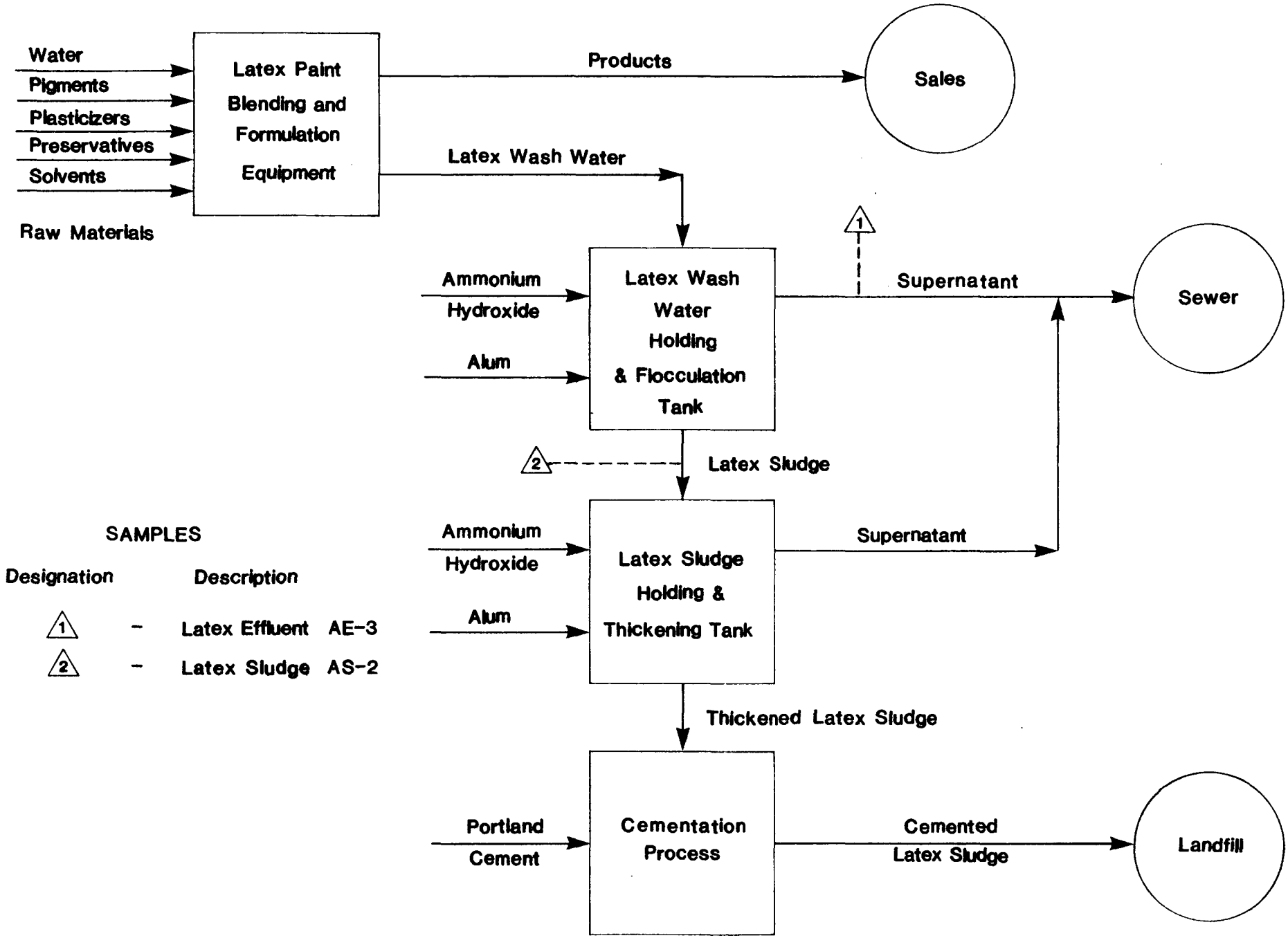
3. PLANT A

3.1 PROCESS DESCRIPTION - PLANT A

Plant A manufactures a wide variety of products which include alkyd and latex paints, stains, varnishes, lacquers, metal primers, metal enamels, and a wood preservative. Manufacture involves the blending of paint resins, pigments, solvents and a wide variety of additives such as plasticizers, preservatives and colloids. A full discussion of paint formulation is beyond the scope of this report. Reference should be made to the general literature for technical information on the components of latex and alkyd paints. Technical information on paints was extracted from references (2) and (3). Schematics for latex and alkyd paint manufacture at Plant A are provided in Figures 1 and 2.

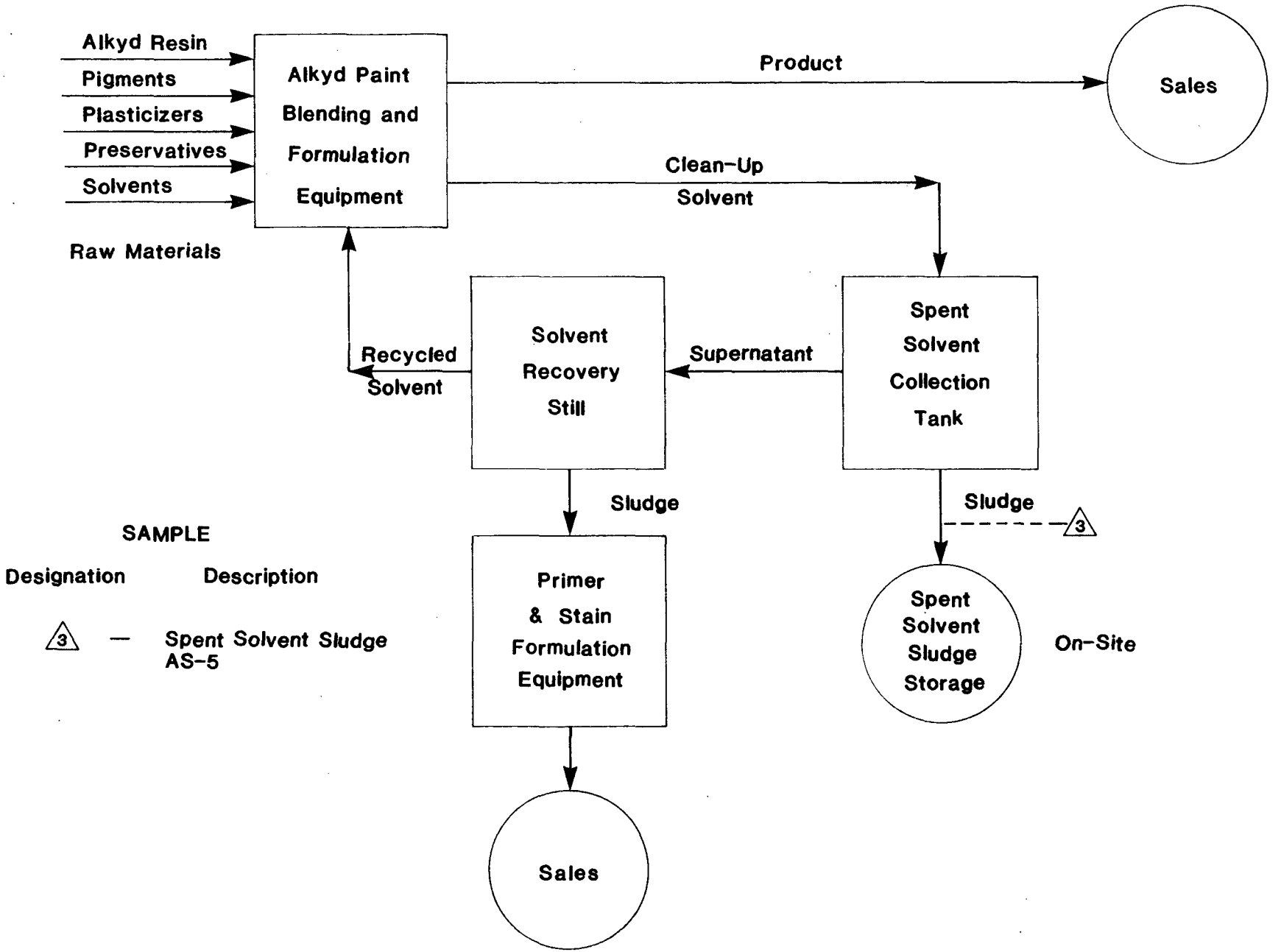
All basic components of the paint formulations produced by Plant A are manufactured by others and stored on-site. Total annual production is approximately 4100 m^3 with solvent based coatings representing 35%, water based coatings at 50% and the remainder divided into varnishes, lacquers, paint thinner and cleaners. Waste handling is divided into two main areas; one for latex paints (water based) and one for alkyd paints (solvent based). All alkyd blending tanks and equipment are cleaned with a solvent mixture containing xylene which is then collected after use and re-distilled in a waste solvent recovery still. Clean solvent is then recycled for paint production or clean-up. The "bottoms" from the solvent still are used in the production of metal primers and wood stains.

A "spent solvent sludge" accumulates in the portable waste solvent collection tanks. This material cannot be easily re-suspended for process through the solvent recovery system. Approximately 0.2 m^3 per month of "spent solvent sludge" is scraped from the solvent collection tanks and stored on site. Approximately 200 drums of this material are stored on site. Application has been made for shipment and disposal to a hazardous waste disposal site in the US.



PLANT A – LATEX PAINT MANUFACTURE PROCESS SCHEMATIC

FIGURE 1



PLANT A – ALKYD PAINT MANUFACTURE PROCESS SCHEMATIC

FIGURE 2

The latex formulation equipment is washed with water which discharges via an open floor sewer system to an underground sump. Latex wash water is pumped from the sump to a flocculation tank (11 m^3). Once this tank is full, ammonium hydroxide is added to adjust pH and alum is added to coagulate solids. After mixing is complete, solids are allowed to settle to the bottom of the tank as "latex sludge" and supernatant (treated latex wash water) is decanted off and discharged to the municipal sewer. Treated latex washwater (11 m^3) is batch discharged on average every two weeks, broken down into once a week during busy periods and every three weeks during slow periods.

An alternative for pH control which could reduce latex effluent toxicity is provided in section 3.6.1.

The "latex sludge" in the flocculation tank accumulates and is pumped to a separate sludge holding tank (18 m^3) once every five weeks on average. Approximately 16 m^3 of "latex sludge" is produced annually. Prior to final disposal, the collected latex sludge is thickened an additional 15% using alum and ammonium hydroxide. This thickened sludge is pumped into 45 gallon barrels, mixed with portland cement and allowed to harden. The sludge/cement ratio is approximately 4:1 on a w/w basis. Approximately 70 barrels are produced annually for disposal to local landfill. The cementing and disposal operation is carried out annually on a batch basis. Samples of cemented sludge were not available during the site visits. Recommendations for additional study on cemented latex sludge are provided in section 3.6.2.

3.2 SAMPLE DESCRIPTIONS - PLANT A

Detailed descriptions for each sample at Plant A are provided in the following sections.

3.2.1 Latex Effluent

This sample represents treated latex washwater generated from the latex (water based) production section of the Plant. The wastewater essentially

consists of paint residues, in fact the samples had the appearance of dilute paint. Standard analytical characteristics as listed in Table A-1 indicate that samples collected were high in NFR, COD, turbidity, TOC, TN and ammonia. Sample AE-3 was toxic to fish and registered a LT 50 less the 0.17 hour.

Two samples were collected, however the February 19, 1985 sample was of insufficient volume to permit organic analysis and bioassay. Therefore only conventional analyses were conducted on the February 19, 1985 sample.

The organic characteristics, as listed in Table A-2 indicate the sample has major concentrations of hydrocarbons and fatty acids plus minor amounts of acetone, ethanol, methanol, methyl ethyl ketone, xylene and ethylbenzene. The presence of the above compounds indicates that some cross-over is taking place from the alkyd system into the latex system.

3.2.2 Latex Sludge

This sample is essentially concentrated latex paint with a high TR, COD and oil and grease (Table A-3).

Results of the conventional analyses of this sample are reported in Table A-3. Total organic analyses were not performed on this sample, since the leaching characteristics were considered more important and would provide information on the fate of soluble components after landfilling.

3.2.3 Spent Solvent Sludge

This sample consisted of a heavy clay-like material containing significant amounts of hydrocarbons and fatty acids. Standard analytical characteristics as listed in Table A-3 indicate that the sludge contains high levels of inorganic solids, CAOV and oil and grease. Organic analytical results are presented in Table A-4.

3.2.4 Paint Skins

"Paint skins" are generated by weekly plant clean-up and consists of paint floor scrapings plus other general paper and plastic debris (Tables A-3, 4).

3.3 PRIORITY CHEMICALS - PLANT A

3.3.1 Phthalic Acid Esters

Diethyl, Di-n-butyl and Bis (2-ethyl Hexyl) phthalates were detected at concentrations an order of magnitude above detection limit. Butyl benzyl phthalate was also present but only slightly above detection limit. Dimethyl and di-n-octyl phthalate were below detection limits in all samples. These compounds are utilized in paint formulation as plasticizers to provide film flexibility.

The presence and concentration of a particular phthalate compound in paint wastes would be highly variable since a wide variety of plasticizers are utilized depending on the type of paint being manufactured.

3.3.2 Chlorinated Phenols

Tetrachlorophenol and pentachlorophenol were detected at low levels in all samples with the highest concentrations in the spent solvent sludge.

3.3.3 Triaryl Phosphates

Triphenyl, tricresyl and tri-butyl phosphate were all less than detection limit in the latex effluent.

3.3.4 Organotins

Analyses were not performed due to low levels of total tin observed in the latex effluent and sludges.

3.4 MAJOR WASTE COMPONENTS - PLANT A

The major components of the wastewater generated from Plant A originate from the manufacture of latex paint. These components fall into the general categories listed in Table 7, namely latex resins, alkyd resins, pigments, surfactants, plasticizers, preservatives, thickeners and solvents. These general categories are discussed below with reference to the analytical results. The component list in Table 7 is not intended to be comprehensive or to necessarily reflect the compounds utilized by Plant A.

3.4.1 Latex Resin

Latex resins are produced by polymerization of organic monomers. This type of compound cannot be analyzed for directly in wastewater but is evident from the general parameters, colour, turbidity, COD, TOC, TR and NFR. These resins are concentrated in the latex sludge, evident by the high COD and percent residue.

3.4.2 Alkyd Resin

Alkyd resins are produced by polymerization similar to latex but contain drying oils, aliphatic hydrocarbons, and other solvents. These compounds are at high concentrations in the spent solvent sludge and also appear in the latex effluent and sludge due to cross-over from the alkyd circuit.

TABLE 7

POTENTIAL WASTE COMPONENTS OF
LATEX PAINT MANUFACTURE

Water	
Latex (Binder)	Polyvinyl acetate
	Ethyl acrylate
	Methyl methacrylate
	Ethyl hexyl acrylate
	Dibutyl maleate
	Polyvinyl chloride
Pigments	Titanium dioxide
	Zinc oxide
	Lead carbonate
Pigment Extenders	Barium Sulfate
	Calcium carbonate
	Aluminium silicate
	Silica dioxide
	Magnesium Silicate
	Mica
Surfactants	Alkyl sulfate
	Alkyl sulfonates
	Alkyl ethers
	Thioethers
	Glycols
	Octylphenoxy polyethoxy - ethanol

Coalescing Agents (Plasticizers)	di-n-butyl phthalate
	di-octyl phthalate
	tricresyl phosphate
	tributyl phosphate
	butyl carbitol acetate
	butyl cellosolve acetate
Fungicides & Preservatives	sodium pentachlorophenate
	phenyl mercury oleate
	sodium tetrachlorophenate
	tri-n-butyltin
	copper naphthenate
	zinc naphthenate
Protective Celloids & Thickeners	methyl cellulose
	carboxy methyl cellulose
	hydroxy ethyl cellulose
Solvents	ethylene glycol
	propylene glycol
	butyl cellosolve

3.4.3 Pigments and Pigment Extenders

The presence of pigments and extenders is indicated by the metal levels in both the effluent and sludges. Minor amounts of other metals not generally used in pigment could be due to impurities in the general pigment formulation. Metals present due to pigments include barium, cobalt, chromium, manganese, aluminum, lead, zinc, titanium, iron, silicon, calcium and magnesium.

3.4.4 Surfactants

Surfactants can be subdivided into wetting agents, emulsifiers, detergents and dispersing agents. All surfactants except the dispersing agents are organic compounds which would only be detectable by GC/MS identification. Three different glycol ethers potentially added as surfactants were detected in the Latex Effluent and the Latex Sludge Leachate. Fatty acids present in the latex effluent and sludge in major concentrations may also have resulted from their use as surfactants, but were more likely present due to cross-over. Linseed oil and other vegetable oils are common components of alkyd paints. Many fatty acid derivatives are also used as plasticizers and defoamers in emulsion paints. The presence of dispersing agents such as sodium phosphates and sodium silicates are evident from the metal analyses of the latex effluent, latex sludge, spent solvent sludge and paint skins.

3.4.5 Plasticizers - Phthalic Acid Esters

Diethyl phthalate had the highest concentration of the phthalic acid esters in the latex effluent, latex sludge leachate, spent solvent sludge and spent solvent sludge leachate. The paint skin leachate contained di-n-butyl phthalate and bis (2-ethyl hexyl) phthalate at 37 and 11 ug/g respectively but less than detectable concentrations of diethyl phthalate. Concentrations of the phthalic acid esters would be highly dependent on the type of paint or lacquer being manufactured prior to sample collection.

3.4.6 Plasticizers - Fatty Acids

A number of fatty acid derivatives are used as plasticizers in both latex and alkyd based paints. Fatty acids were present at high concentrations in the latex effluent, spent solvent leachate and paint skins leachate.

3.4.7 Preservatives

Tetrachlorophenol and pentachlorophenol were at relatively low concentrations in the effluent, sludge and leachate samples. Mercury was detected at low concentrations in the latex effluent, potentially due to the use of phenyl mercury oleate or similar compounds as fungicides. Copper and zinc present in the sludge is also potentially due to the use of naphthenate preservatives.

3.4.8 Solvents

3.4.8.1 Latex Effluent

Solvents detected in the Latex Effluent at measurable concentrations included acetone, ethanol, ethylbenzene, methanol, methyl ethyl ketone, xylenes, 2-butoxyethanol, and aliphatic hydrocarbons (Table A-2). The presence of xylenes and hydrocarbons in the latex effluent indicates that cross-over is taking place from the alkyd section to the latex section potentially due to spills and leaks.

3.4.8.2 Spent Solvent Sludge

Solvents detected included 2-butoxyethanol, glycol ether A and aliphatic hydrocarbons (Table A-4).

3.5 VOLUMETRIC AND MASS LOADINGS - PLANT A

Estimated volumetric and organic mass loadings are presented in Table 8. Mass loading estimates should be utilized for comparative purposes only, since they are based on single samples collected during the site visit.

3.6 SUMMARY AND RECOMMENDATIONS - PLANT A

Wastes generated at Plant A consist mainly of latex effluent, latex sludge and spent solvent sludge.

3.6.1 Latex Effluent

The latex effluent exhibits high concentrations of hydrocarbons, solvents, fatty acids and ammonia in addition to being acutely toxic to fish. This toxicity is partially attributable to elevated levels of un-ionized ammonia. Percent ammonia as un-ionized ammonia in aqueous solution increases with both temperature and pH. Current latex wastewater treatment practice at Plant A involves ammonium hydroxide addition to adjust pH prior to alum addition. The optimum pH range for alum addition is 7.5 - 8.5. Preliminary recommendations to improve latex effluent quality are:

1) Adjust pH using sodium hydroxide instead of ammonium hydroxide. Sodium hydroxide can be purchased as a 50% solution, and handled in an identical fashion to ammonium hydroxide.

2) Evaluate alternative coagulants and flocculants plus addition and mixing methods to optimize treatment process.

3) Investigate crossover of waste components from the alkyd circuit into the latex waste water circuit and reduce these inputs as much as possible.

3.6.2 Latex Sludge

Latex sludge is essentially concentrated latex paint with high COD and oil and grease. The organic solvent components of the latex sludge prior to cementation are highly leachable. The methodology for the SWEP test does not cover evaluation of the cementation process in terms of fixation of water soluble compounds. Future study of the cementation process is recommended to determine if the water soluble components of the sludge are immobilized by cementation and to evaluate the longer term fate of the cemented sludge in sanitary landfill.

3.6.3 Spent Solvent Sludge

A significant quantity of this material is presently stored on site. This represents a potential environment hazard if containers are accidently spilled or leak. It is recommended that ultimate disposal of this stored sludge be investigated. In addition, modifications to the equipment used to handle spent solvent should be considered so as to incorporate this spent solvent sludge with the solvent recovery still "bottoms" presently being recycled into the production of metal primers and stains.

TABLE 8 - VOLUMETRIC AND MASS LOADINGS - PLANT A

Sample		Discharge Frequency	Quantity	Daily Flowrate m^3	Disposal Method	Organic Waste Components	Mass Loadings kg/yr
Latex Effluent	AE-1 AE-3	Biweekly	11 m^3	0.8	Sewer	Phthalates	0.18
						Chlorophenols	0.04
						Aliphatic Hydrocarbons (C19-30)	200
						Aliphatic Hydrocarbons (C7-C13)	129
						Methanol	55
						Fatty Acids	43
						Methyl Ethyl Ketone	16
						Xylenes	16
						Ethanol	15
						Acetone	11
						Ethylbenzene	3
Spent Solvent Sludge	AS-5	Monthly	0.2 m^3	0.007	Stored on Site	Phthalates	.06
						Chlorophenols	.005
						Aliphatic Hydrocarbons (C6-C13)	216
						Fatty Acids	4.3
						Glycol Ether A	0.06
						2-Butoxyethanol	0.05
Latex Sludge	AS-2	Annual	14 m^3	0.04	Cemented & Landfill		
Paint Skins	AS-6	Weekly	0.03 m^3	0.004	Landfill		

ANALYTICAL RESULTS

CONVENTIONAL AND ORGANIC ANALYSES

PLANT A

TABLE A-1

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSA1C
Latest Rev: 24-Oct-85

PLANT A **** EFFLUENTS ****

Item	Description	Unit	Detection Limit	Latex Effluent	Latex Effluent
A	DATE SAMPLED			Feb 19/85	Feb 25/85
B	SAMPLE DESIGNATION			AE-1	AE-3
C	CONSTITUENTS				
	pH	NA	NA	5.4	6.5
	Ammonia (N)	mg/L	0.005	597	685
	COD	mg/L	20	5600	4750
	Chloride (Cl)	mg/L	0.5	29	26.8
	Colour	Units	5	NA-Opaque	NA-Opaque
	Conductivity	umhos/cm	1	7000	7100
	Fluoride (F)	mg/L	0.05	L	L
	Nitrate (N)	mg/L	0.005	0.23	L
	Nitrite (N)	mg/L	0.005	0.37	0.61
	Non-Filterable Residue	mg/L	5	511	423
	Oils & Grease	mg/L	2	28	737
	P. Alk. as CaCO3	mg/L	1	nil	
	Phenols	mg/L	0.02	0.148	0.11
	Sulphate (SO4)	mg/L	1	3200	3700
	T - N	mg/L	0.03	670	670
	T. Alk. as CaCO3	mg/L	1	142	299
	T.O.C.	mg/L	1	1690	1570
	Total PO4 (P)	mg/L	0.005	1.7	1.9
	Total Residue	mg/L	5	6250	6020
	Turbidity	FTU	1	2300	3900

TABLE A-1

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSA1C
Latest Rev: 24-Oct-85

PLANT A **** EFFLUENTS ****

Item	Description		Unit	Detection Limit	Latex Effluent	Latex Effluent
A	DATE SAMPLED				Feb 19/85	Feb 25/85
B	SAMPLE DESIGNATION				AE-1	AE-3
D	METALS - ICP Scan					
	Arsenic	-As	ug/ml	0.05	0.06	L
	Boron	-B	ug/ml	0.001	0.268	0.184
	Barium	-Ba	ug/ml	0.001	0.051	0.03
	Beryllium	-Be	ug/ml	0.001	L	L
	Cadmium	-Cd	ug/ml	0.002	0.012	0.004
	Cobalt	-Co	ug/ml	0.005	1.51	1.3
	Chromium	-Cr	ug/ml	0.005	0.153	0.029
	Copper	-Cu	ug/ml	0.005	0.028	0.017
	Manganese	-Mn	ug/ml	0.001	0.808	0.728
	Molybdenum	-Mo	ug/ml	0.005	L	0.017
	Nickel	-Ni	ug/ml	0.02	L	L
	Phosphorus	-P	ug/ml	0.05	2.39	2.05
	Lead	-Pb	ug/ml	0.02	1.02	0.22
	Antimony	-Sb	ug/ml	0.05	0.07	L
	Selenium	-Se	ug/ml	0.05	L	L
	Tin	-Sn	ug/ml	0.01	L	L
	Strontium	-Sr	ug/ml	0.001	0.123	0.107
	Titanium	-Ti	ug/ml	0.002	0.596	0.166
	Vanadium	-V	ug/ml	0.005	0.014	0.007
	Zinc	-Zn	ug/ml	0.002	0.697	0.38
	Aluminum	-Al	ug/ml	0.05	29	7.43
	Iron	-Fe	ug/ml	0.005	4.92	1.58
	Silicon	-Si	ug/ml	0.1	10.6	4.4
	Calcium	-Ca	ug/ml	0.1	348	410
	Magnesium	-Mg	ug/ml	0.1	4.1	4.1
	Sodium	-Na	ug/ml	0.1	240	232
	Hardness	-Ca, Mg	ug/ml		886	1040
	Hardness	-Total	ug/ml		1060	1090
	Mercury	-Hg	ug/ml	0.00005	0.16	0.145
E	BIOASSAY					
	96 HOUR LT 50		hour			<0.17

TABLE A-2

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMaet
Latest revision: 15-Nov-85

PLANT A **** EFFLUENT (TOTAL) ****

Item	Description	Unit	Detection Limit	Latex Effluent
A	DATE SAMPLED			Feb 25/85
B	ASL SAMPLE #			1630-3
C	SIGMA SAMPLE #			AE-3
D	ORGANIC COMPONENTS			
	Dimethyl Phthalate	mg/L	0.01	L
	Diethyl Phthalate	mg/L	0.01	0.56
	Di-n-butyl Phthalate	mg/L	0.001	0.024
	Butyl Benzyl Phthalate	mg/L	0.001	0.009
	Bis (2-Ethyl Hexyl) Phthalate	mg/L	0.001	0.036
	Di-n-octyl Phthalate	mg/L	0.001	L
	Tetrachlorophenol	mg/L	0.001	0.083
	Pentachlorophenol	mg/L	0.001	0.066
	Acetone	mg/L	0.5	38
	Benzene	mg/L	0.2	0.96
	Ethanol	mg/L	0.5	51
	Ethylbenzene	mg/L	0.2	10
	Methanol	mg/L	0.5	190
	Methyl Ethyl Ketone	mg/L	0.5	57
	Toluene	mg/L	0.2	3.6
	Xylenes	mg/L	0.2	57
	2-Butoxyethanol	mg/L	0.01	5.1
	Glycol Ether A (n.p.i)	mg/L	0.01	1.4
	Glycol Ether B (n.p.i)	mg/L	0.01	1.4
	Glycol Ether C (n.p.i)	mg/L	0.01	1.5
	Fatty Acids	mg/L	0.5	150
	Aliphatic Hydrocarbons (C7-C13)	mg/L	0.05	450
	Aliphatic Hydrocarbons (C19-C30)	mg/L	0.5	700
	Parameters Below Detection Limit:			
	2-Phenoxyethanol	mg/L	0.01	
	Acetaldehyde	mg/L	0.5	
	Benzoic Acid	mg/L	0.01	
	Butylated Hydroxytoluene (BHT)	mg/L	0.01	
	Diethylene Glycol	mg/L	0.01	
	Dipropylene Glycol	mg/L	0.01	
	Methyl Isobutyl Ketone	mg/L	0.5	
	Phthalic Acid	mg/L	0.01	
	Propionaldehyde	mg/L	0.5	
	Styrene	mg/L	0.2	
	Tributyl Phosphate	mg/L	0.01	

TABLE A-3

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSA2C
Latest Rev: 24-Oct-85

PLANT A **** SLUDGE ****

Item	Description	Unit	Detection Limit	Latex Sludge	Spent Solvent Sludge		Paint Skins	
A	DATE SAMPLED			Feb 19/85	Feb 25/85	Feb 25/85	Feb 25/85	Feb 25/85
B	SAMPLE DESIGNATION			AS-2	AS-5	AS-5	AS-6	AS-6
C	REPLICATES			A	A	B	A	B
D	CONSTITUENTS							
	Total Residue	mg/kg		173,000	660,000		635,000	
	% Moisture	%		82.7				
	Total Volatile Residue	mg/kg		94,500	43,500		298,000	
	COD	mg/kg		26,600				
	CADV	%			2.9			
	Oils & Grease	mg/kg	100	14,000	11,200		64,300	
E	METALS - ICP Scan							
	Arsenic -As	ug/g	8	L	L	11	L	L
	Barium -Ba	ug/g	0.2	4.2	99.9	179	144	95.8
	Beryllium -Be	ug/g	0.2	L	0.2	0.2	L	L
	Cadmium -Cd	ug/g	0.3	L	L	L	35.8	34.2
	Cobalt -Co	ug/g	0.8	37.1	158	173	149	123
	Chromium -Cr	ug/g	0.8	73.7	465	540	429	437
	Copper -Cu	ug/g	0.8	12.6	20.2	22.7	67.2	63.7
	Manganese -Mn	ug/g	0.2	18.3	150	163	111	110
	Molybdenum -Mo	ug/g	0.8	L	16.3	23.8	3.6	14.2
	Nickel -Ni	ug/g	3	L	4	4	9	7
	Phosphorus -P	ug/g	8	565	276	286	602	522
	Lead -Pb	ug/g	3	303	3330	3630	5610	3560
	Tin -Sn	ug/g	2	L	7	6	110	72
	Strontium -Sr	ug/g	0.2	5	18.3	18.1	21.3	19.6
	Titanium -Ti	ug/g	0.3	484	110	100	439	489
	Vanadium -V	ug/g	0.8	12.6	4.2	4.5	7.4	6.1
	Zinc -Zn	ug/g	0.3	27.7	223	247	769	770
	Aluminum -Al	ug/g	8	24240	22100	21700	10300	9440
	Iron -Fe	ug/g	80	3020	5910	5560	9330	7090
	Silicon -Si	ug/g	20	6170	2060	2360	1790	1730
	Calcium -Ca	ug/g	20	2670	11900	13300	28200	30300
	Magnesium -Mg	ug/g	20	366	3450	3510	2160	1670
	Sodium -Na	ug/g	20	2930	13200	13100	3280	2960

TABLE A-4

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMast
Latest revision: 15-Nov-85

PLANT A **** SLUDGE (TOTAL) ****

Item	Description	Unit	Detection Limit	Spent Solvent Sludge
A	DATE SAMPLED			Feb 25/85
B	ASL SAMPLE #			1630-5
C	SIGMA SAMPLE #			AS-5
D	ORGANIC COMPONENTS			
	Dimethyl Phthalate	ug/g	0.5	L
	Diethyl Phthalate	ug/g	0.5	14
	Di-n-butyl Phthalate	ug/g	0.05	4.1
	Butyl Benzyl Phthalate	ug/g	0.05	0.1
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.05	2.35
	Di-n-octyl Phthalate	ug/g	0.05	L
	Tetrachlorophenol	ug/g	0.01	0.76
	Pentachlorophenol	ug/g	0.01	0.96
	2-Butoxyethanol	ug/g	1	16
	Glycol Ether A (n.p.i)	ug/g	1	22
	Fatty Acids	ug/g	20	1500
	Aliphatic Hydrocarbons(C7-C13)	ug/g	2	75000
	Parameters Below Detection Limits:			
	2-Phenoxyethanol	ug/g	1	
	Aliphatic Hydrocarbons(C19-C30)	ug/g	20	
	Benzoic Acid	ug/g	1	
	Biphenyl	ug/g	0.5	
	Butylated Hydroxytoluene (BHT)	ug/g	1	
	Diphenyl Ether	ug/g	0.5	
	Glycol Ether B (n.p.i)	ug/g	1	
	Glycol Ether C (n.p.i)	ug/g	1	
	Phthalic Acid	ug/g	1	
	Toluene 2.4-Diisocyanate(TDI)	ug/g	1	
	Tributyl Phosphate	ug/g	1	

TABLE A-5

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSA3C
Latest Rev: 25-Oct-85

PLANT A **** LEACHATES ****

Item	Description	Unit	Detection Limit	Latex Sludge Leachate	Spent Solvent Sludge Leachate	Paint Skins Sludge Leachate
A	DATE SAMPLED			Feb 19/85	Feb 25/85	Feb 25/85
B	SAMPLE DESIGNATION			ASL-2	ASL-5	ASL-6
C	REPLICATES			A	A	A
D	CONSTITUENTS					
	T.O.C.	ug/g	20	2300	4480	28800
	T.I.C.	ug/g	20	55	50	104
	Phenols	ug/g	0.4	3.6	6	10.8
	Oils & Grease	ug/g	40	350	L	4620
E	METALS - ICP Scan					
	Arsenic -As	ug/g	1	L	L	L
	Boron -B	ug/g	0.02	0.4	0.47	3.46
	Barium -Ba	ug/g	0.02	0.31	0.27	0.52
	Beryllium -Be	ug/g	0.02	L	L	L
	Cadmium -Cd	ug/g	0.04	0.036	0.12	2.44
	Cobalt -Co	ug/g	0.1	2.7	40	10.8
	Chromium -Cr	ug/g	0.1	0.13	2.9	0.96
	Copper -Cu	ug/g	0.1	0.11	0.92	3.56
	Manganese -Mn	ug/g	0.02	1.35	32	3.34
	Molybdenum -Mo	ug/g	0.1	L	L	0.26
	Nickel -Ni	ug/g	0.4	L	L	L
	Phosphorus -P	ug/g	1	1.6	3.5	27.6
	Lead -Pb	ug/g	0.4	43	35.9	25.8
	Antimony -Sb	ug/g	1	L	5.5	2.4
	Selenium -Se	ug/g	1	L	L	L
	Tin -Sn	ug/g	0.2	L	L	L
	Strontium -Sr	ug/g	0.02	0.51	1	0.82
	Titanium -Ti	ug/g	0.04	L	L	0.88
	Vanadium -V	ug/g	0.1	L	L	0.16
	Zinc -Zn	ug/g	0.04	1.83	16.1	16
	Aluminum -Al	ug/g	1	110	8	18.6
	Iron -Fe	ug/g	0.1	7	0.33	15.9
	Silicon -Si	ug/g	2	24	100	52
	Calcium -Ca	ug/g	2	675	1330	984
	Magnesium -Mg	ug/g	2	7.3	190	32
	Sodium -Na	ug/g	2	220	352	272
	Hardness -Ca,Mg	ug/g		1720	4110	2600
	Hardness -Total	ug/g		2350	4240	2760

TABLE A-6

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMasl
Latest revision: 15-Nov-85

PLANT A **** SLUDGE (LEACHATE) ****

Item	Description	Unit	Detection Limit	Latex Sludge Leachate	Spent Solvent Sludge Leachate	Paint Skins Sludge Leachate
A	DATE SAMPLED			Feb 19/85	Feb 25/85	Feb 25/85
B	ASL SAMPLE #			1630-2	1630-5	1630-6
C	SIGMA SAMPLE #			ASL-2	ASL-5	ASL-6
D	ORGANIC COMPONENTS					
	Dimethyl Phthalate	ug/g	0.2	L	L	L
	Diethyl Phthalate	ug/g	0.2	1.5	0.5	L
	Di-n-butyl Phthalate	ug/g	0.02	0.18	0.36	37
	Butyl Benzyl Phthalate	ug/g	0.02	0.06	0.04	0.39
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.02	L	0.08	11
	Di-n-octyl Phthalate	ug/g	0.02	L	L	L
	Tetrachlorophenol	ug/g	0.01	0.31	0.67	0.66
	Pentachlorophenol	ug/g	0.01	0.05	0.7	0.9
	Acetone	ug/g	10	86	17	530
	Benzene	ug/g	4	L	6	L
	Ethanol	ug/g	10	55	170	49
	Ethylbenzene	ug/g	4	240	400	62
	Methanol	ug/g	10	160	1600	3800
	Methyl Ethyl Ketone	ug/g	10	64	230	22
	Methyl Isobutyl Ketone	ug/g	10	27	21	L
	Toluene	ug/g	4	95	110	L
	Xylenes	ug/g	4	880	1700	330
	2-Butoxyethanol	ug/g	0.2	16	10	L
	Butylated Hydroxytoluene(BHT)	ug/g	0.2	0.4	0.33	0.87
	Glycol Ether (n.p.i.)	ug/g	0.2	200	L	2.5
	Glycol Ether (n.p.i.)	ug/g	0.2	170	L	2.2
	Glycol Ether (n.p.i.)	ug/g	0.2	80	L	L
	Fatty Acids	ug/g	10	400	1000	500
	Aliphatic Hydrocarbons(C7-C13)	ug/g	1	L	3	L
	Aliphatic Hydrocarbons(C19-C30)	ug/g	10	L	L	150
	Diethylene Glycol	ug/g	0.2	15	L	L
	Parameters Below Detection Limits:					
	2-Phenoxyethanol	ug/g	0.2			
	Acetaldehyde	ug/g	10			
	Benzoic Acid	ug/g	0.2			
	Biphenyl	ug/g	0.05			
	Diacetone Alcohol	ug/g	0.02			
	Diphenyl Ether	ug/g	0.05			
	Dipropylene Glycol	ug/g	0.2			
	Phthalic Acid	ug/g	0.2			
	Propionaldehyde	ug/g	10			
	Styrene	ug/g	4			
	Toluene 2,4-Diisocyanate(TDI)	ug/g	0.2			
	Tributyl Phosphate	ug/g	0.2			

4. PLANT B

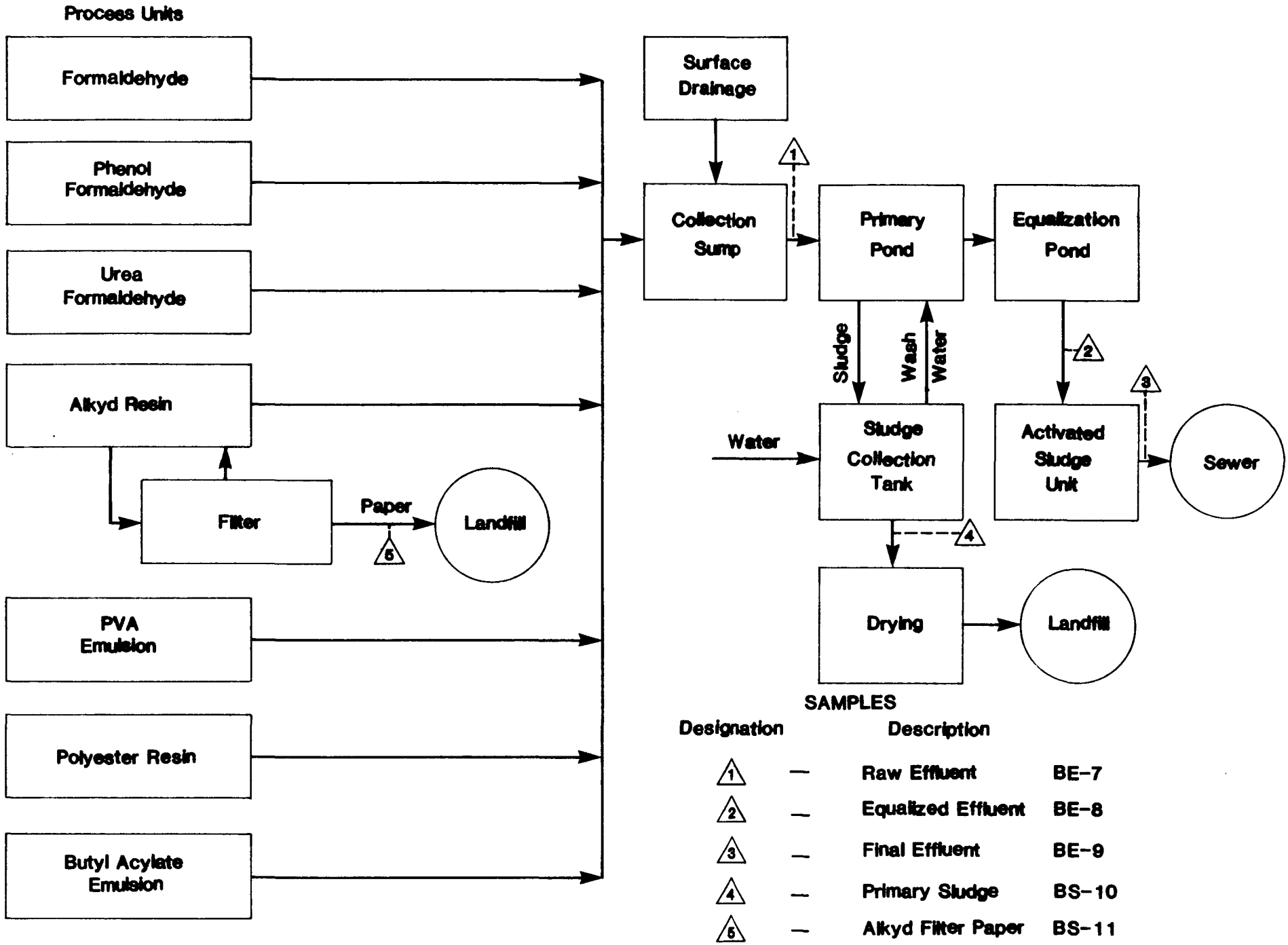
4.1 PROCESS DESCRIPTION - PLANT B

Plant B manufactures the following products:

- Formaldehyde
- Phenol Formaldehyde Resin
- Urea Formaldehyde Resin
- Alkyd Paint Resin
- Polyester Resins
- Polyvinyl Acetate Emulsions
- Butyl Acrylate Emulsions
- Treated Paper

Major feed stocks include methanol, phenol, urea, phthalic and maleic anhydrides, glycols, vinyl acetate, soya oil, linseed oil, tall oil, toluene, styrene and caustic soda. In addition a large number of additives such as plasticizers, solvents, catalysts, driers, preservatives etc. are utilized. Formaldehyde is produced on-site via catalytic oxidation of methanol and in turn is used in resin manufacture. Description of the chemical processes involved is beyond the scope of this report. Reference should be made to the general literature for detailed information. Technical information for evaluation of Plant B was derived in part from reference (4). In general resins are produced by polymerization of various monomers in the presence of catalysts and under specified conditions of temperature, pressure and reaction time. Reaction temperatures and pressures are kept relatively low. A list of potential waste components, resulting from the manufacture of resins at Plant B is provided in Table 9. This list provides general information only and does not indicate the compounds present in the wastes from Plant B. A generalized process diagram for Plant B is presented in Figure 3.

All wastewater generated within the confines of Plant B discharges to a common collection sump. Wastewater includes by-products and spills from resin manufacture, vessel and floor washing water, collected rainwater, vacuum



PLANT B - RESIN MANUFACTURING PROCESS SCHEMATIC

FIGURE 3

pump seal water plus waste associated with raw material spills. Wastewater is pumped from the sump to a waste treatment system consisting in series of a primary settling pond, an equalization basin and an activated sludge unit. Additional waste treatment equipment includes (1) a pH control system to lower equalization basin overflow pH prior to discharge to the activated sludge unit; (2) a sideline equalization tank for storing high strength waste resulting from process upsets; (3) a primary sludge holding tank plus (4) associated mixers and aeration equipment. Treated wastewater discharges continuously to the municipal sewer at an average flowrate of 150 m^3/d. Equalization pond overflow rate was estimated at 115 m^3/d based on a V-notch weir measurement taken during the site visit. Approximate equalization pond retention time is 14 days.

Sludge generation at Plant B includes primary pond sludge, alkyd filter paper, off-spec resins, and other sludges.

Sludge from the primary settling pond is pumped to a sludge holding tank. This sludge is water washed, dried, packed in metal drums and sent to landfill once the sludge holding tank is full. Approximately 10 m^3 is produced annually. Alkyd filter paper is the material remaining after alkyd resins have been polished through a plate and frame filter press. A small amount of colloidal material is removed by the filter. Off-spec resins generated over many years of operation are currently stored on-site. Off-spec material was restricted from sampling as the company was in the process of determining final product designations.

TABLE 9

POTENTIAL WASTE COMPONENTS FROM
RESIN MANUFACTURE

Process	Waste Compounds
Formaldehyde	Methanol, formaldehyde
Phenol Formaldehyde Resin	Phenol, formaldehyde
Urea Formaldehyde Resin	Urea, formaldehyde
Polyester	styrene o-phthalic anhydride propylene glycol maleic anhydride diethylene glycol adipic acid hydroquinone methylene chloride organotin triethylphosphate
Alkyd Resins	polyols, phthalic anhydride drying oils, mineral spirits cobalt naphthenate, cobalt octoate
Polyvinyl Acetate Resins	See Components of Latex Paint (Table 7)
Treated Paper	phenol, methanol, formaldehyde methyl ethyl ketone isopropanol
Polyvinyl acetate	vinyl acetate ethylene, dibutyl maleate polyvinyl alcohol

4.2 SAMPLE DESCRIPTIONS - PLANT B

4.2.1 Raw Effluent

This sample was a grab collected from the sump pump discharge, it does not represent typical operation since resins are manufactured on a batch basis. It was intended however to provide a general indication of components in the raw wastewater and potentially provide information on the degree of treatment taking place in the equalization pond. The sample had a milky appearance, and was high in NFR, COD, turbidity and TOC (Table B-1).

The organic analyses, as listed in Table B-2, indicated that the major components were methanol and acetone. However, based on the TOC and the appearance, it is likely the sample contained a significant quantity of polyvinyl acetate or other resins which would not be included in the organic analyses. The sample also contained formaldehyde based on smell, but this compound cannot be analyzed for by GC.

4.2.2 Equalized Intermediate Effluent

This sample was a grab collected from the equalization pond overflow. Since the pond is mixed using floating mixers the sample collected could be considered typical of longer term operation than the raw sample. The sample was cloudy, high in COD and contained a measurable quantity of phenol. Organic analyses indicated that the main organic components were methanol and phenol, however the sample contained formaldehyde based on smell and also it is expected that it contained polymerized compounds (Table B-2).

4.2.3 Final Effluent

This sample was a grab collected from the activated sludge clarifier overflow. It would be considered relatively typical of long term operation due to the retention time of the equalization pond and activated sludge unit. The sample was relatively clear with some colour, and fine suspended matter. COD and phenol were an order of magnitude less than the intermediate sample (Table B-1). The organic analyses indicated very low levels of organics (Table B-2).

4.2.4 Primary Sludge - Collection Tank

This sample was a grab collected from the collection tank adjacent to the primary pond. It was relatively dry with the texture of organic soil and had a noticeable solvent odour. It consisted mainly of polymerized resin (Tables B-3 and 4).

4.2.5 Filter Paper

This sample represented a portion of the filter paper collected during turnaround of the filter press. It obviously consists mainly of alkyd resin.

4.3 PRIORITY CHEMICALS - PLANT B

4.3.1 Phthalic Acid Esters

Concentrations of the phthalates in the raw, intermediate and final effluent samples were all relatively low. Di-n-butyl phthalate was present at 0.028 mg/L in the raw sample but below detection limit in the intermediate and final effluent samples. Di-n-butyl phthalate is used as a plasticizer in the manufacture of polyvinyl acetate and alkyd resins.

Significant concentrations of Di-n-butyl and Bis (2-ethyl hexyl) phthalates were present in the primary pond sludge (1300 and 230 ug/g respectively). A smaller amount of butyl benzyl phthalate (4.8 ug/g) was also encountered in the primary pond sludge. The alkyd resin filter paper also contained small amounts of di-n-butyl, butyl benzyl and bis (2-ethyl hexyl) phthalates. The partition of the phthalates with the primary sludge is to be expected since the property of a plasticizer is to remain dispersed with the plastic material and not to leach back into the aqueous phase after polymerization is complete. The presence of phthalates in the primary sludge is due to resin losses. Phthalates in the alkyd resin filter were present since they are the plasticizers used in the manufacture of the resin. The material left on the filter paper is essentially alkyd resin with a small amount of fine solids filtered out of the product. A very small amount

of di-n-butyl phthalates (1.5 ug/g) was leached from the primary sludge using the SWEP method. This amount represents approximately 0.1% of the total concentration present in the sludge.

4.3.2 Chlorinated Phenol

Low levels of tetrachlorophenol and pentachlorophenol were present in the raw, intermediate and final effuent samples as well as the primary sludge. A general observation is that the activated sludge unit is removing 90% of chlorinated phenols present in the equalized intermediate sample. Both of these compounds are biodegradable at low concentrations.

4.3.3 Organotin

Organotin analyses were not performed on any samples collected at Plant B. Total tin was near or at detection limits in raw, intermediate and final effluent samples. Di-butyl tin dilaurate was reported as a raw material in the EPS Report. Total tin was detectable in both the primary sludge and alkyd resin filter paper, potentially due to the use of di-butyl tin dilaurate as a plasticizer in alkyd resins. Organotin plasticizers would be expected to partition into the solid phase similar to the phthalic acid ester plasticizers. The methodology required for extraction and analysis of organotins from complex samples has not been developed at this point.

4.3.4 Triaryl Phosphates

Tricresyl phosphate was reported as a raw material in the EPS Report. However, triphenyl, tricresyl and tributyl phosphates were below detection limit in all samples. Total phosphate levels in the effluent samples were low.

4.4 MAJOR WASTE COMPONENTS - PLANT B

The major components of the wastewater generated by Plant B result from the manufacture of the following resins; phenol-formaldehyde, urea formaldehyde, polyester, alkyd and polyvinyl acetate. Formaldehyde used in resin

manufacture is produced on-site. All other raw materials are received by rail car or transport truck and stored prior to use. Finished products such as alkyd resins and polyvinyl acetate emulsions are also stored on site prior to shipment to customers. Polymerized waste material is removed in the primary pond and is transferred to the primary sludge.

4.4.1 Solvents

A measurable concentration of methanol was present in the raw and intermediate effluent samples (both at 270 mg/L). Methanol was below detection limit in the final effluent probably due to its high biodegradability. The presence of methanol likely results from losses during the manufacture of formaldehyde. Formaldehyde was detectable by smell in both the raw and the intermediate samples but not detected by smell in the final effluent. Formaldehyde cannot be detected by the GC method used for solvent identification. A small amount of acetone was present in the raw effluent sample (2.5 mg/L) but was below detection limit in the intermediate and final effluent samples.

Formaldehyde is readily biodegradable and would not be expected in the effluent after activated sludge treatment.

Acetone is used as solvent in paint formulations but would likely be stripped from solution during equalization due to its low boiling point and low vapour pressure.

Other solvents identified in the raw and intermediate samples were biphenyl, diphenyl ether, phenol, and unidentified adipic acids. All of these compounds are effectively removed from the wastewater by biological treatment.

The primary sludge contained measurable quantities of diphenyl ether, biphenyl, toluene 2, 4-diisocyanate, alkyl benzenes and aliphatic hydrocarbons. Extremely small amounts of these compounds were leached, using the SWEP method.

4.5 VOLUMETRIC AND MASS LOADINGS - PLANT B

Estimated volumetric and organic mass loadings are presented in Table 10. Mass loading estimates should be utilized for comparative purposes only, since they are based on single samples collected during the site visit.

4.6 SUMMARY AND RECOMMENDATION - PLANT B

4.6.1 Effluent

Final effluent quality is good, as indicated by its low COD and lack of toxicity. Priority and candidate chemicals were also at low concentrations.

4.6.2 Off-Spec Resins

Storage of this material on site could represent a potential environmental hazard. Therefore it is recommended that the company investigate disposal options to reduce this hazard.

TABLE 10 - VOLUMETRIC AND MASS LOADINGS - PLANT B

Sample		Discharge Frequency	Quantity	Daily Flowrate m^3	Disposal Method	Organic Waste Components	Mass Loadings kg/yr
Final Effluent	BE-7	Continuous	150 m^3/d	150 m^3/d	Sewer	Phthalates	0.22
						Chlorophenols	2.90
Primary Sludge	BS-10	Annual	10 m^3	.027	Dried & Landfill	Phthalates	18.4
						Chlorophenols	0.19
						Diphenyl Ether	43.2
						Aliphatic Hydrocarbons (C9-C15)	24
						Biphenyl	16.8
						Toluene 2, 4 - Diisocyanate (TDI)	7.8
						Diacetone Alcohol	0.13
Filter Press Paper	BS-11	Weekly	N/A		Landfill		

ANALYTICAL RESULTS

CONVENTIONAL AND ORGANIC ANALYSES

PLANT B

TABLE B-1

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSB1C
Latest Rev: 24-Oct-85

PLANT B **** EFFLUENTS ****

Item	Description	Unit	Detection Limit	Raw Effluent	Equalized Int. Effl.	Final Effluent
A	DATE SAMPLED			Feb 26/85	Feb 26/85	Feb 26/85
B	SAMPLE DESIGNATION			BE-7	BE-8	BE-9
C	CONSTITUENTS					
	pH	NA	NA	8.6	11.7	7.6
	Ammonia (N)	mg/L	0.005	0.03	1.16	1.46
	COD	mg/L	20	7500	2650	250
	Chloride (Cl)	mg/L	0.5	30.4	27.4	22.8
	Colour	Units	5	NA-Opaque	NA-Opaque	50
	Conductivity	umhos/cm	1	550	2530	1900
	Fluoride (F)	mg/L	0.05	L	0.05	0.08
	Nitrate (N)	mg/L	0.005	0.65	0.3	0.03
	Nitrite (N)	mg/L	0.005	0.26	0.098	0.013
	Non-Filterable Residue	mg/L	5	1150	193	94
	Oils & Grease	mg/L	2	10	4	2
	Phenols	mg/L	0.02	2.9	14.6	0.72
	Sulphate (SO4)	mg/L	1	55	33	210
	T - N	mg/L	0.03	19	37	13
	T. Alk. as CaCO3	mg/L	1	119	735	832
	T.O.C.	mg/L	1	2890	937	30
	Total PO4 (P)	mg/L	0.005	0.72	2.3	0.82
	Total Residue	mg/L	5	2120	2230	1480
	Turbidity	FTU	1	5750	140	35

TABLE B-i

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSB1C
Latest Rev: 24-Oct-85

PLANT B **** EFFLUENTS ****

Item	Description		Unit	Detection Limit	Raw Effluent	Equalized Int. Effl.	Final Effluent
A	DATE SAMPLED				Feb 26/85	Feb 26/85	Feb 26/85
B	SAMPLE DESIGNATION				BE-7	BE-8	BE-9
D	METALS - ICP Scan						
	Arsenic	-As	ug/ml	0.05	0.06	L	L
	Boron	-B	ug/ml	0.001	0.02	0.025	0.008
	Barium	-Ba	ug/ml	0.001	0.024	0.018	0.008
	Beryllium	-Be	ug/ml	0.001	L	L	L
	Cadmium	-Cd	ug/ml	0.002	L	L	L
	Cobalt	-Co	ug/ml	0.005	0.009	0.011	L
	Chromium	-Cr	ug/ml	0.005	0.009	0.007	L
	Copper	-Cu	ug/ml	0.005	0.05	0.037	0.007
	Manganese	-Mn	ug/ml	0.001	0.056	0.05	0.021
	Molybdenum	-Mo	ug/ml	0.005	0.591	0.084	0.05
	Nickel	-Ni	ug/ml	0.02	L	L	L
	Phosphorus	-P	ug/ml	0.05	L	0.23	0.05
	Lead	-Pb	ug/ml	0.02	0.04	0.05	L
	Antimony	-Sb	ug/ml	0.05	L	L	L
	Selenium	-Se	ug/ml	0.05	L	L	L
	Tin	-Sn	ug/ml	0.01	0.07	0.04	L
	Strontium	-Sr	ug/ml	0.001	0.053	0.026	0.018
	Titanium	-Ti	ug/ml	0.002	0.065	0.033	0.003
	Vanadium	-V	ug/ml	0.005	0.005	L	L
	Zinc	-Zn	ug/ml	0.002	0.096	0.114	0.025
	Aluminum	-Al	ug/ml	0.05	1.29	0.99	0.17
	Iron	-Fe	ug/ml	0.005	2.41	1.56	0.261
	Silicon	-Si	ug/ml	0.1	1.5	0.9	0.7
	Calcium	-Ca	ug/ml	0.1	12.6	5.6	4.5
	Magnesium	-Mg	ug/ml	0.1	1.6	0.5	0.2
	Sodium	-Na	ug/ml	0.1	111	391	402
	Hardness	-Ca, Mg	ug/ml		38.1	16.1	11.9
	Hardness	-Total	ug/ml		50	24.7	13.4
	Mercury	-Hg	ug/ml	0.00005	0.0256	0.00549	0.0018
E	BIOASSAY						
	96 HOUR LT 50		hour				NT

TABLE B-2

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMbet
Latest revision: 15-Nov-85

PLANT B **** EFFLUENT (TOTAL) ****

Item	Description	Unit	Detection Limit	Raw Effluent	Equalized Int. Effl.	Final Effluent
A	DATE SAMPLED			Feb 26/85	Feb 26/85	Feb 26/85
B	ASL SAMPLE #			1630-7	1630-8	1630-9
C	SIGMA SAMPLE #			BE-7	BE-8	BE-9
D	ORGANIC COMPONENTS					
	Dimethyl Phthalate	ug/L	0.01	L	L	L
	Diethyl Phthalate	ug/L	0.01	0.02	L	L
	Di-n-butyl Phthalate	ug/L	0.001	0.028	L	L
	Butyl Benzyl Phthalate	ug/L	0.001	0.006	0.006	0.002
	Bis (2-Ethyl Hexyl) Phthalate	ug/L	0.001	0.003	0.006	0.002
	Di-n-octyl Phthalate	ug/L	0.001	L	L	L
	Tetrachlorophenol	ug/L	0.001	0.035	0.4	0.049
	Pentachlorophenol	ug/L	0.001	0.01	0.11	0.004
	Acetone	ug/L	0.5	2.5	L	L
	Methanol	ug/L	0.5	270	270	L
	Biphenyl	ug/L	0.005	0.04	0.24	L
	Diphenyl Ether	ug/L	0.005	0.11	0.93	L
	Toluene 2.4-Diisocyanate(TDI)	ug/L	0.01	L	0.06	L
	Phenol	ug/L	0.005	1	47	L
	Adipic Acid Ester A (n.p.i.)	ug/L	0.01	0.1	0.7	L
	Adipic Acid Ester B (n.p.i.)	ug/L	0.01	0.2	1.4	L
	Adipic Acid Ester C (n.p.i.)	ug/L	0.01	0.05	0.12	0.14
	Parameters Below Detection Limits:					
	2-Butoxyethanol	ug/L	0.01			
	2-Phenoxyethanol	ug/L	0.01			
	Acetaldehyde	ug/L	0.5			
	Aliphatic Hydrocarbons (C9-C15)	ug/L	0.05			
	Alkyl Benzenes	ug/L	0.05			
	Benzene	ug/L	0.2			
	Benzoic Acid	ug/L	0.01			
	Butylated Hydroxytoluene (BHT)	ug/L	0.01			
	Diacetone Alcohol	ug/L	0.005			
	Diethylene Glycol	ug/L	0.01			
	Dipropylene Glycol	ug/L	0.01			
	Ethanol	ug/L	0.5			
	Ethylbenzene	ug/L	0.2			
	Glycol Ether A (n.p.i)	ug/L	0.01			
	Glycol Ether B (n.p.i)	ug/L	0.01			
	Glycol Ether C (n.p.i)	ug/L	0.01			
	Methyl Ethyl Ketone	ug/L	0.5			
	Methyl Isobutyl Ketone	ug/L	0.5			
	Phthalic Acid	ug/L	0.01			
	Propionaldehyde	ug/L	0.5			
	Styrene	ug/L	0.2			
	Toluene	ug/L	0.2			
	Tributyl Phosphate	ug/L	0.01			
	Xylenes	ug/L	0.2			

TABLE B-3

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSB2C
Latest Rev: 22-Nov-85

PLANT B **** SLUDGE ****

Item	Description	Unit	Detection Limit	Collection Tank	Filter Paper
A	DATE SAMPLED			Feb 26/85	Feb 25/85
B	SAMPLE DESIGNATION			BS-10	BS-11
C	REPLICATES			A	A
D	CONSTITUENTS				
	Total Residue	mg/kg		303,000	740,000
	Total Volatile Residue	mg/kg		241,000	591,000
	CAOV	%		25.3	
	Oils & Grease	mg/kg		26,500	408,000
E	METALS - ICP Scan				
	Arsenic -As	ug/g	8	L	L
	Barium -Ba	ug/g	0.2	110	3.8
	Beryllium -Be	ug/g	0.2	L	L
	Cadmium -Cd	ug/g	0.3	1.2	L
	Cobalt -Co	ug/g	0.8	101	2.5
	Chromium -Cr	ug/g	0.8	38.3	3
	Copper -Cu	ug/g	0.8	114	2.5
	Manganese -Mn	ug/g	0.2	121	4.8
	Molybdenum -Mo	ug/g	0.8	65	2.3
	Nickel -Ni	ug/g	3	31	L
	Phosphorus -P	ug/g	8	263	3380
	Lead -Pb	ug/g	3	524	L
	Tin -Sn	ug/g	2	53	3
	Strontium -Sr	ug/g	0.2	31.3	1.5
	Titanium -Ti	ug/g	0.3	182	9.8
	Vanadium -V	ug/g	0.8	12.7	1.7
	Zinc -Zn	ug/g	0.3	238	5.7
	Aluminum -Al	ug/g	8	2830	855
	Iron -Fe	ug/g	80	16100	78.2
	Silicon -Si	ug/g	20	1480	280
	Calcium -Ca	ug/g	20	5830	400
	Magnesium -Mg	ug/g	20	1350	120
	Sodium -Na	ug/g	20	1000	320

TABLE B-4

SIGMA ENGINEERING LTD. Program name: CHEMbst
WASTE CHARACTERIZATION STUDY Latest revision: 15-Nov-85
ANALYTICAL RESULTS

PLANT B **** SLUDGE (TOTAL) ****

Item	Description	Unit	Detection Limit	Collection Tank	Filter Paper
A	DATE SAMPLED			Feb 26/85	Feb 26/85
B	ASL SAMPLE #			1630-10	1630-11
C	SIGMA SAMPLE #			BS-10	BS-11
D	ORGANIC COMPONENTS				
	Dimethyl Phthalate	ug/g	0.5	L	L
	Diethyl Phthalate	ug/g	0.5	L	L
	Di-n-butyl Phthalate	ug/g	0.05	1300	66
	Butyl Benzyl Phthalate	ug/g	0.05	4.8	32
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.05	230	38
	Di-n-octyl Phthalate	ug/g	0.05	L	L
	Tetrachlorophenol	ug/g	0.01	9.9	L
	Pentachlorophenol	ug/g	0.01	6.3	L
	Diacetone Alcohol	ug/g	0.5	11	L
	Biphenyl	ug/g	0.5	1400	18
	Diphenyl Ether	ug/g	0.5	3600	40
	Toluene 2,4-Diisocyanate(TDI)	ug/g	1	650	17
	Phenol	ug/g	0.5	6.1	110
	Aliphatic Hydrocarbons(C9-C15)	ug/g	2	2000	75000
	Alkyl Benzenes	ug/g	2	500	L
	Parameters Below Detection Limits:				
	2-Butoxyethanol	ug/g	1		
	2-Phenoxyethanol	ug/g	1		
	Adipic Acid Ester A (n.p.i.)	ug/g	1		
	Adipic Acid Ester B (n.p.i.)	ug/g	1		
	Adipic Acid Ester C (n.p.i.)	ug/g	1		
	Benzoic Acid	ug/g	1		
	Butylated Hydroxytoluene (BHT)	ug/g	1		
	Diethylene Glycol	ug/g	1		
	Dipropylene Glycol	ug/g	1		
	Glycol Ether A (n.p.i)	ug/g	1		
	Glycol Ether B (n.p.i)	ug/g	1		
	Glycol Ether C (n.p.i)	ug/g	1		
	Phthalic Acid	ug/g	1		
	Tributyl Phosphate	ug/g	1		

TABLE B-5

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSB3C
Latest Rev: 22-Nov-85

PLANT B **** LEACHATE ****

Item	Description	Unit	Detection Limit	Collection Tank Sludge Leachate	Filter Paper Leachate
A	DATE SAMPLED			Feb 26/85	Feb 25/85
B	SAMPLE DESIGNATION			BSL-10	BSL-11
C	REPLICATES			A	A
D	CONSTITUENTS				
	T.O.C.	ug/g	20	1580	440
	T.I.C.	ug/g	20	40	40
	Phenols	ug/g	0.4	40	40
	Oils & Grease	ug/g	40	L	L
E	METALS - ICP Scan				
	Arsenic -As	ug/g	1	L	L
	Boron -B	ug/g	0.02	0.82	L
	Barium -Ba	ug/g	0.02	2.84	0.08
	Beryllium -Be	ug/g	0.02	L	L
	Cadmium -Cd	ug/g	0.04	L	L
	Cobalt -Co	ug/g	0.1	1.68	L
	Chromium -Cr	ug/g	0.1	L	L
	Copper -Cu	ug/g	0.1	L	0.26
	Manganese -Mn	ug/g	0.02	2.38	0.18
	Molybdenum -Mo	ug/g	0.1	0.4	0.2
	Nickel -Ni	ug/g	0.4	L	L
	Phosphorus -P	ug/g	1	L	109
	Lead -Pb	ug/g	0.4	L	L
	Antimony -Sb	ug/g	1	L	L
	Selenium -Se	ug/g	1	L	L
	Tin -Sn	ug/g	0.2	L	0.2
	Strontium -Sr	ug/g	0.02	1.64	0.06
	Titanium -Ti	ug/g	0.04	L	L
	Vanadium -V	ug/g	0.1	L	L
	Zinc -Zn	ug/g	0.04	1.94	1.2
	Aluminum -Al	ug/g	1	L	6.6
	Iron -Fe	ug/g	0.1	1.54	0.3
	Silicon -Si	ug/g	2	12	4
	Calcium -Ca	ug/g	2	158	14
	Magnesium -Mg	ug/g	2	28	4
	Sodium -Na	ug/g	2	148	32
	Hardness -Ca,Mg	ug/g		516	53.8
	Hardness -Total	ug/g		532	93.2

TABLE B-6

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMbsl
Latest revision: 15-Nov-85

PLANT B **** SLUDGE (LEACHATE) ****

Item	Description	Unit	Detection Limit	Collection Tank Sludge Leachate	Filter Paper Leachate
A	DATE SAMPLED			Feb 26/85	Feb 26/85
B	ASL SAMPLE #			1630-10	1630-11
C	SIGMA SAMPLE #			BSL-10	BSL-11
D	ORGANIC COMPONENTS				
	Dimethyl Phthalate	ug/g	0.2	L	L
	Diethyl Phthalate	ug/g	0.2	L	L
	Di-n-butyl Phthalate	ug/g	0.02	1.5	0.12
	Butyl Benzyl Phthalate	ug/g	0.02	L	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.02	0.2	0.26
	Di-n-octyl Phthalate	ug/g	0.02	L	L
	Tetrachlorophenol	ug/g	0.01	0.08	L
	Pentachlorophenol	ug/g	0.01	0.06	L
	Diacetone Alcohol	ug/g	0.02	0.04	0.12
	Biphenyl	ug/g	0.05	8.4	L
	Diphenyl Ether	ug/g	0.05	27	0.08
	Toluene 2,4-Diisocyanate(TDI)	ug/g	0.2	7.6	L
	Phenol	ug/g	0.05	3.8	5.5
	Aliphatic Hydrocarbons(C9-C15)	ug/g	1	20	10
	Parameters Below Detection Limits:				
	2-Butoxyethanol	ug/g	0.2		
	2-Phenoxyethanol	ug/g	0.2		
	Acetaldehyde	ug/g	10		
	Acetone	ug/g	10		
	Adipic Acid Ester A (n.p.i.)	ug/g	0.2		
	Adipic Acid Ester B (n.p.i.)	ug/g	0.2		
	Adipic Acid Ester C (n.p.i.)	ug/g	0.2		
	Alkyl Benzenes	ug/g	1		
	Benzene	ug/g	4		
	Benzoic Acid	ug/g	0.2		
	Butylated Hydroxytoluene (BHT)	ug/g	0.2		
	Diethylene Glycol	ug/g	0.2		
	Dipropylene Glycol	ug/g	0.2		
	Ethanol	ug/g	10		
	Ethylbenzene	ug/g	4		
	Glycol Ether A (n.p.i)	ug/g	0.2		
	Glycol Ether B (n.p.i)	ug/g	0.2		
	Glycol Ether C (n.p.i)	ug/g	0.2		
	Methanol	ug/g	10		
	Methyl Ethyl Ketone	ug/g	10		
	Methyl Isobutyl Ketone	ug/g	10		
	Phthalic Acid	ug/g	0.2		
	Propionaldehyde	ug/g	10		
	Styrene	ug/g	4		
	Toluene	ug/g	4		
	Tributyl Phosphate	ug/g	0.2		
	Xylenes	ug/g	4		

5. PLANT C

5.1 PROCESS DESCRIPTION - PLANT C

Plant C manufactures ABS and PVC pipe by the extrusion process using powdered resins delivered to the plant by rail car. The PVC resin is offloaded pneumatically into storage silos, weighed and dispensed to blenders. Additives such as plasticizers, pigments, fillers, stabilizers and oils are added during blending. The finished blends are then utilized to extrude pipe. Reference should be made to the literature for more detail on the pipe extrusion process and manufacture of ABS and PVC resins. ABS resin is transferred directly from rail car to the extrusion lines, since it already contains the required additives. Water is used to cool the hot extruded pipe. Cooling water drains from the individual extrusion lines to a cooling water sump. Water is then pumped from this sump, cooled by a forced air cooling tower and recycled back to the individual extrusion lines. An excess cooling water bleed overflows to the storm sewer. Freshwater make-up discharges to the cooling water sump on a continuous basis. A schematic of the manufacturing process at Plant C is provided in Figure 4.

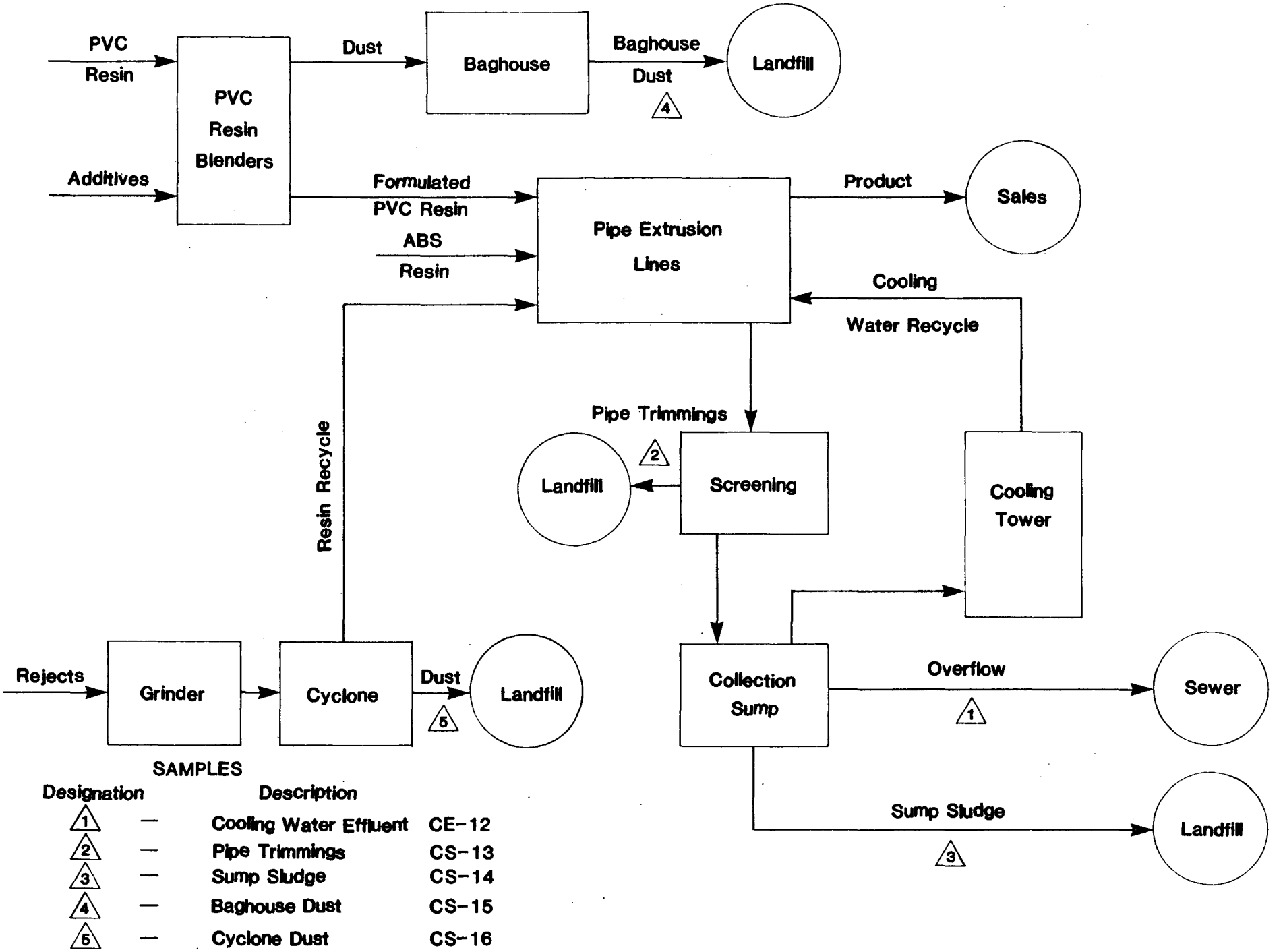
5.2 SAMPLE DESCRIPTIONS - PLANT C

5.2.1 Cooling Water Effluent

This sample was a grab collected from the cooling water sump. It would be considered fairly representative since this water is constantly being recycled to the extrusion lines. The sample was clear, colourless and low in NFR, COD, TOC and organic compound (Tables C-1 and C-2).

5.2.2 Pipe Trimmings

This material was collected off a coarse screen located in the inlet channel to the sump. It consists of chips of PVC and ABS pipe (Table C-3).



SAMPLES

Designation		Description	
1	—	Cooling Water Effluent	CE-12
2	—	Pipe Trimmings	CS-13
3	—	Sump Sludge	CS-14
4	—	Baghouse Dust	CS-15
5	—	Cyclone Dust	CS-16

PLANT C – PVC & ABS PIPE MANUFACTURING SCHEMATIC FIGURE 4

5.2.3 Sump Sludge

This sample was collected from the bottom of the sump using a fine mesh strainer.

This material consisted of a gray, very fine sludge composed of PVC, ABS and other fugitive dusts from the blending area that have entered the cooling water at the extrusion lines. The organic analyses indicated low levels of measurable organics. Aliphatic hydrocarbons were the main components picked up by analyses. The polymers cannot be analyzed for by GC. (Tables C-3 and C-4)

5.2.4 Baghouse Dust

The baghouse removes dust collected by hoods in the blending area. The collected dust is dropped manually from the baghouse hopper into a 0.2 m^3 barrel. Approximately 0.2 m^3 of this material is generated every 12 days. Disposal is via landfill. The dust is a fine white powder with a low concentration of measurable organic compounds. This material is too fine to permit re-use. (Tables C-3 and C-4)

5.2.5 Cyclone Dust

PVC cuttings and off-spec pipe fragments remaining after the extrusion process are ground to pellets to permit re-use in pipe production. Dust generated during grinding is removed pneumatically using a cyclone. This fine PVC powder cannot be re-used in pipe manufacture. This dust was fine white powder containing some larger particles and would be expected to consist mainly of PVC and associated additives (Tables C-3 and C-4).

5.3 PRIORITY CHEMICALS - PLANT C

5.3.1 Phthalic Acid Esters

The cooling water contained a low level of dimethyl and diethyl phthlate. Both of these compounds were also detected in the sump sludge, baghouse dust and cyclone dust. In addition Bis (2-ethyl hexyl) phthalate was detected in the sump sludge. Dimethyl and diethyl phthalate were leached from the sump sludge and the baghouse dust by the SWEP method. Dimethyl phthalate yield via leaching was 20% from the cyclone dust, while the yield from the baghouse dust was less than 2%. The sump sludge releases less than detectable concentrations of phthalates via the SWEP method. Phthalates are used as plasticizers for PVC and ABS pipe.

5.3.2 Organotin

Dibutyltin dilaurate was present at a concentration of 0.1% in the cyclone dust sample but did not transfer to the cyclone dust leachate following the SWEP test. Dibutyltin dilaurate was below the detection limit in all other effluent, sludge and leachate samples.

5.4 WASTE COMPONENTS - PLANT C

5.4.1 Cooling Water

The manufacture of plastic pipe basically involves melting of resins, extrusion of the molten plastic through dies to form the pipe, and cooling of the extruded pipe using water spray. Since no chemical reactions are involved waste components in the cooling water consist of either fugitive dust from the air which is picked up by the water spray, or compounds leached from the plastic during cooling. Excess cooling water therefore contains very low levels of organic and inorganic compounds.

5.4.2 Sludges and Dusts

The major waste components of the sludges and dust samples are polymerized PVC and ABS compounds which cannot be detected by conventional GC methods. Low levels of aliphatic hydrocarbons were present in the sludge dust sample (Table C-4).

5.5 VOLUMETRIC AND MASS LOADING - PLANT C

Estimated volumetric and organic mass loadings are presented in Table 11. Mass loading estimates should be utilized for comparative purposes only, since they are based on single samples collected during the site visit.

5.6 SUMMARY AND RECOMMENDATIONS - PLANT C

Excess cooling water discharged to sewer does not present a serious environmental hazard due to the low organic concentrations involved. However it is recommended the present methods utilized for the collection and disposal of cyclone dust should be investigated to determine the ultimate fate of the organotin component of this material.

TABLE 11 - VOLUMETRIC AND MASS LOADINGS - PLANT C

Sample		Discharge Frequency	Quantity	Daily Flowrate m^3	Disposal Method	Organic Waste Components	Mass Loadings kg/yr
Cooling Water Effluent	CE-12	Continuous	70 m^3/d	70 m^3/d	Sewer	Phthalates	3.1
Sump Sludge	CS-14	4 months	5.5 m^3	0.045	Landfill	Phthalates	1.0
						Aliphatic Hydrocarbon (C8-C11)	1.65
						Aliphatic Hydrocarbon (C19-C30)	1.65
Baghouse Dust	CS-15	1.5 - 2 weeks	0.2 m^3	0.016	Landfill	Phthalates	0.1
						Aliphatic Hydrocarbon	0.5
Cyclone Dust	CS-16	2 - 3 days	0.2 m^3	0.08	Landfill	Phthalates	0.25
						Dibutyltin Dilaurate	23.4
						Aliphatic Hydrocarbon	4.7

ANALYTICAL RESULTS

CONVENTIONAL AND ORGANIC ANALYSES

PLANT C

TABLE C-1

SIGMA ENGINEERING LTD.
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSC1C
Latest Rev: 15-Nov-85

PLANT C **** EFFLUENTS ****

Item	Description	Unit	Detection Limit	Cooling Water Effluent
A	DATE SAMPLED			Feb 27/85
B	SAMPLE DESIGNATION			AE-12
C	CONSTITUENTS			
	pH	n.a.	n.a.	7
	COD	mg/l	20	L
	Chloride (Cl)	mg/l	0.5	2.7
	Colour	Units	5	10
	Conductivity	umhos/cm	1	23.5
	Fluoride (F)	mg/l	0.05	L
	Nitrate (N)	mg/l	0.005	0.2
	Nitrite (N)	mg/l	0.005	0.013
	Non-Filterable Residue	mg/l	5	6
	Oils & Grease	mg/l	2	L
	Phenols	mg/l	0.02	0.06
	Sulphate (SO4)	mg/l	1	5
	T - N		0.03	0.31
	T. Alk. as CaCO3	mg/l	1	7.5
	T.O.C.	mg/l	1	3
	Total Residue	mg/l	5	25
	Turbidity	FTU	1	2.3

TABLE C-1

SIGMA ENGINEERING LTD.
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-OFO)

Program name: EPSC1C
Latest Rev: 15-Nov-85

PLANT C **** EFFLUENTS ****

Item	Description		Unit	Detection Limit	Cooling Water Effluent
A	DATE SAMPLED				Feb 27/85
B	SAMPLE DESIGNATION				AE-12
D	METALS - ICP Scan				
	Arsenic	-As	ug/ml	0.05	L
	Boron	-B	ug/ml	0.001	0.013
	Barium	-Ba	ug/ml	0.001	0.004
	Beryllium	-Be	ug/ml	0.001	L
	Cadmium	-Cd	ug/ml	0.002	L
	Cobalt	-Co	ug/ml	0.005	L
	Chromium	-Cr	ug/ml	0.005	222
	Copper	-Cu	ug/ml	0.005	0.013
	Manganese	-Mn	ug/ml	0.001	0.008
	Molybdenum	-Mo	ug/ml	0.005	L
	Nickel	-Ni	ug/ml	0.02	L
	Phosphorus	-P	ug/ml	0.05	L
	Lead	-Pb	ug/ml	0.02	L
	Antimony	-Sb	ug/ml	0.05	L
	Selenium	-Se	ug/ml	0.05	L
	Tin	-Sn	ug/ml	0.01	L
	Stontium	-Sr	ug/ml	0.001	0.009
	Titanium	-Ti	ug/ml	0.002	0.049
	Vanadium	-V	ug/ml	0.005	L
	Zinc	-Zn	ug/ml	0.002	0.26
	Aluminum	-Al	ug/ml	0.05	0.05
	Iron	-Fe	ug/ml	0.005	0.181
	Silicon	-Si	ug/ml	0.1	1.3
	Calcium	-Ca	ug/ml	0.1	2
	Magnesium	-Mg	ug/ml	0.1	L
	Sodium	-Na	ug/ml	0.1	0.9
	Hardness	-Ca,Mg	ug/ml		5.16
	Hardness	-Total	ug/ml		6.2
	Mercury	-Hg	ug/ml	0.00005	0.00007
E	BIOASSAY				
	96 HOUR LT 50		hour		NT

TABLE C-2

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMcet
Latest revision: 25-Oct-85

PLANT C **** EFFLUENT (TOTAL) ****

Item	Description	Unit	Detection Limit	Cooling Water Effluent
A	DATE SAMPLED			Feb 27/85
B	ASL SAMPLE #			1630-12
C	SIGMA SAMPLE #			CE-12
D	ORGANIC COMPONENTS			
	Dimethyl Phthalate	mg/L	0.01	0.11
	Diethyl Phthalate	mg/L	0.01	0.01
	Di-n-butyl Phthalate	mg/L	0.001	L
	Butyl Benzyl Phthalate	mg/L	0.001	L
	Bis (2-Ethyl Hexyl) Phthalate	mg/L	0.001	0.002
	Di-n-octyl Phthalate	mg/L	0.001	L
	Parameters Below Detection Limits:			
	Acetaldehyde	mg/L	0.5	
	Acetone	mg/L	0.5	
	Aliphatic Hydrocarbons (C8-C11)	mg/L	0.05	
	Aliphatic Hydrocarbons (C19-C30)	mg/L	0.5	
	Benzene	mg/L	0.2	
	Components of Organotin Compound(Dibutyltin Dilaurate)	mg/L	2	
	Diacetone Alcohol	mg/L	0.005	
	Ethanol	mg/L	0.5	
	Ethylbenzene	mg/L	0.2	
	Methanol	mg/L	0.5	
	Methyl Ethyl Ketone	mg/L	0.5	
	Methyl Isobutyl Ketone	mg/L	0.5	
	Propionaldehyde	mg/L	0.5	
	Styrene	mg/L	0.2	
	Toluene	mg/L	0.2	
	Xylenes	mg/L	0.2	

TABLE C-3

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSC2C
Latest Rev: 24-Oct-85

PLANT C **** SLUDGE ****

Item	Description	Unit	Detection Limit	Pipe Trimmings	Sump Sludge		Baghouse Dust	Cyclone Dust
A	DATE SAMPLED			Feb 27/85	Feb 27/85	Feb 27/85	Feb 27/85	Feb 27/85
B	SAMPLE DESIGNATION			CS-13	CS-14	CS-14	CS-15	CS-16
C	REPLICATES			A	A	B	A	A
D	CONSTITUENTS							
	Total Residue	mg/kg		542,000	501,000		991,000	998,000
	Total Volatile Residue	mg/kg		505,000	444,000		561,000	888,000
	CAOV	%			2.9			
	Oils & Grease	mg/kg		4,630	1,850		17,100	1,160
E	METALS - ICP Scan							
	Arsenic -As	ug/g	8	L	L	L	L	L
	Barium -Ba	ug/g	0.2	0.5	7.6	7.6	7.9	0.4
	Beryllium -Be	ug/g	0.2	L	L	L	L	L
	Cadmium -Cd	ug/g	0.3	L	1.5	1.5	0.4	L
	Cobalt -Co	ug/g	0.8	L	L	2.1	1.5	6.7
	Chromium -Cr	ug/g	0.8	2.1	31	39.8	23.8	L
	Copper -Cu	ug/g	0.8	5.6	376	378	29.5	L
	Manganese -Mn	ug/g	0.2	1.6	54	50.1	72.6	2.1
	Molybdenum -Mo	ug/g	0.8	L	L	L	L	L
	Nickel -Ni	ug/g	3	L	9	10	L	L
	Phosphorus -P	ug/g	8	67	32	35	142	L
	Lead -Pb	ug/g	3	9	101	102	115	L
	Tin -Sn	ug/g	2	8	256	257	248	28
	Strontium -Sr	ug/g	0.2	1.9	12.2	13.8	144	2.9
	Titanium -Ti	ug/g	0.3	8.4	64.3	63.3	148	12.4
	Vanadium -V	ug/g	0.8	L	3.2	3.1	2	L
	Zinc -Zn	ug/g	0.3	8.4	348	368	123	2.1
	Aluminum -Al	ug/g	8	30	770	781	479	59
	Iron -Fe	ug/g	80	92.3	4950	4840	3630	60.5
	Silicon -Si	ug/g	20	40	950	1010	430	150
	Calcium -Ca	ug/g	20	1120	4880	5560	108000	1740
	Magnesium -Mg	ug/g	20	80	190	190	350	L
	Sodium -Na	ug/g	20	60	140	120	190	130

TABLE C-4

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMcst
Latest revision: 25-Nov-85

PLANT C **** SLUDGE (TOTAL) ****

Item	Description	Unit	Detection Limit	Sump	Baghouse Dust	Cyclone Dust
A	DATE SAMPLED			Feb 27/85	Feb 27/85	
B	ASL SAMPLE #			1630-14	1630-15	1630-16
C	SIGMA SAMPLE #			CS-14	CS-15	CS-16
D	ORGANIC COMPONENTS					
	Dimethyl Phthalate	ug/g	0.5	48	16	6.3
	Diethyl Phthalate	ug/g	0.5	5.9	7.2	4.5
	Di-n-butyl Phthalate	ug/g	0.05	L	L	L
	Butyl Benzyl Phthalate	ug/g	0.05	L	L	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.05	8.8	L	L
	Di-n-octyl Phthalate	ug/g	0.05	L	L	L
	Diacetone Alcohol	ug/g	0.5	2.4	L	L
	Components of Organotin Compound(Dibutyltin Dilaurate)	ug/g	100	L	L	1000
	Aliphatic Hydrocarbons(C8-C11)	ug/g	2	100	L	L
	Aliphatic Hydrocarbons(C19-C30)	ug/g	20	100	100	200

TABLE C-5

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSC3C
Latest Rev: 15-Nov-85

PLANT C **** LEACHATES ****

Item	Description		Unit	Detection Limit	Pipe Trimmings	Sump Sludge Leachate	Baghouse Dust Leachate	Cyclone Dust Leachate
A	DATE SAMPLED				Feb 27/85	Feb 27/85	Feb 27/85	Feb 27/85
B	SAMPLE DESIGNATION				CSL-13	CSL-14	CSL-15	CSL-16
C	REPLICATES							
D	CONSTITUENTS							
	T.O.C.		ug/g	20	60	500	560	L
	T.I.C.		ug/g	20	40	1.74	640	0
	Phenols		ug/g	0.4	0.2	0.17	0.8	L
	Oils & Grease		ug/g	40	L	140	L	480
E	METALS - ICP Scan							
	Arsenic	-As	ug/g	1	L	L	L	L
	Boron	-B	ug/g	0.02	L	0.1	0.32	0.34
	Barium	-Ba	ug/g	0.02	0.1	0.96	0.52	0.06
	Beryllium	-Be	ug/g	0.02	L	L	L	L
	Cadmium	-Cd	ug/g	0.04	0.04	0.21	0.08	L
	Cobalt	-Co	ug/g	0.1	L	L	L	L
	Chromium	-Cr	ug/g	0.1	L	L	0.4	L
	Copper	-Cu	ug/g	0.1	3.62	3.15	0.84	0.78
	Manganese	-Mn	ug/g	0.02	0.14	10.3	12.2	0.6
	Molybdenum	-Mo	ug/g	0.1	L	L	0.38	L
	Nickel	-Ni	ug/g	0.4	L	0.5	L	L
	Phosphorus	-P	ug/g	1	L	L	9.6	L
	Lead	-Pb	ug/g	0.4	L	L	L	L
	Antimony	-Sb	ug/g	1	L	L	1.4	L
	Selenium	-Se	ug/g	1	L	L	L	L
	Tin	-Sn	ug/g	0.2	0.6	L	74.2	0.6
	Strontium	-Sr	ug/g	0.02	0.1	3.29	25.2	0.9
	Titanium	-Ti	ug/g	0.04	L	1.84	L	L
	Vanadium	-V	ug/g	0.1	L	L	L	L
	Zinc	-Zn	ug/g	0.04	2.42	40.5	9.08	2.98
	Aluminum	-Al	ug/g	1	L	L	2.4	L
	Iron	-Fe	ug/g	0.1	2.08	4.5	0.94	0.44
	Silicon	-Si	ug/g	2	2	26	12	L
	Calcium	-Ca	ug/g	2	50	1570	14600	594
	Magnesium	-Mg	ug/g	2	L	8.7	80	L
	Sodium	-Na	ug/g	2	4	10.4	48	6
	Hardness	-Ca,Mg	ug/g		132	3950	36800	1490
	Hardness	-Total	ug/g		144	4040	36800	1490

TABLE C-6

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMcsl
Latest revision: 25-Oct-85

PLANT C **** SLUDGE (LEACHATE) ****

Item	Description	Unit	Detection Limit	Pipe Trimmings	Sump Sludge Leachate	Baghouse Dust Leachate	Cyclone Dust Leachate
A	DATE SAMPLED			Feb 27/85	Feb 27/85	Feb 27/85	Feb 27/85
B	ASL SAMPLE #			1630-13	1630-14	1630-15	1630-16
C	SIGMA SAMPLE #			CSL-13	CSL-14	CSL-15	CSL-16
D	ORGANIC COMPONENTS						
	Dimethyl Phthalate	ug/g	0.2	L	0.2	1.3	L
	Diethyl Phthalate	ug/g	0.2	L	0.46	0.44	L
	Di-n-butyl Phthalate	ug/g	0.02	L	L	L	L
	Butyl Benzyl Phthalate	ug/g	0.02	L	L	L	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.02	L	L	L	L
	Di-n-octyl Phthalate	ug/g	0.02	L	L	L	L
	Parameters Below Detection Limits:						
	Acetaldehyde	ug/g	10				
	Acetone	ug/g	10				
	Aliphatic Hydrocarbons(C19-C30)	ug/g	10				
	Aliphatic Hydrocarbons(C8-C11)	ug/g	1				
	Benzene	ug/g	4				
	Components of Organotin Compound(Dibutyltin Dilaurate)	ug/g	25				
	Diacetone Alcohol	ug/g	0.02				
	Ethanol	ug/g	10				
	Ethylbenzene	ug/g	4				
	Methanol	ug/g	10				
	Methyl Ethyl Ketone	ug/g	10				
	Methyl Isobutyl Ketone	ug/g	10				
	Propionaldehyde	ug/g	10				
	Styrene	ug/g	4				
	Toluene	ug/g	4				
	Xylenes	ug/g	4				

6. PLANT D

6.1 PROCESS DESCRIPTION

Plant D is a paint and coatings manufacturer that produces latex, alkyd and clear coatings for commercial and consumer markets. Latex and alkyd paints represent approximately 52% and 45% respectively, of total production. Blending of both alkyd and latex paint formulations is carried out in batch mixing tanks which can be moved from the mixing stations to the canning section of the plant as required. Alkyd paint mixing tanks and equipment are cleaned with solvents. All spent solvent is recycled into the production of metal primers and stains. Latex equipment is washed with a restricted volume of water to minimize wastewater generation.

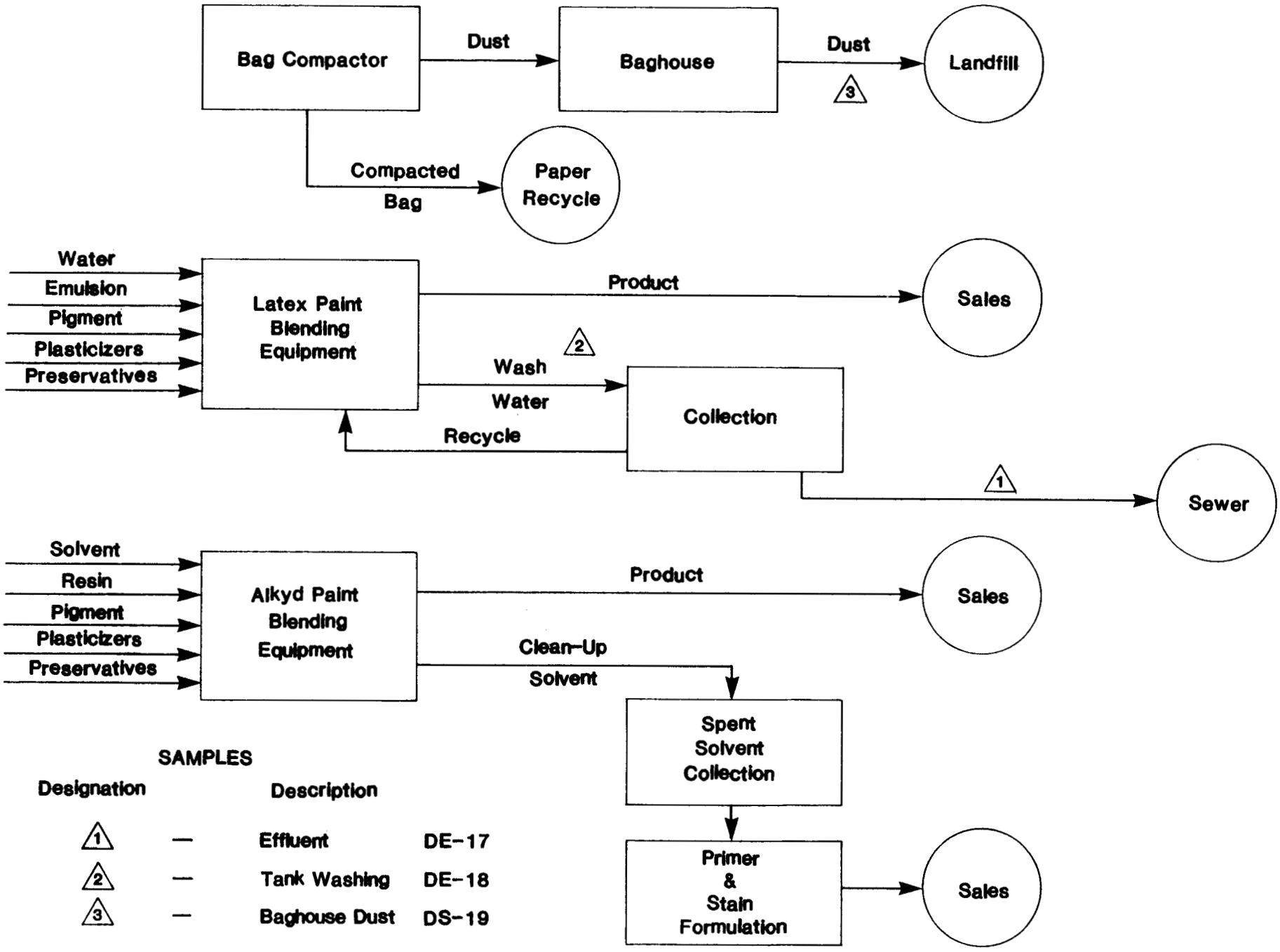
This latex washwater is stored for recycle into subsequent batches of latex paint. A small amount of excess washwater can overflow during tank washing and discharge to sewer. If the latex washwater cannot be utilized within approximately 72 hours it is discharged to a floor sump which overflows to the municipal sewer. Heavy solids in the washwater can settle in the sump. At the time of the sampling trip, the bulk of the waste water discharging to the sewer was cooling water originating from pigment and paint blending mills. The sump was free of solids at the time of sample collection.

A schematic of the process at Plant D is provided in Figure 5.

6.2 SAMPLE DESCRIPTIONS

6.2.1 Combined Effluent

This sample was a composite collected from the floor sump at 2 minute intervals over a 4-hour period during canning and cleanup of three 1300 L batches of latex paint. Cooling water flow was continuous during this period at a rate of approximately 10L/min. Volume of washwater discharged to sewer during the first two batches was small, approximately 2-5 L. Most of washwater generated (20L) was stored for potential re-use. The third latex batch cleanup did not result in a discharge.



SAMPLES

Designation		Description	
1	—	Effluent	DE-17
2	—	Tank Washing	DE-18
3	—	Baghouse Dust	DS-19

PLANT D – LATEX & ALKYD PAINT PROCESS SCHEMATIC

FIGURE 5

6.2.2 Tank Washing

This sample was an aliquot of the wash water from the third latex paint. This material was stored for re-use. This sample would represent a concentrated waste that would be discharged to sewer if it could not be re-used. Conventional analyses were not performed on this sample due to the small sample size. The sample was instead utilized for the organic analyses as reported in Table D-2.

6.2.3 Baghouse Dust

This sample was a grab collected from the bottom of a small baghouse which removed dust from a waste bag crusher. The empty bags result from pigment, filler and other paint additives that are handled in the dry form. The quantity of dust collected is very small. Baghouse dust is sent to landfill for ultimate disposal on an infrequent basis.

6.3 PRIORITY CHEMICALS - PLANT D

6.3.1 Phthalic Acid Esters

Di-n-butyl, butyl benzyl and bis (2-ethyl hexyl) phthalates were an order of magnitude above detection limit in the tank washing, while butyl benzyl and bis (2-ethyl hexyl) were only slightly above detection limit in the combined effluent. The baghouse dust contained a major amount of di-n-butyl phthalate.

6.3.2 Chlorinated Phenols

Chlorinated phenols were not detected in either of the liquids since they would not be expected in a general latex formulation. Small amounts of both tetrachlorophenol and pentachlorophenol were encountered in the baghouse dust.

6.3.3 Triaryl Phosphate

Tributyl phosphate was detected in the baghouse dust but triphenyl and tricresyl phosphates were below detection limit in all samples.

6.3.4 Organotin

Organotin analyses were not performed due to the less than detectable concentration of total tin in the liquid and solid samples.

6.4 MAJOR COMPONENTS - PLANT D

Major waste components would be the basic components of latex paint, i.e. polyvinyl acetate, pigment, colloids etc. These components would be similar to those listed in Table 7.

6.4.1 Solvents

Solvents detected in the tank washing at measurable concentrations included aliphatic hydrocarbons, fatty acids, xylene, ethyl benzene, glycol ethers and ethanol.

All solvents were below detection limit in the combined effluent due to dilution with cooling water. Solvents detected in the baghouse dust were glycol ethers and fatty acids.

6.5 SUMMARY - PLANT D

Plant D manufactures paint on a relatively small batch basis. Generation of liquid wastes is limited and controlled due to the recycle of washings into products. Mass loadings cannot be accurately calculated due to the low intermittent discharge of liquid effluent.

ANALYTICAL RESULTS

CONVENTIONAL AND ORGANIC ANALYSES

PLANT D

TABLE D-1

SIGMA ENGINEERING LTD.
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSD1C
Latest Rev: 24-Oct-85

PLANT D **** EFFLUENTS ****

Item	Description	Unit	Detection Limit	Combined Effluent
A	DATE SAMPLED			Mar 1/85
B	SAMPLE DESIGNATION			DE-17
C	CONSTITUENTS			
	pH	n.a.	n.a.	8.1
	COD	mg/l	20	40
	Chloride (Cl)	mg/l	0.5	8
	Colour	Units	5	NA-Opaque
	Conductivity	umhos/cm	1	46.8
	Fluoride (F)	mg/l	0.05	L
	Nitrate (N)	mg/l	0.005	0.14
	Nitrite (N)	mg/l	0.005	0.059
	Non-Filterable Residue	mg/l	5	L
	Phenols	mg/l	0.02	0.06
	Sulphate (SO4)	mg/l	1	8
	T - N		0.03	0.7
	T. Alk. as CaCO3	mg/l	1	17.2
	T.O.C.	mg/l	1	20
	Total PO4 (P)	mg/l	0.005	0.56
	Total Residue	mg/l	5	81
	Turbidity	FTU	1	9900

TABLE D-1

SIGMA ENGINEERING LTD.
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSD1C
Latest Rev: 24-Oct-85

PLANT D **** EFFLUENTS ****

Item	Description		Unit	Detection Limit	Combined Effluent
A	DATE SAMPLED				Mar 1/85
B	SAMPLE DESIGNATION				DE-17
D	METALS - ICP Scan				
	Arsenic	-As	ug/ml	0.05	L
	Boron	-B	ug/ml	0.001	L
	Barium	-Ba	ug/ml	0.001	0.007
	Beryllium	-Be	ug/ml	0.001	L
	Cadmium	-Cd	ug/ml	0.002	L
	Cobalt	-Co	ug/ml	0.005	L
	Chromium	-Cr	ug/ml	0.005	L
	Copper	-Cu	ug/ml	0.005	0.039
	Manganese	-Mn	ug/ml	0.001	0.019
	Molybdenum	-Mo	ug/ml	0.005	L
	Nickel	-Ni	ug/ml	0.02	L
	Phosphorus	-P	ug/ml	0.05	0.08
	Lead	-Pb	ug/ml	0.02	0.04
	Antimony	-Sb	ug/ml	0.05	L
	Selenium	-Se	ug/ml	0.05	L
	Tin	-Sn	ug/ml	0.01	L
	Stontium	-Sr	ug/ml	0.001	0.012
	Titanium	-Ti	ug/ml	0.002	1.27
	Vanadium	-V	ug/ml	0.005	L
	Zinc	-Zn	ug/ml	0.002	0.07
	Aluminum	-Al	ug/ml	0.05	0.45
	Iron	-Fe	ug/ml	0.005	0.37
	Silicon	-Si	ug/ml	0.1	1.9
	Calcium	-Ca	ug/ml	0.1	6.9
	Magnesium	-Mg	ug/ml	0.1	0.4
	Sodium	-Na	ug/ml	0.1	1
	Hardness	-Ca,Mg	ug/ml		18.8
	Hardness	-Total	ug/ml		22.1
	Mercury	-Hg	ug/ml	0.00005	0.00036
E	BIOASSAY				
	96 HOUR LT 50		hour		NT

TABLE D-2

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMdet
Latest revision: 15-Nov-85

PLANT D **** EFFLUENT (TOTAL) ****

Item	Description	Unit	Detection Limit	Combined Effluent	Tank Washing
A	DATE SAMPLED			Mar 1/85	Mar 1/85
B	ASL SAMPLE #			1630-17	1630-18
C	SIGMA SAMPLE #			DE-17	DE-18
D	ORGANIC COMPONENTS				
	Dimethyl Phthalate	mg/L	0.01	L	L
	Diethyl Phthalate	mg/L	0.01	L	L
	Di-n-butyl Phthalate	mg/L	0.001	L	0.061
	Butyl Benzyl Phthalate	mg/L	0.001	0.004	0.022
	Bis (2-Ethyl Hexyl) Phthalate	mg/L	0.001	0.006	0.048
	Di-n-octyl Phthalate	mg/L	0.001	L	L
	Tetrachlorophenol	mg/L	0.001	L	L
	Pentachlorophenol	mg/L	0.001	L	L
	Acetone	mg/L	0.5	L	1.3
	Ethanol	mg/L	0.5	L	6.6
	Ethylbenzene	mg/L	0.2	L	34
	Xylenes	mg/L	0.2	L	46
	2-Phenoxyethanol	mg/L	0.01	L	3.1
	Butylated Hydroxytoluene (BHT)	mg/L	0.01	L	0.32
	Glycol Ether A (n.p.i.)	mg/L	0.01	L	3.3
	Glycol Ether B (n.p.i.)	mg/L	0.01	L	31
	Glycol Ether C (n.p.i.)	mg/L	0.01	L	30
	Fatty Acids	mg/L	0.5	L	100
	Aliphatic Hydrocarbons (C7-C13)	mg/L	0.05	L	300
	Aliphatic Hydrocarbons (C19-C30)	mg/L	0.5	L	150
	Parameters Below Detection Limits:				
	2-Butoxyethanol	mg/L	0.01		
	Acetaldehyde	mg/L	0.5		
	Benzene	mg/L	0.2		
	Diacetone Alcohol	mg/L	0.005		
	Diphenyl Ether	mg/L	0.005		
	Methanol	mg/L	0.5		
	Methyl Ethyl Ketone	mg/L	0.5		
	Methyl Isobutyl Ketone	mg/L	0.5		
	Propionaldehyde	mg/L	0.5		
	Styrene	mg/L	0.2		
	Toluene	mg/L	0.2		
	Toluene 2.4-Diisocyanate(TDI)	mg/L	0.01		

TABLE D-3

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSD2C
Latest Rev: 25-Oct-85

PLANT D **** SLUDGE ****

Item	Description	Unit	Detection Limit	Baghouse Dust	Baghouse Dust
A	DATE SAMPLED			Mar 1/85	Mar 1/85
B	SAMPLE DESIGNATION			DS-19	DS-19
C	REPLICATES			A	B
D	CONSTITUENTS				
	Total Residue	mg/kg		990,000	
	Total Volatile Residue	mg/kg		113,000	
	Oils & Grease	mg/kg		6,160	
E	METALS - ICP Scan				
	Arsenic -As	ug/g	8	L	L
	Barium -Ba	ug/g	0.2	902	878
	Beryllium -Be	ug/g	0.2	L	L
	Cadmium -Cd	ug/g	0.3	L	L
	Cobalt -Co	ug/g	0.8	1.6	5.3
	Chromium -Cr	ug/g	0.8	625	601
	Copper -Cu	ug/g	0.8	43.6	40.5
	Manganese -Mn	ug/g	0.2	888	866
	Molybdenum -Mo	ug/g	0.8	L	L
	Nickel -Ni	ug/g	3	5	5
	Phosphorus -P	ug/g	8	543	534
	Lead -Pb	ug/g	3	872	869
	Tin -Sn	ug/g	2	L	L
	Strontium -Sr	ug/g	0.2	64.6	62.4
	Titanium -Ti	ug/g	0.3	561	537
	Vanadium -V	ug/g	0.8	21.8	21.1
	Zinc -Zn	ug/g	0.3	4270	4150
	Aluminum -Al	ug/g	8	13600	13200
	Iron -Fe	ug/g	80	23200	22500
	Silicon -Si	ug/g	20	1880	1420
	Calcium -Ca	ug/g	20	52600	51000
	Magnesium -Mg	ug/g	20	12700	12400
	Sodium -Na	ug/g	20	2590	2510

TABLE D-4

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMdst
Latest revision: 15-Nov-85

PLANT D **** SLUDGE (TOTAL) ****

Item	Description	Unit	Detection Limit	Baghouse Dust
A	DATE SAMPLED			Mar 1/85
B	ASL SAMPLE #			1630-19
C	SIGMA SAMPLE #			DS-19
D	ORGANIC COMPOUNDS			
	Dimethyl Phthalate	ug/g	0.5	L
	Diethyl Phthalate	ug/g	0.5	L
	Di-n-butyl Phthalate	ug/g	0.05	4000
	Butyl Benzyl Phthalate	ug/g	0.05	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.05	L
	Di-n-octyl Phthalate	ug/g	0.05	L
	Tetrachlorophenol	ug/g	0.01	8.3
	Pentachlorophenol	ug/g	0.01	4.6
	Tributyl Phosphate	ug/g	1	6
	Glycol Ether A (n.p.i)	ug/g	1	7.8
	Glycol Ether B (n.p.i)	ug/g	1	560
	Glycol Ether C (n.p.i)	ug/g	1	740
	Fatty Acids	ug/g	20	150
	Parameters Below Detection Limits:			
	2-Butoxyethanol	ug/g	1	
	2-Phenoxyethanol	ug/g	1	
	Aliphatic Hydrocarbons(C19-C30)	ug/g	20	
	Aliphatic Hydrocarbons(C7-C13)	ug/g	2	
	Butylated Hydroxytoluene (BHT)	ug/g	1	
	Diacetone Alcohol	ug/g	0.5	

TABLE D-5

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSD3C
Latest Rev: 25-Oct-85

PLANT D **** LEACHATE ****

Item	Description		Unit	Detection Limit	Baghouse Dust Leachate
A	DATE SAMPLED				Mar 1/85
B	SAMPLE DESIGNATION				DSL-19
C	REPLICATES				A
D	CONSTITUENTS				
	T.O.C.		ug/g	20	11200
	T.I.C.		ug/g	20	100
	Phenols		ug/g	0.4	2.4
	Oils & Grease		ug/g	40	L
E	METALS - ICP Scan				
	Arsenic	-As	ug/g	1	L
	Boron	-B	ug/g	0.02	4.72
	Barium	-Ba	ug/g	0.02	0.36
	Beryllium	-Be	ug/g	0.02	L
	Cadmium	-Cd	ug/g	0.04	0.14
	Cobalt	-Co	ug/g	0.1	0.18
	Chromium	-Cr	ug/g	0.1	167
	Copper	-Cu	ug/g	0.1	0.24
	Manganese	-Mn	ug/g	0.02	34.8
	Molybdenum	-Mo	ug/g	0.1	L
	Nickel	-Ni	ug/g	0.4	L
	Phosphorus	-P	ug/g	1	8.6
	Lead	-Pb	ug/g	0.4	0.8
	Antimony	-Sb	ug/g	1	3.2
	Selenium	-Se	ug/g	1	L
	Tin	-Sn	ug/g	0.2	L
	Strontium	-Sr	ug/g	0.02	14
	Titanium	-Ti	ug/g	0.04	18.8
	Vanadium	-V	ug/g	0.1	L
	Zinc	-Zn	ug/g	0.04	596
	Aluminum	-Al	ug/g	1	6.8
	Iron	-Fe	ug/g	0.1	1.5
	Silicon	-Si	ug/g	2	190
	Calcium	-Ca	ug/g	2	9640
	Magnesium	-Mg	ug/g	2	634
	Sodium	-Na	ug/g	2	1100
	Hardness	-Ca,Mg	ug/g		26600
	Hardness	-Total	ug/g		27800

TABLE D-6

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMdsl
Latest revision: 15-Nov-85

PLANT D **** SLUDGE (LEACHATE) ****

Item	Description	Unit	Detection Limit	Baghouse Dust Leachate
A	DATE SAMPLED			Mar 1/85
B	ASL SAMPLE #			1630-19
C	SIGMA SAMPLE #			DSL-19
D	ORGANIC COMPONENTS			
	Dimethyl Phthalate	ug/g	0.2	L
	Diethyl Phthalate	ug/g	0.2	L
	Di-n-butyl Phthalate	ug/g	0.02	0.23
	Butyl Benzyl Phthalate	ug/g	0.02	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.02	L
	Di-n-octyl Phthalate	ug/g	0.02	L
	Tetrachlorophenol	ug/g	0.01	0.4
	Pentachlorophenol	ug/g	0.01	0.7
	2-Phenoxyethanol	ug/g	0.2	210
	2-Butoxyethanol	ug/g	0.2	5.9
	Tributyl Phosphate	ug/g	0.2	5
	Butylated Hydroxytoluene(BHT)	ug/g	0.2	4.2
	Glycol Ether A (n.p.i)	ug/g	0.2	240
	Glycol Ether B (n.p.i)	ug/g	0.2	320
	Glycol Ether C (n.p.i)	ug/g	0.2	240
	Fatty Acids	ug/g	10	4000
	Diethylene Glycol	ug/g	0.2	2.1
	Parameters Below Detection Limits:			
	Acetaldehyde	ug/g	10	
	Acetone	ug/g	10	
	Aliphatic Hydrocarbons(C19-C30)	ug/g	10	
	Aliphatic Hydrocarbons(C7-C13)	ug/g	1	
	Benzene	ug/g	4	
	Diacetone Alcohol	ug/g	0.02	
	Dipropylene Glycol	ug/g	0.2	
	Ethanol	ug/g	10	
	Ethylbenzene	ug/g	4	
	Methanol	ug/g	10	
	Methyl Ethyl Ketone	ug/g	10	
	Methyl Isobutyl Ketone	ug/g	10	
	Propionaldehyde	ug/g	10	
	Styrene	ug/g	4	
	Toluene	ug/g	4	
	Toluene 2.4-Diisocyanate(TDI)	ug/g	0.2	
	Xylenes	ug/g	4	

7. PLANT E

7.1 PROCESS DESCRIPTION - PLANT E

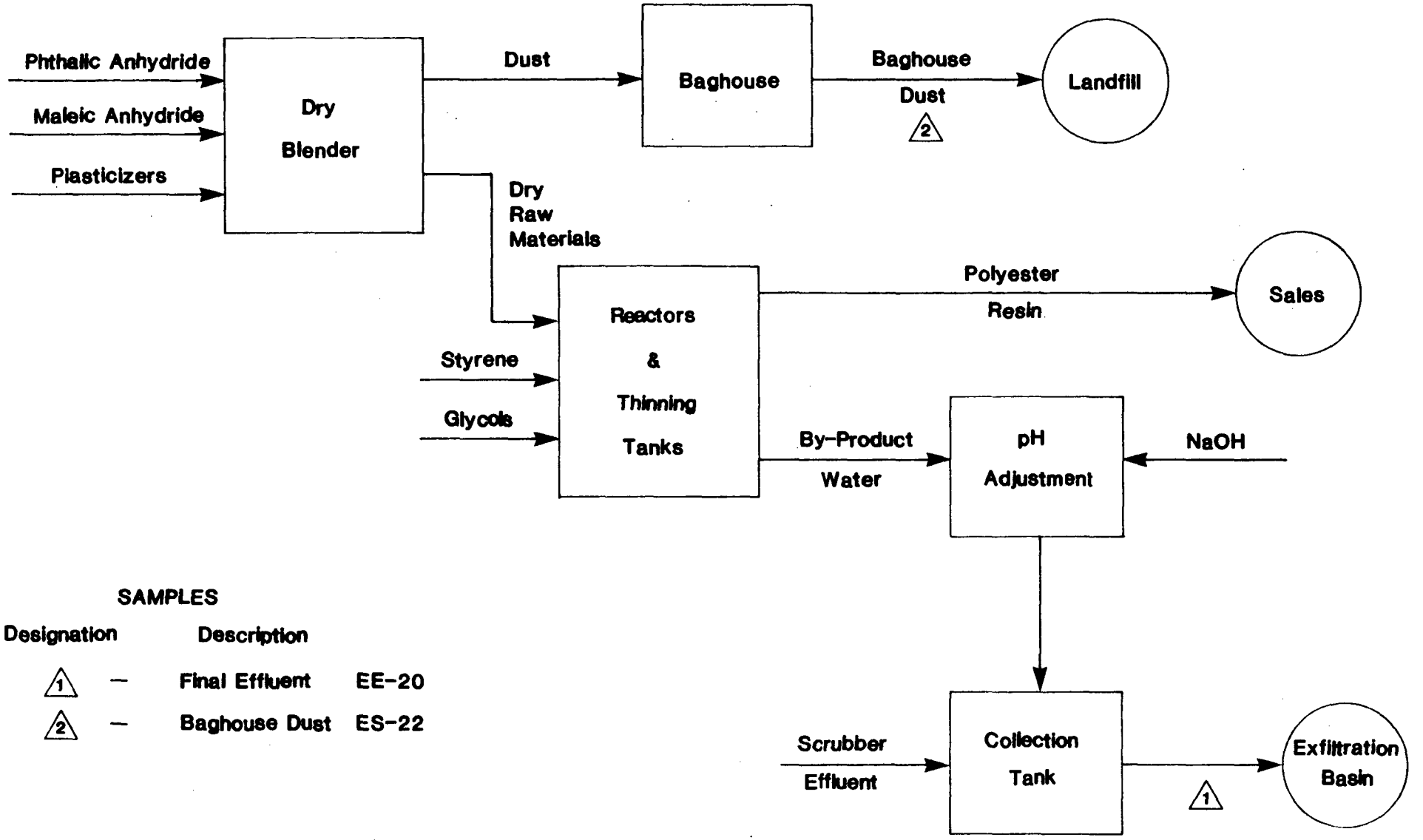
Plant E manufactures polyester resins utilized for the manufacture of fiberglass products. The basic polyester process involves catalytic polymerization of dialcohols and either dicarboxylic acids or anhydrides. Reference should be made to the general literature for more detailed information on the production of polyester resin. Technical information on polyester resin was derived in part from Reference (4). The basic raw materials include:

- propylene glycol
- diethylene glycol
- ethylene glycol
- maleic anhydride
- phthalic anhydride
- isophthalic acid
- adipic acid

Additives utilized include solvents, antioxidants, pigments, fillers, plasticizers. A list of potential waste components from polyester manufacture is provided in Table 12. This list is not comprehensive and is not necessarily representative of the discharge from Plant E. The dry reactants and additives are blended and then charged to batch reactors along with the liquid reactants. The reactors are purged with nitrogen to prevent oxidation. The contents are heated and mixed during the polymerization process.

The polymerization reaction involves dehydration and subsequent production of vapour which contains water and other volatile organic compounds. This vapour is drawn from the reactor and condensed continually into a liquid.

This condensed liquid containing mainly by-product water is stripped from the exit gases and discharged to a tank. This waste water contains diacids used in the polymerization which are neutralized using sodium hydroxide. After pH adjustment the by-product water discharges to an underground storage tank. Collected wastewater is pumped from this tank into a tank truck for ultimate disposal to an exfiltration lagoon which is separate from the plant site.



PLANT E – POLYESTER RESIN PROCESS SCHEMATIC FIGURE 6

TABLE 12

POTENTIAL WASTE COMPONENTS FROM
POLYESTER RESIN MANUFACTURE

styrene

o-phthalic anhydride

propylene glycol

maleic anhydride

diethylene glycol

adipic acid

dibutyltin oxide

diethylanaline

dimethyl analine

dipropylene glycol

methylene chloride

triethyl phosphate

Approximately 4.5 m^3 of wastewater is discharged on a batch basis every 12 days. Annual discharge volume is approximately 285 m^3.

Dust generated during weighing, blending and reactor loading is filtered by a baghouse. The collected dust is sent to local landfill every 3 - 4 months. Annual dust volume generated for disposal is approximately 0.45 m^3.

The only other waste material generated is a sludge which accumulates in the open collection troughs. This material is removed annually during turnaround with an approximate annual volume of 0.3 m^3.

A schematic of the polyester resin manufacturing process at Plant E is provided in Figure 6.

7.2 SAMPLE DESCRIPTION - PLANT E

7.2.1 Final Effluent

This sample was a grab collected from the tank truck during discharge to the exfiltration lagoon. This sample would be fairly representative of 1-2 weeks of operation. The sample was clear, colourless and slightly viscous with a noticeable solvent odour. The standard analytical characteristics as listed in Table E-1 indicate that the sample had a high pH and a high COD and TOC. The organic characteristics as listed in Table E-2 indicate the organic components consisted of major amounts of unidentified aldehydes and ketone, plus relatively high concentrations of styrene, acetone, propionaldehyde and methanol plus minor amounts of acetaldehyde, glycols and phthalic acid.

7.2.2 Baghouse Dust

This sample was collected from a drum containing dust discharged from the baghouse. The sample was a white powder. The conventional analytical results (Table E-3) indicate that the material has a high TVR relative to TR and minor amounts of metal. The organic characteristics Table E-4 indicate that the sample contains a major amount of phthalic acid plus a relatively high concentration of diethylene glycol.

7.2.3 Collection Trough Sludge

This sample was collected from the open floor drain and is representative of the material collected during annual turnaround. The sample had the appearance of polymerized material. The conventional analytical results (Table E-3) indicate the material is mainly volatile organic matter with minor amounts of metal. The organic analyses detected minor amounts of diethyl aniline, phthalic acid and diphenyl ether (Table E-4).

7.3. PRIORITY CHEMICALS - PLANT E

7.3.1. Phthalic Acid Esters

Bis (2-ethyl hexyl) phthalate was detected at a low level in the effluent sample. All other phthalates were below detection limit in the effluent. Di-n-butyl and bis (2-ethyl hexyl) phthalate were detected in both the collection trough sludge and the baghouse dust. Small amounts of both compounds transferred to the leachate during the SWEP test (Table E-6).

7.3.2 Aromatic Amines

A low level of diethyl aniline was detected in the effluent sample. A measurable amount was evident in the baghouse dust, but below detection limit in the collection trough sludge.

7.4 MAJOR COMPONENTS - PLANT E

7.4.1 Solvents

Solvents encountered in the effluent sample in significant concentrations were acetone, methanol, propionaldehyde, styrene, acetaldehyde, plus a major amount of unidentified aldehydes and ketone (Table E-2). The effluent sample TOC was 15,900 mg/L, while total concentration of organic compounds identified, excluding unidentified aldehydes and ketones, was 1914 mg/L,

indicating that a significant amount of the sample remains unidentified. The aldehydes and ketones could not be identified or quantified using GC due to sample complexity.

7.4.2. Toxicity

The effluent samples were very toxic to fish with an LT_{50} value less than 0.08 hr. This toxicity would be primarily due to the significant concentration of solvents in the sample.

7.5 VOLUMETRIC AND MASS LOADING - PLANT E

Estimated volumetric and organic mass loadings are presented in Table 13. Mass loading estimates should be utilized for comparative purposes only, since they are based on single samples collected during the site visit.

7.6 SUMMARY AND RECOMMENDATIONS - PLANT E

The effluent contained significant concentrations of different solvents and was very toxic to fish. The solvents encountered in general are biodegradable in dilute concentrations. However a major concern is whether these compounds are presently being removed prior to the treated effluent reaching the groundwater. Therefore it is recommended that the treatment and disposal operation be investigated to determine the fate of the organic components in the wastewater and to trace the movement from the exfiltration pond to the groundwater to ensure that contamination of groundwater is not taking place.

TABLE 13 - VOLUMETRIC AND MASS LOADINGS - PLANT E

Sample		Discharge Frequency	Quantity	Daily Flowrate m^3	Disposal Method	Organic Waste Components	Mass Loadings kg/yr
Final Effluent	EE-20	5 days	4.2 m^3	0.8	Exfiltration	Phthalates	0.006
						Unidentified Aldehydes and Ketones	Major
						Acetone	173
						Styrene	142
						Propionaldehyde	130
						Methanol	76
						Acetaldehyde	10.2
						Dipropylene Glycol	4.8
						Phthalic Acid	3.6
						Diethylene Glycol	1.5
						TOC	4515
						COD	12354
Sludge	ES-21	Annual	0.32m^3	0.0009	Landfill	Phthalates	0.005
						Phthalic Acid	0.02
						Diethyl Aniline	0.007
						Diphenyl Ether	0.013
Baghouse Dust	ES-22	Every 3-4 months	0.13m^3	0.001	Landfill	Phthalates	0.012
						Phthalic Acid	15.3
						Diethylene Glycol	1.4

ANALYTICAL RESULTS

CONVENTIONAL AND ORGANIC ANALYSES

PLANT E

TABLE E-1

SIGMA ENGINEERING LTD.
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSE1C
Latest Rev: 24-Oct-85

PLANT E **** EFFLUENTS ****

Item	Description	Unit	Detection Limit	Final Effluent
A	DATE SAMPLED			Mar 11/85
B	SAMPLE DESIGNATION			EE-20
C	CONSTITUENTS			
	pH	n.a.	n.a.	9.9
	COD	mg/l	20	43500
	Chloride (Cl)	mg/l	0.5	34
	Colour	Units	5	>100
	Conductivity	umhos/cm	1	3400
	Fluoride (F)	mg/l	0.05	0.18
	Nitrate (N)	mg/l	0.005	0.02
	Nitrite (N)	mg/l	0.005	0.024
	Non-Filterable Residue	mg/l	5	131
	Oils & Grease	mg/l	2	101
	P. Alk. as CaCO3	mg/l	1	286
	Phenols	mg/l	0.02	0.25
	Sulphate (SO4)	mg/l	1	35
	T - N		0.03	L
	T. Alk. as CaCO3	mg/l	1	1260
	T.O.C.	mg/l	1	15900
	Total PO4 (P)	mg/l	0.005	0.17
	Total Residue	mg/l	5	6000
	Turbidity	FTU	1	44

TABLE E-1

SIGMA ENGINEERING LTD.
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSE1C
Latest Rev: 24-Oct-85

PLANT E **** EFFLUENTS ****

Item	Description		Unit	Detection Limit	Final Effluent
A	DATE SAMPLED				Mar 11/85
B	SAMPLE DESIGNATION				EE-20
D	METALS - ICP Scan				
	Arsenic	-As	ug/ml	0.05	0.05
	Boron	-B	ug/ml	0.001	0.879
	Barium	-Ba	ug/ml	0.001	0.01
	Beryllium	-Be	ug/ml	0.001	L
	Cadmium	-Cd	ug/ml	0.002	L
	Cobalt	-Co	ug/ml	0.005	0.144
	Chromium	-Cr	ug/ml	0.005	0.009
	Copper	-Cu	ug/ml	0.005	0.142
	Manganese	-Mn	ug/ml	0.001	0.121
	Molybdenum	-Mo	ug/ml	0.005	L
	Nickel	-Ni	ug/ml	0.02	L
	Phosphorus	-P	ug/ml	0.05	0.08
	Lead	-Pb	ug/ml	0.02	0.04
	Antimony	-Sb	ug/ml	0.05	L
	Selenium	-Se	ug/ml	0.05	L
	Tin	-Sn	ug/ml	0.01	0.35
	Stontium	-Sr	ug/ml	0.001	0.076
	Titanium	-Ti	ug/ml	0.002	0.013
	Vanadium	-V	ug/ml	0.005	L
	Zinc	-Zn	ug/ml	0.002	0.37
	Aluminum	-Al	ug/ml	0.05	0.15
	Iron	-Fe	ug/ml	0.005	4.22
	Silicon	-Si	ug/ml	0.1	20.3
	Calcium	-Ca	ug/ml	0.1	10.5
	Magnesium	-Mg	ug/ml	0.1	9.5
	Sodium	-Na	ug/ml	0.1	1060
	Hardness	-Ca,Mg	ug/ml		65.3
	Hardness	-Total	ug/ml		74.5
	Mercury	-Hg	ug/ml	0.00005	0.00011
E	BIOASSAY				
	96 HOUR LT 50		hour		<0.08

TABLE E-2

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMeet
Latest revision: 15-Nov-85

PLANT E **** EFFLUENT (TOTAL) ****

Item	Description	Unit	Detection Limit	Final Effluent
A	DATE SAMPLED			Mar 11/85
B	ASL SAMPLE #			1630-20
C	SIGMA SAMPLE #			EE-20
D	ORGANIC COMPONENTS			
	Dimethyl Phthalate	mg/L	0.01	L
	Diethyl Phthalate	mg/L	0.01	L
	Di-n-butyl Phthalate	mg/L	0.001	L
	Butyl Benzyl Phthalate	mg/L	0.001	L
	Bis (2-Ethyl Hexyl) Phthalate	mg/L	0.001	0.022
	Di-n-octyl Phthalate	mg/L	0.001	L
	Acetaldehyde	mg/L	0.5	36
	Acetone	mg/L	0.5	610
	Methanol	mg/L	0.5	270
	Propionaldehyde	mg/L	0.5	460
	Styrene	mg/L	0.2	500
	Diethylene Glycol	mg/L	0.01	5.4
	Dipropylene Glycol	mg/L	0.01	17
	Diethyl Aniline	mg/L	0.05	0.32
	Diphenyl Ether	mg/L	0.005	1.3
	Phthalic Acid	mg/L	0.01	13
	Benzoic Acid	mg/L	0.01	1.5
	Unidentified Aldehydes & Ketones		NA	*major*
	Parameters Below Detection Limits:			
	1-Phenyl-1,2-Ethanediol	mg/L	0.01	
	Benzene	mg/L	0.2	
	Ethanol	mg/L	0.5	
	Ethylbenzene	mg/L	0.2	
	Methyl Ethyl Ketone	mg/L	0.5	
	Methyl Isobutyl Ketone	mg/L	0.5	
	Toluene	mg/L	0.2	
	Xylenes	mg/L	0.2	

TABLE E-3

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSE2C
Latest Rev: 24-Oct-85

PLANT E **** SLUDGE ****

Item	Description	Unit	Detection Limit	Collection Trough Sludge		Baghouse Dust	
A	DATE SAMPLED			Mar 11/85	Mar 11/85	Mar 11/85	Mar 11/85
B	SAMPLE DESIGNATION			ES-21	ES-21	ES-22	ES-22
C	REPLICATES			A	B	A	B
D	CONSTITUENTS						
	Total Residue	mg/kg		277,000		852000	
	Total Volatile Residue	mg/kg		256,000		790,000	
	Oils & Grease	mg/kg		42,700		50,300	
E	METALS - ICP Scan						
	Arsenic -As	ug/g	8	L	L	L	L
	Barium -Ba	ug/g	0.2	19.1	11.3	0.8	0.9
	Beryllium -Be	ug/g	0.2	L	L	L	L
	Cadmium -Cd	ug/g	0.3	1.3	1.2	L	L
	Cobalt -Co	ug/g	0.8	93.3	91.9	4.8	1.4
	Chromium -Cr	ug/g	0.8	34.6	11.2	L	L
	Copper -Cu	ug/g	0.8	59.7	39.8	L	L
	Manganese -Mn	ug/g	0.2	44	35.5	9.9	10.5
	Molybdenum -Mo	ug/g	0.8	L	L	L	L
	Nickel -Ni	ug/g	3	11	4	L	L
	Phosphorus -P	ug/g	8	64	58	L	L
	Lead -Pb	ug/g	3	109	47	3	3
	Tin -Sn	ug/g	2	323	332	24	23
	Strontium -Sr	ug/g	0.2	9.6	9.5	0.3	0.3
	Titanium -Ti	ug/g	0.3	80.6	59.4	14.3	18.6
	Vanadium -V	ug/g	0.8	3.7	2.4	L	L
	Zinc -Zn	ug/g	0.3	126	131	12.6	18.9
	Aluminum -Al	ug/g	8	1240	826	100	64
	Iron -Fe	ug/g	80	6340	4570	92.9	113
	Silicon -Si	ug/g	20	1820	1740	1970	2170
	Calcium -Ca	ug/g	20	1820	1780	20	L
	Magnesium -Mg	ug/g	20	670	570	L	L
	Sodium -Na	ug/g	20	2140	1990	110	50

TABLE E-4

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - ASL LTD.

Program name: CHEMest
Latest revision: 15-Nov-85

PLANT E **** SLUDGE (TOTAL) ****

Item	Description	Unit	Detection Limit	Collection Tank Sludge	Baghouse Dust
A	DATE SAMPLED			Mar 11/85	Mar 11/85
B	ASL SAMPLE #			1630-21	1630-22
C	SIGMA SAMPLE #			ES-21	ES-22
D	ORGANIC COMPONENTS				
	Dimethyl Phthalate	ug/g	0.5	L	L
	Diethyl Phthalate	ug/g	0.5	L	L
	Di-n-butyl Phthalate	ug/g	0.05	8.8	19.9
	Butyl Benzyl Phthalate	ug/g	0.05	L	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.05	5.6	12.8
	Di-n-octyl Phthalate	ug/g	0.05	L	L
	Diethylene Glycol	ug/g	1	L	3900
	Diethyl Aniline	ug/g	5	23	L
	Diphenyl Ether	ug/g	0.5	42	L
	Phthalic Acid	ug/g	1	72	43000
	Benzoic Acid	ug/g	1	1	47
	Parameters Below Detection Limits:				
	1-Phenyl-1,2-Ethanediol	ug/g	1		
	Dipropylene Glycol	ug/g	1		

TABLE E-5

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSE3C
Latest Rev: 15-Nov-85

PLANT E **** LEACHATE ****

Item	Description		Unit	Detection Limit	Collection Tank Sludge Leachate	Baghouse Dust Leachate
A	DATE SAMPLED				Mar 11/85	Mar 11/85
B	SAMPLE DESIGNATION				ESL-21	ESL-22
C	REPLICATES				A	A
D	CONSTITUENTS					
	T.O.C.		ug/g	20	5500	66000
	T.I.C.		ug/g	20	0	40
	Phenols		ug/g	0.4	1	1.2
	Oils & Grease		ug/g	40	420	1200
E	METALS - ICP Scan					
	Arsenic	-As	ug/g	1	L	L
	Boron	-B	ug/g	0.02	0.33	0.38
	Barium	-Ba	ug/g	0.02	0.44	0.32
	Beryllium	-Be	ug/g	0.02	L	L
	Cadmium	-Cd	ug/g	0.04	0.35	L
	Cobalt	-Co	ug/g	0.1	5.13	2.52
	Chromium	-Cr	ug/g	0.1	L	0.24
	Copper	-Cu	ug/g	0.1	1.01	5.16
	Manganese	-Mn	ug/g	0.02	1.86	5.28
	Molybdenum	-Mo	ug/g	0.1	L	L
	Nickel	-Ni	ug/g	0.4	L	L
	Phosphorus	-P	ug/g	1	L	L
	Lead	-Pb	ug/g	0.4	L	0.8
	Antimony	-Sb	ug/g	1	L	L
	Selenium	-Se	ug/g	1	L	L
	Tin	-Sn	ug/g	0.2	0.17	15.8
	Stontium	-Sr	ug/g	0.02	1.2	0.06
	Titanium	-Ti	ug/g	0.04	0.49	L
	Vanadium	-V	ug/g	0.1	L	L
	Zinc	-Zn	ug/g	0.04	7.41	9.46
	Aluminum	-Al	ug/g	1	0.9	L
	Iron	-Fe	ug/g	0.1	7.01	9.58
	Silicon	-Si	ug/g	2	134	52
	Calcium	-Ca	ug/g	2	311	16
	Magnesium	-Mg	ug/g	2	47	L
	Sodium	-Na	ug/g	2	642	6
	Hardness	-Ca,Mg	ug/g		976	33.6
	Hardness	-Total	ug/g		1010	77.4

TABLE E-6

SIGMA RESOURCE CONSULTANTS — Program name: CHEMesl
WASTE CHARACTERIZATION STUDY — Latest revision: 15-Nov-85
ANALYTICAL RESULTS - ASL LTD.

PLANT E **** SLUDGE (LEACHATE) ****

Item	Description	Unit	Detection Limit	Collection Tank Sludge Leachate	Baghouse Dust Leachate
A	DATE SAMPLED			Mar 11/85	Mar 11/85
B	ASL SAMPLE #			1630-21	1630-22
C	SIGMA SAMPLE #			ESL-21	ESL-22
D	ORGANIC COMPONENTS				
	Dimethyl Phthalate	ug/g	0.2	L	L
	Diethyl Phthalate	ug/g	0.2	L	L
	Di-n-butyl Phthalate	ug/g	0.02	0.32	1.3
	Butyl Benzyl Phthalate	ug/g	0.02	L	L
	Bis (2-Ethyl Hexyl) Phthalate	ug/g	0.02	0.93	1.3
	Di-n-octyl Phthalate	ug/g	0.02	L	L
	Acetone	ug/g	10	200	L
	Methanol	ug/g	10	160	L
	Styrene	ug/g	4	2800	L
	Diethylene Glycol	ug/g	0.2	0.46	2700
	Diethyl Aniline	ug/g	1	18	130
	1-Phenyl-1,2-Ethanediol	ug/g	0.2	5.3	L
	Diphenyl Ether	ug/g	0.05	0.33	L
	Phthalic Acid	ug/g	0.2	61	29000
	Benzoic Acid	ug/g	0.2	26	35
	Parameters Below Detection Limits:				
	Acetaldehyde	ug/g	10		
	Benzene	ug/g	4		
	Dipropylene Glycol	ug/g	0.2		
	Ethanol	ug/g	10		
	Ethylbenzene	ug/g	4		
	Methyl Ethyl Ketone	ug/g	10		
	Methyl Isobutyl Ketone	ug/g	10		
	Propionaldehyde	ug/g	10		
	Toluene	ug/g	4		
	Xylenes	ug/g	4		

8. CLASSIFICATION OF WASTES WITH RESPECT TO TRANSPORTATION OF DANGEROUS GOODS REGULATIONS

The Ministry of Transport has recently made effective new regulations pursuant to the Transportation of Dangerous Goods Act. These regulations, in part, serve to describe the classification of dangerous goods and the safety standards under which they are to be transported in Canada. The act applies primarily to hazardous chemicals, products, formulations and wastes that can be classified into the following major categories.

Class 1 - Explosives
Class 2 - Gases
Class 3 - Flammable Liquids
Class 4 - Flammable Solids; substances liable to spontaneous combustion; substances that on contact with water emit flammable gases
Class 5 - Oxidizing substances and organic peroxides
Class 6 - Poisonous (toxic) (6.1) and infectious substances (6.2)
Class 7 - Radioactive materials
Class 8 - Corrosives
Class 9 - Miscellaneous products or substances, including environmental hazards, dangerous wastes and other substances deemed hazardous.

Criteria are set out in the regulations for each of the above classifications. The regulations also provide for classification of diluted dangerous goods, such that environmentally hazardous and dangerous goods that are primarily considered to be in Class 2 to 6.1 or Class 8, are still considered environmentally hazardous when so diluted so that they do not meet the criteria for the primary classifications.

The wastes generated by the five plants under investigation in this study were each evaluated using the criteria provided in the regulations to establish their classification in accordance with the Transportation of Dangerous Goods Act.

These evaluations should only be considered preliminary as further testing would have to be carried out to determine flammability, toxicity and environmental impact.

The wastes that can be classified according to the regulations are as follows:

Plant	Sample	Shipping Name	Product Identification Number	Class
A	AS-5	Waste Type 3	9303	3.1
C	CS-16	Waste contaminated with organotin compounds	-	9.2
E	EE-20	Waste contaminated with styrene	-	9.2
E	ES-21	Waste contaminated with styrene	-	9.2

The regulations do not appear to be applicable to all other waste samples evaluated. However, the environmental significance of the priority chemicals and other substances detected in these samples would have to be determined in order to make a final judgement.

REFERENCES

(1) ENVIRONMENTAL PROTECTION AGENCY, **"Guidelines Establishing Test Procedures for the Analysis of Pollutants under the Clean Water Act",** 40 CFR Part 136, Oct. 26, 1984.

(2) CHARLES R MARTENS, **Emulsions and Water - Soluble Paints and Coating,** Reinhold Publishing Corp. 1964.

(3) H R PREUSS, **Paint Additives,** Noyes Data Corp. 1970.

(4) WALTER E DRIVER, **Plastics Chemistry and Technology,** Van Nostrand Reinhold, 1979.

(5) K VERRCHUEREN, **Handbook of Environmental Data on Organic Chemicals.**

(6) P KRAHN, **Internal EPS Plant Dossier Reports.**

APPENDIX A

A.1. ANALYTICAL METHODOLOGY

A.2 SPECIAL WASTE EXTRACTION PROCEDURE

A.3 GAS CHROMATOGRAPHY / MASS SPECTROMETRY ANALYSIS

A.4 QUALITY ASSURANCE PROGRAM

APPENDIX A

A.1. ANALYTICAL METHODOLOGY

A.1.1 GENERAL

The details of the analytical methodology are presented in the following sections. The analysis of all liquid and the majority of solid wastes was performed on a total or total extractable basis. In addition, all of the sludges and solid wastes were subjected to a leaching test followed by a total analysis of the leachate solution. The methods described are broken down into categories based on the various analytical groups.

All gas chromatography analyses were carried out using a Hewlett-Packard Model 5890 Gas Chromatograph coupled to a Hewlett-Packard Model 3392 Printer/Plotter Integrator. Details of the chromatographic conditions are presented in the relevant sections. All solvents used were of pesticide-grade (MCB Omnisolv). All other reagents were of reagent grade or better.

A.1.2 CONVENTIONAL PARAMETERS AND METALS

A representative aliquot of each of the liquid and solid waste samples was removed from the samples obtained from each of the plants and sent to the Environmental Protection Service / Department of Fisheries and Oceans laboratory located in West Vancouver, British Columbia. All analyses for conventional wastewater parameters and major and trace metals were carried out by that laboratory according to the 1979 laboratory manual, as amended.

A.1.3 SOLVENTS

All liquid effluents were analyzed for solvent compounds.

The technique used involved direct injection of the aqueous sample onto a gas chromatographic column. A direct injection technique was used so that both

water miscible solvents such as alcohol and ketones and slightly water soluble solvents such as toluene and benzene could be analyzed in a single analysis. This method also had the advantage of eliminating a number of factors that would affect the analyses using other techniques such as head space or liquid-liquid extraction.

The gas chromatographic column used was a 10 ft x 1/8" O.D. (4 mm I.D.) stainless steel column packed with 3% SP 1500 on 80/120 mesh Carbopack B. (Supelco).

The chromatographic conditions were as follows:

Temperatures	- Oven	: 70°C - 230°C at 4°C/min, hold for 5 min.
	- Injector	: 225°C
	- Detector	: 275°C
Column Flow		: 30 ml/min (Helium)
Attenuation		: 16
Range		: 1
Injection Volume		: 2 UL

Detection was carried out using a flame-ionization detector.

Calibration of the instrument and column for each compound with respect to retention time and detector response was achieved by injection of standard solutions prepared from pure reference materials. Water miscible compounds were dissolved in reagent grade (Milli-Q) water and diluted to various concentrations. Water immiscible solvents were first dissolved in methanol and then diluted with reagent grade water to the appropriate concentrations.

A.1.4 BASE NEUTRAL AND ACID FRACTIONS

Both liquid and solid samples were subjected to a generalized base-neutral and acid fraction extraction.

A generalized extraction was used such that the majority of the compounds present would be extracted. These extracts could then be used for the following purposes:

- to determine the complexity of the samples in terms of organic compounds present;
- to allow for comparisons between wastes within a plant and between different plants;
- to establish criteria for choosing extracts for subsequent analysis by gas chromatography/mass spectrometry;
- to allow quantitation of the identified compounds.

The extraction procedure generally followed that of the United States Environmental Protection Agencies priority pollutant analysis (1). Three deviations were made from the published procedure. Both the sample volume and consequently the solvent volume were less than recommended. In addition, concentration of the extract was carried out on a rotary flash evaporator rather than a Kuderna-Danish evaporative concentrator. Water samples were extracted on a total extractable basis. A 150 mL aliquot of the sample was adjusted to pH 12 with 10N sodium hydroxide. The sample was then separatory funnel extracted with 50 ml of dichloromethane. The solvent layer was then filtered through anhydrous sodium sulphate and glass wool into a 250 ml round bottom flask. The extraction was then repeated a second and third time with further 50 ml aliquots of dichlormethane. The aqueous layer was retained. The extracts were combined and then evaporated and concentrated using a rotary flash evaporator. Evaporation was carried out to near dryness. The resulting extract was then reconstituted in 5.0 ml of dichloromethane and transferred to a glass vial. This was labelled as the "base-neutral fraction".

The retained aqueous portion was then adjusted to pH 2 with sulphuric acid (1 + 1). Extractions were then carried out as with the base-neutral fraction using three 50 mL aliquots of dichlormethane. The resulting extract was labelled as the "acid fraction".

Solids samples were extracted in a similar manner except for a number of modifications made to accommodate the matrix. A representative portion of the sample was weighed into a 250 ml Erlenmeyer flask. Fifty ml of dichloromethane was added and the flask was sealed with precleaned aluminum foil and placed on a wrist action shaker and agitated for one hour. The residue was allowed to settle and the solvent decanted and filtered through anhydrous sodium sulphate and glass fibre filter paper (934 AH) into a second Erlenmeyer flask. A second 50 ml portion of dichloromethane was added to the extraction flask and agitated for one hour. The solvent was decanted and filtered and combined with the first extraction. Both the residue in the extraction flask and the sodium sulphate/glass fibre filter were washed three times with 5 ml dichloromethane. One-half of the combined extract was then placed in a 250 ml separatory funnel. The extract was washed with two 50 ml portions of dilute sodium hydroxide (0.2N). The dichloromethane layer was then drawn off and filtered through anhydrous sodium sulphate and glass wool. This extract was then concentrated using a rotary flash evaporator and reconstituted in 5.0 ml dichloromethane. This extract was labelled as the "base-neutral fraction". The aqueous wash was then adjusted to pH 2 with sulphuric aid (1 + 1) and extracted with two 50 ml portions of dichloromethane. This extract was filtered, concentrated, reconstituted and labelled as the "acid fraction"

The extracts were then analyzed by capillary column gas chromatography. Both base-neutral and acid fractons were analyzed under identical conditions. The column used was a 25 meter by 0.31 millimeter I.D. fused silica capillary column coated with crosslinked 5% phenyl methyl silicone (Hewlett-Packard High Performance). The chromatographic conditions were as follows:

Temperatures to	- Oven	: 60°C, hold for 0.5 minute then 8°C/minute 270°C, hold for 15 minutes
	- Injector	: 225°C
	- Detector	: 275°C
Linear Velocity		: 30 cm/sec. (Helium)
Column Head Pressure		: 80 kPa
Injection Mode		: Splitless, 2.0 UL injection
Attentuation		: 16
Range		: 1

Detection was carried out using a flame ionization detector.

A.1.5 PHTHALIC ACID ESTERS

Phthalate ester compounds were determined by a modification of the US E.P.A. Method 606. For liquid samples, a 150 ml aliquot of sample was extracted with three 50 ml portions of dichloromethane. The resulting extracts were filtered through anhydrous sodium sulphate and glass wool and combined in a 250 ml round bottom flask. The extracts were then concentrated to just dryness on a rotary flash evaporator, reconstituted in 5.0 ml iso-octane and transferred to a glass vial.

For solids samples a portion of the crude dichloromethane extract was evaporated to just dryness on a rotary flash evaporator and reconstituted with 5.0 ml iso-octane. The resulting extract was then transferred to a glass vial.

Analysis of the extracts was carried out using capillary column gas chromatography with electron capture detection. The column used was as per the analysis of the base-neutral and acid fractions. The chromatographic conditions were as follows:

Temperatures to	- Oven	: 60°C, hold for 0.5 minute then 8°C/minute 270°C, hold for 2minutes
	- Injector	: 200°C
	- Detector	: 325
Linear Velocity		: 30 cm/sec. (Helium)
Column Head Pressure		: 80 kPa
Injection Mode		: Splitless, 2 UL injection
Attentuation		: 256
Range		: 1

Six representative phthalate esters were used to calibrate the instrument:

- dimethyl phthalate
- diethyl phthalate
- di-n-butyl phthalate
- di-n-octyl phthalate
- bis (2-ethylhexyl) phthalate
- butyl benzyl phthalate

These compounds were chosen as they are included in the US E.P.A. priority pollutant list.

A.1.6 CHLORINATED PHENOLS

Chlorinated phenols were determined by a modification of the US E.P.A. Method 604. For liquid samples a 150 ml aliquot of the sample was acidified to pH 2 with sulphuric acid (1 + 1) and extracted by liquid - liquid separatory funnel extraction using three 50 ml aliquots of dichlorometane. The extracts were filtered through anhydrous sodium sulphate and glass wool and combined in a 250 ml round bottom flask. The extract was then concentrated to just dryness, and reconstituted in 5.0 ml iso-octane and transferred to a glass vial. For solids samples a portion of the crude dichloromethane extract was evaporated to just dryness, reconstituted in 5.0 ml iso-octane and transferred to a glass vial.

Analysis of the extracts was carried out using gas chromatography with electron capture detection. The column used was a 5 meter by 0.53 mm I.D. fused silica wide-bore column coated with methyl silicone (Hewlett Packard Mega-bore). The chromatographic conditions were as follows:

Temperatures	- Oven	: 50°C, hold for 0.5 minute then 40°/minute to 180°C, then 2°C/min to 200°C
	- Injector	: 200°C
	- Detector	: 325
Carrier Gas Flowrate		: 12 ml/min
Injection Mode		: Splitless, 2 UL injection
Attenuation		: 256
Range		: 2

A.1.7 TRI-ARYL PHOSPHATES AND CHLORINATED PARAFFINS

The analysis for these groups of parameters was carried out on the extracts generated for the phthalate ester analysis. Analysis for the tri-aryl phosphates was performed using gas chromatography with flame ionization detection. The chromatographic conditions were identical to those used for base-neutral fraction analysis. Tri-phenyl phosphate and tri-cresyl phosphate were used to calibrate the instrument.

Analysis for chorinated paraffins was performed using gas chromatography with electron capture detection.

A.1.8 BIOASSAY

Effluent samples from each plant were submitted to the Bioassay Laboratory of the Environemntal Protection Service, North Vancouver for bioassay determination. The static bioassay test involved determination of 96 hr LT_{50} which can be defined as the time required to kill 50% of the test species when exposed to an undiluted sample. Test procedures follow the BC Guidelines, titled **"Laboratory Procedures for Measuring Acute Lethal Toxicity of Liquid Effluent to Fish"**, November 1982.

A.2. SPECIAL WASTE EXTRACTION PROCEDURE

All solid wastes were subjected to a test to determine the extent of leaching of organic compounds and conventional anions and cations from the solids matrix. The method used was that of the BC Ministry of the Environment Special Waste Extraction Procedure (SWEP) which is modelled after the US E.P.A. procedure. This test is used to simulate conditions in sanitary landfills by mixing a portion of the solid waste with water at a slightly acid pH for a period of 24 hours. One major modification was made to the published procedure in that dilute sulphuric acid was used to adjust the pH rather than the prescribed dilute acetic acid. This modification was made to facilitate the analysis of the leachate solution for total organic carbon, chemical oxygen demand and to eliminate possible interferences in the analyses of other organic parameters.

Specifically the procedure was as follows. Approximately 100 grams of solid waste material (de-watered where required) was accurately weighed and placed in a 1 litre glass container. Beakers were used for the majority of samples, except where it was suspected that the material could contain volatile solvents in which case Erlenmeyer flasks were used. To each sample was then added 1600 ml of reagent grade (Milli-Q) water.

Agitation of the mixture was the undertaken using a paddle mixer for samples contained in beakers and magnetic stirrers for samples contained in flasks. The top of each flask was covered in aluminum foil to avoid losses of volatile components.

The agitation was carried out for a period of 24 hours during which the pH of the suspension was monitored and adjusted down to pH 5.0 with 0.1 N sulphuric acid when necessary. Where the pH was below 5.0 no adjustment up to pH 5.0 was made. At the end of the 24 hour period reagent grade water was added to the mixture to bring the total volume of liquid (including added acid) up to 2000 ml. The mixture was then filtered through a 0.45 u membrane filter. The resulting leachate solution was analyzed for the organic parameters of interest as well as conventional parameters and metals. Extractions and analyses for organic parameters were carried out as for liquid waste samples.

A.3. GAS CHROMATOGRAPHY/MASS SPECTROMETRY ANALYSIS

A selected number of the base-neutral and acid fraction extracts were also analyzed by gas chromatography/mass spectrometry (GC/MS). All GC/MS analyses were performed by Enviro-Test Laboratories of Edmonton, Alberta, using a Hewlett-Packard Model 5993A system. Each of the base-neutral extracts were subjected to a target compound search for the base-neutral and polycyclic aromatic hydrocarbon parameters in the US E.P.A. priority pollutant list. The acid extracts were subjected to a target search for the acidic parameters (phenols) on the priority pollutant list. The spectral data obtained on the extracts analyzed was also searched through an extensive library (National Bureau of Standards) of over 25,000 mass spectra to facilitate identification of the major components.

All raw data obtained from the GC/MS analysis was investigated by ASL to allow for comparisons between samples and plants and to finalize identification of the major components of the wastes.

A.4. QUALITY ASSURANCE PROGRAM

Quality assurance is an integral part of the management of a laboratory and includes day to day procedures such as calibration of instruments, balances, glassware, and standards. Instruments and balances are checked and calibrated on a minimum daily basis with more frequent calibrations carried out during heavy use periods. All standards in use are checked against previous analyses to avoid degradation of standard quality. Glassware is cleaned and or rinsed with

appropriate acids, bases, solvents or reagent grade water. All final rinses are checked for contamination from the parameters of interest. Quality assurance samples (ie. blanks, duplicates, spikes, etc) are analyzed at pre-determined intervals concurrently with the samples. The type of quality assurance samples selected is greatly dependent upon the program in question. Details are discussed below.

For this project, the analysis for conventional parameters and metals was carried out by the Environmental Protection Service / Department of Fisheries and Oceans laboratory. Details of the quality assurance program undertaken in that laboratory would be well known by the Scientific Authority.

For the analysis of the organic parameters carried out by ASL, the quality assurance program was designed to accommodate the great variation in the sample matrices as well as addressing the intent of the study. The primary focus was on the extraction and analysis of blanks. Due to the nature of many of the parameters under investigation, that is industrial chemicals in common use and proven or potential environmental contaminants, it was felt that this was of utmost importance. The analysis of blanks allows a monitoring of any contribution from reagents used in the analysis or from other sources such as laboratory apparatus or the laboratory atmosphere. In addition, one particular group of compounds under study, the phthalate esters, are used extensively as plasticizers in many common polymeric materials. Blank samples, using reagent grade (milli-Q) water, were carried through every step of the extraction and analysis for each set of sample extractions.

Spiked samples were also analyzed where specific target groups of priority chemical compounds were investigated. In the analysis for phthalate esters, two representative compounds, di-ethylphthalate and di-n-octyl phthalate were added to reageant grade water at concentrations calculated to be at a level of 1 mg/L in the final extract at 100 percent recovery. For chlorinated phenol analysis a tetrachlorophenol isomer was used. It is recognized that spiking reagent grade water is not ideal as analyte recovery can be greatly affected by the sample matrix. However, due to the highly diverse nature of the sample matrices involved in this project, spiking of actual samples would not be representative of the group.

A number of duplicate analyses were also carried out. Two effluent, two sludge and two leachate solutions were analyzed in duplicate as a check on the precision of each of the analyses. Specifically samples AE-3, BE-9, BS-10, ES-21, ASL-5 and DSL-19 were analyzed. Results between duplicate pairs were found to agree very closely, however a statistical analysis was not performed. Chromatograms obtained on the sample extracts were essentially identical.

Calibration of the gas chromatograph with respect to detector response and column retention times was achieved by injection of standard solutions of the compounds of interest. The solutions were prepared from pure materials (obtained from various sources) dissolved in the appropriate nanograde solvent. Various concentrations were injected to monitor detector response and linearity. The standard solutions were injected a number of times during each day of analysis of the extracts in order to monitor any changes in detector performance and chromatographic column characteristics. Calculation of the concentrations of the compounds detected was achieved by comparison of the peak areas of the sample peaks versus the standard peaks. In some cases compounds were detected and identified by gas chromatography/mass spectrometry (GC/MS) but standards were not available. For these compounds quantitation was achieved by assuming a detector response for the identified compounds based on structural and functional similarities to available standards. This yielded a valid estimate of the concentration of the compound.

Blank samples were concurrently extracted and analyzed during the base-neutral and acid extract phase of the organic analyses. The chromatograms obtained showed no major or minor peaks occurring at retention times matching those of reported compounds.

However the presence of phthalate ester compounds in extracted blanks during that phase of the analyses was noted. The average levels found are shown in Table A1. These levels are insignificant when compared to those found in samples.

As mentioned previously, phthalate esters are used extensively as plasticizers in many polymer materials. The complete removal or absence of phthalate esters from laboratory glassware and reagents is very difficult to achieve.

The results of the spiking experiments are shown in Table A2. The recoveries achieved are in the range of seventy or eighty percent, which is generally considered acceptable for extraction of organic compounds from water.

Blanks carried through the SWEP procedure showed no signs of contamination or interference, with one exception. In one set of extractions, all samples (including the blank) were found to contain a low concentration of 2-propanol. This was traced to its use in the laboratory in an area adjacent to the SWEP extraction area. As the concentration in each leachate solution was identical, the presence of this solvent was eliminated. Results of the conventional analyses of the leachate blanks are presented in Table A3.

TABLE A1 - ANALYSIS OF METHOD BLANKS
FOR PHTHALATE ESTERS

COMPOUND	No. of Occurrences	Average Value (mg/L)
Dimethyl Phthalate	0	-
Diethyl Phthalate	1	0.001
Di-n-butyl Phthalate	5	0.002
Butyl benzyl Phthalate	3	0.002
Bis (2-Ethylhexyl) Phthalate	10	0.004
Di-n-Octyl Phthalate	2	0.001

NOTE: **Total Number of Blanks = 11**

TABLE A2 - RECOVERY OF SPIKED COMPOUNDS

COMPOUND	Spike Level mg/L	Average Recovery (%)	Standard Deviation
Diethyl Phthalate	1.0	85.0	11.5
Di-n-octyl Phthalate	1.0	78.2	11.0
Tetrachlorophenol	1.0	81.3	14.7

NOTE: **Number of Trials = 7**

TABLE A3

SIGMA RESOURCE CONSULTANTS
WASTE CHARACTERIZATION STUDY
ANALYTICAL RESULTS - LABORATORY SERVICES (EPS-DFO)

Program name: EPSBLC
Latest Rev: 25-Oct-85

**** LEACHATES-BLANKS ****

Item	Description	Unit	Detection Limit	Blank Leachate	Blank Leachate	Blank Leachate
A	DATE SAMPLED			Feb 19/85	Feb 25/85	Feb 25/85
B	SAMPLE DESIGNATION			!B-23	!B-24	!B-25
C	REPLICATES			A	A	A
D	CONSTITUENTS					
	T.O.C.	ug/g	20	L	L	L
	T.I.C.	ug/g	20	L	L	0
	Phenols	ug/g	0.4	L	L	L
	Oils & Grease	ug/g	40	L	L	140
E	METALS - ICP Scan					
	Arsenic -As	ug/g	1	L	L	L
	Boron -B	ug/g	0.02	L	L	0.1
	Barium -Ba	ug/g	0.02	0.04	L	0.02
	Beryllium -Be	ug/g	0.02	L	L	L
	Cadmium -Cd	ug/g	0.04	0.26	0.08	0.06
	Cobalt -Co	ug/g	0.1	L	L	L
	Chromium -Cr	ug/g	0.1	L	L	L
	Copper -Cu	ug/g	0.1	1.46	0.26	0.16
	Mercury -Hg	ug/g	0.001			
	Manganese -Mn	ug/g	0.02	0.04	L	0.02
	Molybdenum -Mo	ug/g	0.1	L	L	L
	Nickel -Ni	ug/g	0.4	L	L	L
	Phosphorus -P	ug/g	1	L	L	L
	Lead -Pb	ug/g	0.4	L	L	L
	Antimony -Sb	ug/g	1	L	L	L
	Selenium -Se	ug/g	1	L	L	L
	Tin -Sn	ug/g	0.2	L	L	L
	Strontium -Sr	ug/g	0.02	L	L	L
	Titanium -Ti	ug/g	0.04	L	L	L
	Vanadium -V	ug/g	0.1	L	L	L
	Zinc -Zn	ug/g	0.04	2.26	L	0.44
	Aluminum -Al	ug/g	1	2.4	L	L
	Iron -Fe	ug/g	0.1	0.84	0.26	0.22
	Silicon -Si	ug/g	2	L	L	L
	Calcium -Ca	ug/g	2	12	4	8
	Magnesium -Mg	ug/g	2	L	L	L
	Sodium -Na	ug/g	2	6	2	4
	Hardness -Ca,Mg	ug/g		37.6	15.2	20
	Hardness -Total	ug/g		56.6	18.4	21

LIST OF ABBREVIATIONS AND DEFINITIONS

CAOV	-	Chromic Acid Oxygen Value, equivalent to COD
COD	-	Chemical Oxygen Demand
GC	-	Gas Chromatography
ICP	-	Induction Coupled Plasma
L	-	Less than Detection Limit
LT_{50}	-	Lethal Time for 50% of Test Species
NA	-	Not applicable
N/A	-	Not Available
NT	-	Non-toxic
NFR	-	Nonfilterable Residue
n.p.i.	-	not positively identified
MS	-	Mass Spectrometry
T.I.C.	-	Total Inorganic Carbon
T.O.C.	-	Total Organic Carbon
T-N	-	Total Nitrogen
TR	-	Total Residue
TVR	-	Total Voletile Residue